3GPP TSG-RAN WG1 Meeting #110bis-e Draft R1-2210251

e-Meeting, 10th – 19th October 2022

**Agenda Item: 9.6.1**

**Title: FL summary #4 on Rel-18 RedCap UE complexity reduction**

**Source: Moderator (Ericsson)**

**Document for: Discussion, Decision**

# 1 Introduction

This feature lead (FL) summary (FLS) concerns the Rel-18 work item (WI) on enhanced support of reduced capability (RedCap) NR devices [1, 2]. This Rel-18 RedCap WI was preceded by Rel-17 RedCap WI [3, 4], a Rel-18 study item (SI) on further UE complexity reduction [5] and a RAN plenary discussion on the Rel-18 RedCap WI scope [6].

The core part of the WI [1] has the following objective and notes related to further reduced UE complexity:

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| **Complexity/cost reduction**   * Further reduced UE complexity in FR1 [RAN1, RAN2, RAN4]   + UE BB bandwidth reduction     - 5 MHz BB bandwidth only for PDSCH (for both unicast and broadcast) and PUSCH, with 20 MHz RF bandwidth for UL and DL     - The other physical channels and signals are still allowed to use a BWP up to the 20 MHz maximum UE RF+BB bandwidth.   + UE peak data rate reduction     - Relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for peak data rate reduction     - The relaxed constraint is, e.g., 1 (instead of 4).     - The parameters (*vLayers*, *Qm*, *f*) can be as in Rel-17 RedCap.   + Both 15 kHz SCS and 30 kHz SCS are supported.   + Aim to define at most one Rel-18 RedCap UE type for further UE complexity reduction.   + The existing UE capability framework is used, and changes to capability signalling are specified only if necessary. By default, all UE capabilities applicable to a Rel-17 RedCap UE are applicable unless otherwise specified.   Notes:   * The work defined as part of this WI is not to overlap with LPWA use cases. * Coexistence with non-RedCap UEs and Rel-17 RedCap UEs should be ensured. * This WI considers all applicable duplex modes unless otherwise specified.   Check in RAN#98-e regarding:   * Whether UE peak data rate reduction for UE is limited only with UE BB bandwidth reduction or standalone * Whether or not/how a separate early indication can be supported * Other restrictions of the WI (e.g., connectivity restrictions, band, etc.) |

This document summarizes contributions [7] – [35] submitted to agenda item 9.6.1 and the following email discussion:

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| [110bis-e-R18-RedCap-01] Email discussion on further UE complexity reduction by October 19 – Johan (Ericsson)   * Check points: October 14, October 19 |

The earlier FLSs are available in [36, 37, 38]. The issues in this document are tagged and color coded with High Priority or Medium Priority. The issues that are in the focus of this round of the discussion are furthermore tagged FL8.

Follow the naming convention in this example:

* *eRedCapFLS4-v000.docx*
* *eRedCapFLS4-v001-CompanyA.docx*
* *eRedCapFLS4-v002-CompanyA-CompanyB.docx*
* *eRedCapFLS4-v003-CompanyB-CompanyC.docx*

If needed, you may “lock” a discussion document for 30 minutes by creating a checkout file, as in this example:

* Assume CompanyC wants to update *eRedCapFLS4-v002-CompanyA-CompanyB.docx*.
* CompanyC uploads an empty file named *eRedCapFLS4-v003-CompanyB-CompanyC.checkout*
* CompanyC checks that no one else has created a checkout file simultaneously, and if there is a collision, CompanyC tries to coordinate with the company who made the other checkout (see, e.g., contact list below).
* CompanyC then has 30 minutes to upload *eRedCapFLS4-v003-CompanyB-CompanyC.docx*
* If no update is uploaded in 30 minutes, other companies can ignore the checkout file.
* Note that the file timestamps on the server are in UTC time.

In file names, please use the hyphen character (not the underline character) and include ‘v’ in front of the version number, as in the examples above and in line with the general recommendation (see slide 16 in [R1-2208323](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208323.zip)), otherwise the sorting of the files will be messed up (which can only be fixed by the RAN1 secretary).

To avoid excessive email load on the RAN1 email reflector, please note that there is NO need to send an info email to the reflector just to inform that you have uploaded a new version of this document. Companies are invited to enter the contact info in the table below.

**FL8 Question 1-1a: Please consider entering contact info below for the points of contact for this email discussion.**

|  |  |  |
| --- | --- | --- |
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# 2 UE BB bandwidth reduction

**Maximum number of PRBs**

Several contributions [11, 15, 16, 28, 29] propose that the maximum number of contiguous PRBs for PDSCH and PUSCH is 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS. A few contributions [8, 13] propose 25 PRBs and 12 PRBs, respectively. One contribution [14] proposes 27 PRBs and 13 PRBs, respectively. One contribution [35] proposes 28 PRBs and 14 PRBs, respectively. A couple of contributions [18, 20] propose to send an LS to RAN4 to ask about the maximum number of PRBs.

For information,

* For 15 kHz SCS, the occupied bandwidth for {25, 26, 27, 28, 29} PRBs is {4.50, 4.68, 4.86, 5.04, 5.22} MHz
* For 30 kHz SCS, the occupied bandwidth for {11, 12, 13, 14, 15} PRBs is {3.96, 4.32, 4.68, 5.04, 5.40} MHz

Based on the above considerations, the following proposal can be considered.

**FL1 High Priority Proposal 2-1a: For UE BB bandwidth reduction, for PDSCH (for both unicast and broadcast) and PUSCH, down-select between the following options for the maximum number of contiguous PRBs:**

* **Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS**
* **Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS**
* **Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS**
* **Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS**

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| --- | --- | --- | --- |
| **Company** | **Y/N** | **Preferred option(s), if any** | **Comments** |
| Huawei, HiSilicon |  | Option 4 | Option 4 is in line with the current PRB number specified in RAN4 for 5MHz channel bandwidth. |
| Nordic | Y | Option 3 |  |
| MediaTek | N |  | In general, we are OK with PUSCH to be confined with 5MHz physically contiguous resource blocks. However, for PDSCH in the main bullet, we have concerns and cannot agree to it before **we clarify further whether/how Rel-18 eRedCap can *indeed* reduce its post-FFT buffer size for *most* of the OFDM symbols in a slot.**   1. As agreed in RAN#97e and promised by RAN chair, PR3 can be revisited. We are not fine with confining PDSCH resource allocation to 5MHz (i.e. BW3). PR3 vs BW3 discussion should be revisited for both broadcast and unicast PDSCHs. 2. For broadcast PDSCHs, based on the coverage evaluation results in TR 38.865, it is more reasonable to allow gNB to transmit them with resource allocation bandwidth more than 5MHz. 3. For unicast PDSCHs, we currently still believe that post-FFT buffer in eRedCap will likely support up to 20MHz for almost every symbol, if not all, in a slot (taking lower PDCCH decoding capability, support for CSI-RS up to 20MHz, and LTE-NR dual-mode support into account). Hence, we prefer to understand companies’ assumption UE’s post-FFT buffer size first.   With the above, we would like to revise the FL’s proposal as follows:  **Revised Proposal: For UE BB bandwidth reduction, for ~~PDSCH (for both unicast and broadcast) and~~ PUSCH, down-select between the following options for the maximum number of contiguous PRBs:**   * **Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS** * **Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS** * **Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS** * **Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS** |
| FUTUREWEI |  |  | We proposed 12 RBs for the at least the PUSCH. |
| Nokia, NSB | Y | Option 4 | In our view, we prefer to stay with the RAN4 numbers for channel bandwidth of 5 MHz.  In the SI, we studied 11 vs 12 PRBs for 30 kHz SCS. However, the performance improvement shown in the SI is small. For PUSCH, we don’t see the need to support 12 PRBs for transform precoding as we can have a mix of different UE types in the same BWP. In addition, cell-edge UEs where DFT-S-OFDM would be beneficial would not be using more than few PRBs. Finally, the peak data rates can be met with 25/11 PRBs.  In addition, it is important to support the same number of PRBs for PDSCH and PUSCH to avoid implementation complexity. |
| Qualcomm | Y | Option 3 | We are fine with the current proposal for now even though we prefer option 3. RAN1 assumed option 3 or option 4 for complexity and coverage analysis during the study item so we may choose one from the two options unless there is good justification for the other options. |
| China Telecom | Y |  | We are generally fine with the current proposal. We think only one option can be selected for both PDSCH and PUSCH to reduce the unnecessary workload. |
| Sharp |  | Option3/4 | The conclusions in TR regarding bandwidth reduction, peak data rate reduction, and coverage recovery are based on the evaluations with option 4 or option 3. Aside from the recommendations of the SI, we do not see a reason for the introduction of a wider frequency band. |
| CATT | Y | Option 1, 2 or 3 | The number of PRB is important, especially when we calculate the constraint of v\*Qm\*f when adopting PR1 as add-on. We should be more careful in this issue.  Option 4 is under the assumption of BW1— the RF, BB and BWP are within 5 MHz, so a lot of edge PRBs are wasted as guardband. The group just used Option 4 for ‘coverage evaluation’. It is not justified for current designed, i.e. RF and BWP is 20 MHz.  Option 2 is with the largest PRB number <5MHz, which is justified to adopted.  Option 1 is also OK to us if the majority doesn’t mind the bandwidth (5.04 MHz) is very slightly larger than 5 MHz. It is more flexible than Option 2 indeed.  Option 3 is not our first preference, but at least the strange number of 11 PRB is avoided in the case of SCS=30kHz. |
| Vivo |  |  | For the main bullet, we suggest to remove the wording of “**contiguous**”. Even for PUSCH, from the specification perspective, the non-continuous resource allocation can be supported for CP-OFDM waveform.  We would also like to echo MTK’s suggestion to first clarify whether/how Rel-18 eRedCap can reduce its post-FFT buffer size. It is not clear from the main bullet the maximum number of PRBs is for UE to buffer, receive, process or for network’s scheduling? |
| ZTE, Sanechips | Y | Option3 or Option4 | For option1 and option2, the maximum number of PRBs is increased to 27 or 28, which would increase the UE complexity and is not aligned with our main target, i.e. complexity reduction.  Option3 can provide some additional benefits, e.g., performance, data rate and would not have impacts on UE complexity.  For option4, it is in line with the current PRB number in RAN4, which is also can be a candidate. |
| DOCOMO | Y |  | We support this proposal at this point. While Option ½ were not studied in SI phase, the coverage would be improved without significant increase of UE complexity unless the post-FFT data buffering BW exceeds 5MHz. Therefore, we are open to discuss including Option ½. We think it would affect to the peak rate calculation, i.e., how the constraint on *vLayers*·*Qm*·*f* can be relaxed, and such aspect can be considered together. |
| Spreadtrum | Y | Option 4 | We only evaluated the cost/complexity for option 4 and option 3 at the SI phase. In general, larger PRBs corresponding to higher peak data rate and hence larger buffer requirements.  Besides, if the bandwidth of a cell is 5MHz, larger PRB number may not be able to meet the guard band requirements. Therefore, if the PRB number is not 11/25 (different from the value in RAN4’s spec 38.101 table Table 5.3.2-1), we prefer to send an LS to RAN4 to ask about the maximum number of PRBs. |
| SONY | Y | Option 3 or 4 | This is a good list for down-selection purposes.  Regarding option 4, we agree with Nokia that for DFT-s-OFDM, only a few PRBs are likely to be used at the cell edge, hence the transform precoding issue with 11 PRBs isn’t a big deal. We would also be OK with option 3 (12 PRBs). |
| CMCC | Y | Option3 | Compare to BW3 and PR3, we support BW3, with proper design during WI, BW3 can achieve the post FFT buffer benefit.  So we think the hardcode limit RB number of BB reduction should be contiguous PRBs. This does not mean the allocation within maximum 5MHz need to be contiguous, but the span of PDSCH/PUSCH allocation is less than 5MHz.  12RB is better for CORESET resource allocation, since the *frequencyDomainResources* of *ControlResourceSet* is inidicated with a granularity of 6RBs and 12 is also a valid RB number for DFT-S-OFDM resource allocation. |
| Panasonic | Y with update | Option 3 or 4 | We would propose to remove the confusing word “contiguous” because the allocation could be non-contiguous PRBs based on the outcome of the discussion related to the Question 2-6a.  Among the options, we prefer Option 4 in general. The current number of RBs is enough for the required peak data rate. RAN4 impact should be avoided. For UL, we understand the argument for SC-FDMA needs to be specific number. Therefore, 12 PRBs for 30 kHz SCS is reasonable for UL. |
| Xiaomi | Y | Option 4 | Support option 4 for both (broadcast and unicast) PDSCH and PUSCH. We believe it is sufficient to follow the current PRB number specified in RAN4 for 5MHz channel bandwidth, and can’t see the necessity to involve other specifications. |
| Ericsson | Y | Option 1 | We think Option 1 provides a good balance between complexity reduction and link performance, in particular for broadcast channels. For instance, the link performance loss for SIB1 can be reduced by supporting more PRBs. Also, the complexity reduction is more or less the same for Option 1 and other options.  Note that unlike RF bandwidth reduction, the UE BB bandwidth reduction for PDSCH/PUSCH is like scheduling restriction which does not need to consider RAN4 requirements, e.g., on guard bands.  We are also fine with making Option 1 a WA and sending an LS to RAN4 asking for their input. |
| Samsung | Y | Option 3 or option 4 | We are fine with the proposal. We prefer option 3 or option 4. |
| NEC | Y | Option 2 | As RF BW is decided up to 20MHz, RAN1 does not need to stick to maximum number of RBs defined for 5 MHz RF channel bandwidth. |
| LGE | Y | Option ¾ | Okay to down-select from the complete list of proposals.  We prefer to further consider Option 3 and Option 4. As we don’t have the same interference issues for Option BW3 as we had for 5 MHz UE channel bandwidth, allowing 12 PRBs for 30 kHz SCS seems to be a reasonable option to consider. |
| Sequans | Y |  | We support in principle the proposal for later down-select.  Agree to remove “contiguous” but clarify that total data PRB allocation is within 5MHz. |
| Intel | Y | Option 4 | We prefer to clarify single option will be down selected. 11 PRB is fine for uplink since there is no issue for 10Mbps target data rate. |
| FL2 | Based on received responses, the following updated proposal can be considered. The PDSCH case can be revisited once other aspects (e.g., resource allocation) have progressed further.  **High Priority Proposal 2-1b: For UE BB bandwidth reduction, for ~~PDSCH (for both unicast and broadcast) and~~ PUSCH, down-select between the following options for the maximum number of ~~contiguous~~ PRBs:**   * **Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS** * **Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS** * **Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS** * **Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS** | | |
| OPPO | Y | Option 3 | 11 PRB will be greatly restrict the resource in of DFT pre coded PUSCH. It means even with BWP of 10/20MHz, The UE can be allowed with very few PRB and thus waste the processing capability.  We agree that the UE can follow the restriction of 11RB when system bandwith is 5MHz, that is for guard band reservation as purposed in RAN4 specificaiton. |
| Nordic | Y | Option 3 | If only PUSCH is discussed, contiguous can be left there. Even with intra-slot hopping the transmission is contiguous at a given time/symbol. |
| Nokia, NSB | N | Option 4 | We would like to have the same number of PRBs for PDSCH and PUSCH to avoid implementation complexity. Therefore, we cannot accept doing the down-selection for PUSCH only. We would like “**~~PDSCH (for both unicast and broadcast) and~~**” to be added back.  Our preference is Option 4 as explained in previous round. |
| FUTUREWEI | Y | Option 3 or 4 | While our first preference is option 3 was for DFT-S-OFDM considerations, but given some explanations regarding scheduling and UL data rate, we would also be ok with option 4. We do not support options 1 nor 2 since one motivation for those options was improving DL performance. |
| Apple |  | Opt.4 | Other options, except Opt.4, introduces irregular RB numbers that are not specified by RAN4 yet, which potential request new implementation and RAN4 requirement. We do not see strong justification to do these. |
| Sharp | Y | Option3 or 4 | Agree with Nodic that “contiguous” should be left there. |
| Lenovo |  |  | Since “contiguous” has been removed from the main proposal, we think “PDSCH (for both unicast and broadcast” shall be kept. Same with Nokia, we also support to have same number of PRBs for PDSCH and PUSCH. |
| Sierra Wireless | Y | Option 3 or 4 |  |
| Spreadtrum | Y | Opt.4 | We agree with Apple. Also fine with Nokia to add PDSCH back. |
| DOCOMO | N |  | We share the similar view as Nokia to have the same maximum number of PRBs for PDSCH and PUSCH. For example, if Option 3 is supported for PUSCH, we don’t see the big difference between supporting Option 3 and Option 4 for PDSCH, e.g., in terms of UE complexity, and then it is fair to support Option 3 even for PDSCH. For the implementation simplicity, we prefer to align the number of PRBs between PDSCH and PUSCH.  If the system bandwidth is 5MHz, we think of course the Rel-18 RedCap UE follows the RAN4 spec, i.e., the number of RBs should not exceed 25/11 for 15/30 kHz SCS, otherwise, the number of RBs can be larger as Option ½/3. |
| SONY | Y | Option 3 or 4 | The main proposal is fine. |
| MediaTek | Y | Opt.4 | We prefer Option 4 as it is the PRB number supported in RAN4 spec. However, we are open for considering Option 3 if we are sure it does not require any special handling in any corner cases.  As to Nokia’s concern, we can understand one would like uplink and downlink *BWP* configurations to be consistent (though NR already allows different BW for UL and DL BWP pairs). But for PUSCH and PDSCH resource allocation, we don’t see why they need to be coupled together (given the fact that the BWP configuration is likely to be larger than 5MHz anyway for eRedCap). After all, UE is equipped with separate baseband hardware modules for uplink transmission and downlink reception. Hence, we have not been able to see where the implementation complexity comes from if the number of PRBs supported by uplink and downlink are different. It is for UE or for gNB or both? Maybe some further clarification from Nokia (or other companies) would be helpful.  Finally, this proposal does not say that a same or similar proposal cannot be applied to PDSCH later on. We just need more time to align companies’ understanding and assumptions about PDSCH transmission/reception. |
| Panasonic | Y | Option 3 or 4 |  |
| CATT | Y | Option 1, 2 or 3 | OK with the update. Our technical view is unchanged as previous round, so no need to repeat here.  For PDSCH, we agree with Nokia. If the contradictory point is broadcast channel, can we addback “**PDSCH (for unicast and FFS broadcast) and**”?  For deleting ‘continuous’, Rel-15 PUSCH already supports non-continuous RB allocation (optional capability). In our understanding, removing ‘continuous’ does NOT mean mandating non-continuous RB allocation, but just to make situation general and decouple UE capability discussion. Anyway, the most critical point of this proposal is about the ‘PRB number’, regardless continuous or non-continuous. |
| Vivo |  | Option 3 or 4 | We would like to keep “unicast” in front of PUSCH, or does the PUSCH here also includes MSG3? |
| Qualcomm | Y | Option 3 | We are fine with the updated proposal for now. Also fine with adding PDSCH back to the proposal as we do not see any reason to have different RB numbers between PDSCH and PUSCH. |
| Samsung |  |  | Same view as Nokia. That UL and DL shall have the same number. |
| NEC | Y | Option 1, 2 or 3 | Considering UL data rate could be likely restrictive due to fewer UL slots in TDD, option 1, 2 or 3 would be preferable. |
| LGE | N | Option ¾ for both PDSCH and PUSCH | We share the view with Nokia and DOCOMO. |
| Sequans | Y | Option 3 or 4 | We are fine with the update. Also fine to add back PDSCH. |
| ZTE, Sanechips | Y | Option 3 or 4 | We support that the PDSCH and PUSCH in unicast should have the same implementation of PRBs number. |
| CMCC | Y | Option 3 or 4 | Agree with other companies that PDSCH can be added back, since contiguous is deleted. |
| Ericsson | Y | Option 1 | Our reasons for preferring Option 1 have been provided in our FL1 response.  For PDSCH, the proposal can be updated as follows:  **For UE BB bandwidth reduction, for a PDSCH (for both unicast and broadcast), down-select between the following options for the maximum number of PRBs that the UE can receive:**   * **Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS** * **Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS** * **Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS** * **Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS** |
| Intel |  | Option 4 | We share views from Nokia and Lenovo, PDSCH should be added back since ‘contiguous’ is removed. As commented in first round, both 11 and 12 can meet the 10Mbps target data rate for DL and UL, so Option 4 is sufficient. Option 4 is beneficial in complexity reduction compared to Option 3 too. |
| Xiaomi2 | N | Option 4 for both PDSCH and PUSCH | Share the same view as Nokia, DOCOMO and other companies. |
| MediaTek2 |  |  | For PDSCH, our view is that eRedCap UE will be capable of *receiving* 20MHz because its RF and post-FFT buffer size will be 20MHz. (See our comments in response to Proposal 2-9b). With the above assumption, we don’t know why we should limit the UE’s “reception bandwidth” to 5MHz. On the other hand, we can only agree to that UE’s “processing bandwidth” is reduced to 5MHz, at least for now. We hence would like to revise Ericsson’s proposal as follows:  **For UE BB bandwidth reduction, for a PDSCH (for both unicast and broadcast), down-select between the following options for the maximum number of PRBs that the UE can ~~receive~~ process:**  **• Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS**  **• Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS**  **• Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS**  **• Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS** |
| Huawei, Hisilicon | Y | Option 4 | Option 4 is in line with the current PRB number specified in RAN4 for 5MHz channel bandwidth and can meet the UL peak data rate of 10 Mbps. Thus, in our view, there is no need to redefine the PRB number for 5 MHz BW. |
| FL3 | Based on received responses, the following updated proposal can be considered.  **High Priority Proposal 2-1c:**  **For UE BB bandwidth reduction, for PUSCH, down-select between the following options for the maximum number of PRBs that the UE can transmit:**   * **Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS** * **Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS** * **Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS** * **Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS**   **For UE BB bandwidth reduction, for PDSCH (at least for unicast), down-select between the following options for the maximum number of PRBs that the UE can receive:**   * **Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS** * **Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS** * **Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS** * **Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS** | | |
| FL4 | Based on the proposal, the online (GTW) session on Wednesday 12th October made this agreement:  Agreement:  For UE BB bandwidth reduction, for PUSCH, down-select between the following options for the maximum number of PRBs that the UE can transmit:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   For UE BB bandwidth reduction, for PDSCH (at least for unicast), down-select between the following options for the maximum number of PRBs that the UE can [receive/process]:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   Same option will be selected for both PDSCH (at least for unicast) and PUSCH. | | |

**FL4/FL5 High Priority Question 2-1-1a: How should the “[receive/process]” in the above agreement be resolved?**

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| **Company** | **Comments** | |
| Nordic | Whether PRBs are contiguous or not is separate question and should NOT be mixed here.  We think that “process per slot” is better wording. For example, CCE limits are defined as max number that UE can “monitor”, while clearly UE can receive all CCEs.  Therefore, here we have limitation on how many PRBs UE can handle with regard to channel estimation, demodulation, rate-matching per slot ….. in other words how many PRBs UE can process. | |
| Nokia, NSB | In our understanding, the “receive/process” discussion is about BW3 vs PR3, so it would be good to make progress on this issue. Either BW3 or PR3 option is acceptable to us.  We do have a preference for BW3 due to lower UE complexity (in our understanding receiver processing is also simpler with BW3, so it’s not just post-FFT data buffering). However, we do not want to mandate semi-static indication or cross-slot scheduling as this would restrict scheduler flexibility / increase complexity and also require considerable standardization effort considering small complexity reduction. Therefore, we are also fine with PR3 if it turns out to be the simpler option from implementation / specification point of view. | |
| FUTUREWEI | Similar observation as Nokia. The question about receive/process is really about BW3 vs. PR3. It is better to explicitly word the question whether the PRBs are contiguous.  Our preference is BW3 for cost savings. But we are open to hear different views. We want to ensure broadcast / initial access is not hampered or there is no huge specification effort. | |
| Lenovo | We think this is related with how UE perform post-FFT data buffering. If the UE could buffer 20MHz, the UE could “receive” all the 20MHz data, and then “process” 5MHz data out of the received data; If the UE could buffer only 5MHz, the UE could “receive” and “process” only 5MHz data.  For unicast PDSCH, the UE has to buffer and receive 20MHz data for at least a couple of symbols, if the UE does not know where the PDSCH is scheduled before PDCCH is detected. For BW3, it is possible that the UE could be preconfigured a 5MHz BW in the BWP, and the UE could just receive and process the 5MHz data; For both BW3 and PR3, if cross-slot scheduling is used, it is also feasible for the UE to receive and process 5MHz data since UE has enough time to decode PDCCH before receiving PDSCH.  When UE is in RRC idle/inactive and is receiving SIB1, the UE has to buffer (and “receive”) 20MHz data for at least a couple of symbols, since the UE does not know where the SIB1 is scheduled before detecting SIB1 PDCCH. However, if separate SIB1 can be configured for R18 RedCap UEs, it is possible that the position of separate SIB1 can be predefined, and the UE could buffer and receive 5MHz data only for SIB1 detection.  So, we think it would be good to firstly make a working assumption on how UE buffering the data, then the discussion will be easier.  Besides, we share similar view with Nokia and FUTRUEWEI to make progress on selection between BW3 and PR3. | |
| ZTE, Sanechips | 5MHz processing capability is applicable for both BW3 and PR3, therefore, it is a safe option to start with the 5MHz processing capability. As for the maximum number of PRBs for UE receiving, it can be separately discussed. Therefore, we are OK to start with ‘process’ in this proposal and further discuss ‘receive’ in a separate discussion. | |
| vivo | Firstly, we would like to clarify our understanding on the RAN#97 decision/conclusion on the UE BB BW reduction. During the RAN meeting, there is no aligned understanding on what BB BW reduction it is, what is the assumption on the post-FFT buffering etc., these details need to be figure out in WGs. Therefore, both BW3 and PR3 is on the table.  As noticed by many companies that the most controversial issue is whether to further reduce the post FFT buffering with taking into account the impacts on the broadcast PDSCH, i.e., SIB1, we agree and suggest to first discuss this issue and make the question clear.  We are fine with Nordic’s modification of “process per slot”. From TR 38.865, the additional cost reduction for BW3 compared to PR3 is less than 1% for most configurations which is marginal.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Option** | **FD-FDD 1Rx** | **TDD 1Rx** | **HD-FDD 1Rx** | **FD-FDD 2Rx** | **TDD 2Rx** | **HD-FDD 2Rx** | | BW3 | 8.02% | 7.66% | 8.90% | 8.72% | 7.68% | 9.19% | | PR3 | 7.06% | 6.74% | 8.12% | 9.81% | 6.59% | 7.98% |   From UE perspective, it is really questionable whether 1% additional cost can be really saved as long as RedCap UE needs to share the SIB1 which is scheduled in non-contiguous PRBs with legacy UEs. In addition, for DL, RedCap UE still need to handle CORESET, CSI-RS etc which can occupy 20MHz BW.  From NW perspective, as observed by Nokia and discussed in FL High Priority Proposal 2-9c, we need to study in the WI which solutions are feasible to reduce UE’s the post-FFT buffering. These solutions put many scheduling restrictions and increase the implementation complexity at the NW side.   * Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast) * Cross-slot scheduling for PDSCH (for unicast and/or broadcast) * Other solutions are not precluded.   We cannot find clear benefit in either NW side or UE side with BW3. | |
| CATT | We observe that, companies have different understanding on receive and process.   1. Understanding 1: receive 20MHz (and process 5MHz) means PR3, while (receive 5 MHz and) process 5MHz means BW3 2. Understanding 2: receive 20MHz means PDSCH can be scheduled (up to 20 MHz), while process 5 MHz means only 5 MHz can actually be picked up (as a subset of scheduled resource). 3. Understanding 3: receive corresponds to RF capability, and up to 20 MHz can be supported until post-FFT buffer, while process corresponds to the capability after post-FFT buffer. (for both BR3 and PR3)   There may be even more… if it is too complicated to address at this time, we can wait at least until it is clear whether BW3 or PR3 is supported. This agreement, in our view, is mainly to give guidance on the actual supported PRB number🡨the target is already fulfilled.  We like the idea of ‘per slot’, but we need to clarify whether intra-slot hopping is considered. For example, if two intra-slot hops each occupies 5 MHz within a slot, should it be counted as 5 MHz or 10 MHz (in our view, this is 5MHz, but no explicit agreement yet)? Maybe more accurate wording is ‘per symbol’, or add ‘per hop (when intra-slot hopping is applied)’. | |
| Spreadtrum | We think we should have a consensus first for the understanding of the UE behaviors with BB bandwidth reduction (no matter BW3 or PR3)  In our understanding, without any other optimizations for BW3 or PR3, the UE should receive and buffer up to 20Mhz before the DCI is decoded. But the PRBs that the UE needs to process are limited within 25/11(or other values), the “process” here means the UE only needs to extract and decode 25/11 PRBs per slot.  Additionally, if the real goal is related to BW3 vs PR3, although our original preference is BW3, considering two options are very close on cost/complexity reduction and PR3 can potentially provide more scheduling flexibility, we can accept PR3 for progress. | |
| DOCOMO | We have a similar understanding with companies that this discussion is related to the discussion of BW3 vs PR3.  Our preference is “receive” which implies that post-FFT data buffering is limited to 5MHz as per our understanding. Based on the decision in RAN plenary that the objective of Rel-18 RedCap intends BW3 and post-FFT data buffer is captured as contributor for complexity reduction for BW3 in TR, we think RAN1 should aim to reduce post-FFT data buffer at this moment. We think semi-static frequency location indication and/or cross-slot scheduling is not only the solution to reduce post-FFT buffer, i.e., it can be realized by UE implementation like soft-combining. Hence, we also believe that we can minimize the specification impacts/scheduler complexity depending on the discussion.  If whether the post-FFT buffer is reduced or not can be discussed in the other proposal, then we can accept “process” for this proposal, however, it would be good step forward to agree on “receive” at this point. | |
| Sharp | In our understanding, “receive” means only limited PRBs can be sent to BB modules and “process” means PRBs of whole band can be sent to BB modules and BB select some for processing. And both dos not explicit whether the PRBs is contiguous or not.  If it’s correct, we think “process” which have more flexibility may be better for here.  In addition, we think the PRBs for BB processing should be contiguous allocated that follow the description in WID. | |
| SONY | “[receive / process]” should be resolved by having a clear understanding of the terms “receive” and “process” (and “process per slot”). The suggestion from CATT seems like a good way of coming to a common understanding.  From listening to the Wednesday GTW session, it seems like there is another understanding of what “process” means, along the lines of “process per slot”:  “process per slot” would, for example, allow the UE to store 20MHz-worth of DL samples in its post FFT buffers from slot ‘n’ and then process (channel estimate, physical channel process etc) over 4 slots (the processing per slot would be 5MHz-worth of DL samples). The UE could then be scheduled with PDSCH again in slot ‘n+4’.  We could then consider / down-select from the four following understandings:  Understanding 1: receive 20MHz (and process 5MHz) means PR3, while (receive 5 MHz and) process 5MHz means BW3  Understanding 2: receive 20MHz means PDSCH can be scheduled (up to 20 MHz), while process 5 MHz means only 5 MHz can actually be picked up (as a subset of scheduled resource).  Understanding 3: receive corresponds to RF capability, and up to 20 MHz can be supported until post-FFT buffer, while process corresponds to the capability after post-FFT buffer. (for both BR3 and PR3)  Understanding 4: receive corresponds to RF capability, and up to 20 MHz can be supported after post-FFT buffer, while process per slot corresponds to the processing capability after post-FFT buffer. The processing of the 20MHz bandwidth can be spread out in time according to the “processing per slot” capability. | |
| Qualcomm | We also have a similar understanding with Nokia that it is related to BW3 vs PR3 issue and the difference of post-FFT buffering. It may be good to discuss BW3 vs PR3 issue first for common understanding of each option and corresponding receive or process operation. | |
| NEC | Rel-18 RedCap UE should be capable of processing above mentioned number of PRBs at maximum in each slot, irrespective of BW3 or PR1, or unicast or broadcast. We are fine to go for “process” and fix Rel-18 RedCap UE processing capability first. PRB allocation in frequency domain can be discussed separately. | |
| MediaTek | We fully agree with vivo’s comments about RAN plenary discussion on BW3/PR3, UE’s complexity reduction particularly on UE’s post-FFT buffer, etc. In addition, we share a similar view with Nokia and Futurewei that RAN1 should strive for down-selection between BW3 vs PR3 (in other words, the bandwidth span of PDSCH resource allocation <= 5MHz or > 5MHz).  **Receive vs. Process**  As stated in GTW call yesterday, our view at least for now (before any further agreements on configuration/scheduling restriction are made from Proposal 2-9c or other proposals) is that eRedCap is very likely to be capable of “receiving” 20MHz of PDSCH in a slot because its RF and post-FFT buffer will likely to be both 20MHz. If it is capable of *receiving 20MHz of PDSCH per slot*, we don’t know why we want to make an agreement that limits its *reception* capability to 5MHz. What we can agree right now is that “UE processing bandwidth” is 5MHz per slot (while the “UE receiving bandwidth” is still 20MHz per slot). Therefore, we support Nordic’s proposal which is written as follows:   * **Proposal: For UE BB bandwidth reduction, for PDSCH (at least for unicast), down-select between the following options for the maximum number of PRBs that the UE can ~~[receive/~~process per slot~~]~~**   **BW3 vs. PR3**  Our understanding about RAN#97e discussion is that PR3 is still on the table as promised by RAN Chair. The following proposal (from Johan) was in principle agreed in RAN#97e (except the final t-doc number for WID).  Proposal (by Johan in RAN #97e): Approve the WID in RP-222612 (Inbox, Docs), with **the understanding that the exact definition of the UE BB bandwidth reduction will be revisited in RAN1.**  Hence, we think RAN1 should further discuss whether to adopt PR3 (instead of BW3) before next RAN plenary. We should not just wait until next RAN plenary to discuss PR3. If PR3 is not adopted, then how to actually reduce UE’s baseband complexity for BW3 should be supported.   * **Proposal: RAN1 discuss and decide whether bandwidth span of PDSCH resource allocation can be larger than 5MHz for eRedCap UEs before RAN#98e.**   + **If bandwidth span of PDSCH resource allocation is agreed to be confined within 5MHz, at least one of the following approaches should be adopted to strive for further reducing UE’s baseband complexity:**     - **Semi-static configuration of the 5-MHz frequency location for at least for unicast PDSCH. FFS: broadcast PDSCH.**     - **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)** | |
| Panasonic | Although one may say "process" can be generic, our interpretation of the reason of the different views is the relationship to the issue of “BW3 or PR3”. The down-selection between BW3 and PR3 should be finished in advance.  If BW3 (5 MHz is received and 5 MHz is processed) is adopted, either “receive” or “process (per slot)” can be used. If PR3 (max 20 MHz can be received and 5 MHz BB BW is processed) is adopted, “process (per slot)” would be better to avoid confusing. In this sense, “process (per slot)” could cover both interpretations. | |
| Samsung | We prefer to use the wording “process”. For this agreement, the maximum number of PRBs should be to restrict the PRB number of BB receiver processing block, i.e., after UE post-FFT data buffering. Regarding whether the PRBs is contiguous or not, or whether the post-FFT buffer is reduced, it should be another question and should be clarified in other proposal. | |
| CMCC | We think the option of BW3 and PR3 are critical, once selection has been made, future discussion will be clear.  And according to discussion during the SI, we remember there are different understanding of whether BW3 can save the post FFT data buffering, so we think the cost reduction values of BW3 from different companies have different assumptions for this. Once the post FFT data buffer becomes a fact by specification, the cost reduction gain may be a little higher. On the other hand, we think the channel estimation bandwidth of BW3 will be less than PR3, and only limited to 5MHz.  **So our preference is BW3.**  And for this proposal, without known PDSCH resource region before decoding PDCCH, UE has to receive and buffer up to 20MHz, so our understanding is “understanding 3” mentioned in CATT’s comment. For this one, process may be better.  If UE knows the PDSCH resource region before decoding PDCCH, then both “receive” and “process” are correct.  **So if this is the common understanding , process can be used, since it can be used for both PR3 and BW3. and once down selection between BW3 and PR3 are made, the word here does not matter so much.** | |
| Intel | We share CATT’s view on intra-slot hopping for PUSCH. It should be allowed for PUSCH to hop between two frequency location with each location limited to 5MHz. ‘per symbol’ is preferred since frequency hopping may not be configured.  Regarding ‘receive’ versus ‘process’, with many clarifications from companies, i.e., ‘process’ means the number of PRBs that UE actually does for channel estimation, demodulation, etc., while an assumption of post-FFT buffer may be implied by ‘receive’. We can accept to use ‘process’ with the understanding that assumption on post-FFT buffer anyways will be discussed separately.  We prefer to have unified behavior for broadcast PDSCH and unicast PDSCH. Meaning that, the UE will only buffer and decode broadcast/unicast PDSCH in 5MHz. For broadcast PDSCH, whether it can be scheduled to span more than 5MHz can be discussed in other FL proposals. | |
| Sequans | We also find “process per slot” a more meaningful limitation to have from UE point of view. We understand “process” limitation as the PRBs that can be selected by BB for processing. In that sense, “process” gives more flexibility for future down selection between BW3 and PR3 options. But we are fine to focus on reaching common understanding on this terminology, or actually start with selecting between BW3 and PR3 first. | |
| Ericsson | Similar view as other companies above that this is related to BW3 vs. PR3 discussion. We do not think there is consensus yet in RAN1 that a Rel-18 RedCap UE can receive and buffer 20 MHz (for the full DL slot as in PR3), which would be the consequence of agreeing to “process”.  We would be fine with supporting PR3; however, we are not currently supportive of any additional relaxation of the processing time to let the UE process the buffered 20 MHz PDSCH (as in [25]).  Also, from network point-of-view, what we are more interested in knowing is how many PRBs can a Rel-18 RedCap UE be scheduled with for unicast PDSCH. Our understanding is that the number of PRBs that the UE can process may depend on the UE implementation. | |
| LGE | In our view, receive/process is from UE perspective. So, receiving X PRBs (< 5 MHz) for PDSCH is basically referring to BW3 while processing is a wider concept that can accommodate the PR3 as well, i.e., can receive 20 MHz but can only process 5 MHz in many different ways. Processing also opens the possibility of the need for UE to estimate the whole 20 MHz channel even if it only needs to process 5 MHz, which adds complexity to the UE. Buffering, on the other hand, may be a separate issue because even for BW3, companies have different understandings on whether buffer reduction is feasible or not. So, we share the view with Nokia, FUTUREWEI that this is actually related to BW3 vs. PR3.  Our preference is BW3. So, we prefer “receive” over “process”. Receive 25 PRBs here means 25 “contiguous” PRBs in our view. Before down-selecting to one of the Options, we think it is important to have a unified view on this aspect. | |
| MediaTek | The majority seems OK with “process” (or “process per slot”) while “receive” is more debatable. We suggest to agree on “process per slot” (as proposed by Nordic) to resolve the square brackets.  Then we can discuss BW3 vs PR3 (including frequency hopping aspects), and post-FFT buffer in a new discussion thread. | |
| Huawei, HiSilicon | Support “process” or “process per slot”  Similar view as MediaTek and vivo that UE receving bandwidth is 20 MHz because of 20MHz PDCCH and the throughput bandwidth of data processing per slot corresponds to 5Mhz. In this case, post-FFT buffering is better to be 20MHz rather than 5MHz because of small cost difference. On the contrary, 5MHz post-FFT buffering needs more standard efforts or gNB scheduling restrictions (e.g. semi-static indication or cross-slot scheduling). For the sake of commercial success, 20MHz post-FFT buffering is better trade-off and thus not supposed to be precluded.  Based on the discussions, it seems that some companies always assume 20MHz post-FFT buffering has been precluded for BW3, which we have different view.  According to the note in the TR, 20MHz post-FFT data buffering is still needed when cross-slot scheduling or retuning is not applied.  *Note 1: BW3 may have different degrees of impacts on the post-FFT data buffering depending on the scheduling aspects (cross-slot scheduling, RF retuning, etc.).*  We are fine to discuss BW3 vs. PR3 and prefer PR3 if PR3 is the only choice to have 20MHz post-FFT buffering. | |
| Nordic | The issue of buffering has been on the table in Toulouse, and it occurred again in RAN#97-e without being solved. Post FFT bufferting reduction is not about PR3 and BW3. This because sami-static “narrow-bands” could be also defined within distributed VRB to PRB mapping.  We just need to discuss whether there is consensus within RAN1 to further optimize post FFT buffering or not. It is simple as that.  We support “process per slot”. | |
| FL6 | Some of the received responses express the term ‘receive’ may only be appropriate if option BW3 is assumed, whereas the term ‘process’ may apply to both option BW3 and option PR3 (as defined in TR 38.865 [5]). Therefore, assuming that both options BW3 and PR3 are still on the table, the term ‘process’ may be more neutral at this point. Some responses suggest that the term ‘process per slot’ may be a better choice to avoid confusion regarding frequency hopping cases. Based on the responses, the proposal below can be considered, where ‘[receive/process]’ is replaced with ‘process per slot’.  Some responses discuss whether the WI objective is compatible or not with option PR3. RAN#97e made a conclusion that the *“focus of RAN1 work should be on BW3 and PR1 for FR1 (with the understanding that the exact definition of BW3 will be revisited in RAN1)”*. Therefore, two new questions (Question 2-1-3a and Question 2-1-4a) on the exact definition of BW3 have been inserted further down in this document.  **High Priority Proposal** **2-1-1b: Revise the following agreement as follows:**  For UE BB bandwidth reduction, for PUSCH, down-select between the following options for the maximum number of PRBs that the UE can transmit:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   For UE BB bandwidth reduction, for PDSCH (at least for unicast), down-select between the following options for the maximum number of PRBs that the UE can ~~[receive/~~process per slot~~]~~:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   Same option will be selected for both PDSCH (at least for unicast) and PUSCH. | |
| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | Y | The one bullet from proposal 2-3-1b should be added to this receive / process question |
| vivo | Y |  |
| MediaTek | Y |  |
| Intel |  | Similar to ‘process per slot’ for PDSCH, we prefer to clarify that it is per frequency hop for PUSCH. It doesn’t increase UE complexity while achieve clear gain on frequency diversity. |
| DOCOMO | Y | While our preference is “receive” even for this proposal, we can accept “process per slot” at this point. |
| Qualcomm | Y | We tend to agree that BW3 vs PR3 and post-FFT buffering can be separately discussed as proposed by feature lead and "process” seems more general term regardless of BW3 and PR3.  To be aligned with the discussion of **Question 2-1-4a,** we can modify the PUSCH part to consider intra-slot hopping as proposed by Intel.:  For UE BB bandwidth reduction, for PUSCH, down-select between the following options for the maximum number of PRBs that the UE can transmit **per hop**: |
| Spreadtrum | Y |  |
| Lenovo | Y |  |
| NEC | Y |  |
| Xiaomi3 | Y | We think that the maximum number of PRBs that UE can receive is the same as the bandwidth of post-FFT buffering, both are 20MHz. |
| ZTE, Sanechips | Y with a update | process per slot, process per hop, process per symbol are the same, since what we define here is the frequency bandwidth, which is nothing to do with the location of 5MHz. So PUSCH hopping has no impact on using ‘process’  Therefore, ‘process’ is enough and no need to add ‘per slot’ or ‘per hop’. |
| Nordic | Y |  |
| Panasonic | Y |  |
| Huawei, Hisilicon | Y | Support.  The change “per hop” suggested by QC and Intel is better. |
| LGE | Y | We understand the FL’s intention to harmonize the two parties of BW3 and PR3 by the current proposal. We can support the proposal.  We also think the clarification suggested by Intel and Qualcomm is needed. |
| Ericsson | Y | We are fine with supporting the proposal with the understanding that “processing per slot” would not imply agreeing to support any additional time relaxations or spreading out the time for PDSCH processing (as in Sony’s Understanding 4 from the previous round). |
| CMCC | Y |  |
| OPPO | Y | We actually fine with the per Hop clarification as this can keep the current definition of Hopping pattern.  Process is fine for us. |
| CATT | Y | Agree with many companies above. The meaning of ‘5 MHz per hop of PUSCH’ shall not be precluded by the current proposal.  Let’s have separate discussion for other issues. |
| SONY | Y |  |
| Nokia, NSB | Y | We are OK with the proposal. |
| FL7 | Based on the received responses, the following updated proposal can be considered.  **High Priority Proposal 2-1-1c: Revise the following agreement as follows:**  For UE BB bandwidth reduction, for PUSCH, down-select between the following options for the maximum number of PRBs that the UE can transmit per hop:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   For UE BB bandwidth reduction, for PDSCH (at least for unicast), down-select between the following options for the maximum number of PRBs that the UE can ~~[receive/~~process per slot~~]~~:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   Same option will be selected for both PDSCH (at least for unicast) and PUSCH. | |
| FL8 (info) | Based on the proposal, the online (GTW) session on Monday 17th October made this agreement:  Agreement:  Replace the agreement on the maximum number of PRBs supported by UE with the following:  For UE BB bandwidth reduction, for PUSCH, down-select between the following options for the maximum number of PRBs that the UE can transmit per slot or per hop, if applicable:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   For UE BB bandwidth reduction, for PDSCH (at least for unicast), down-select between the following options for the maximum number of PRBs that the UE can process per slot:   * Option 1: 28 PRBs for 15 kHz SCS and 14 PRBs for 30 kHz SCS * Option 2: 27 PRBs for 15 kHz SCS and 13 PRBs for 30 kHz SCS * Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS * Option 4: 25 PRBs for 15 kHz SCS and 11 PRBs for 30 kHz SCS   Same option will be selected for both PDSCH (at least for unicast) and PUSCH. | |

**FL4/FL5 High Priority Question 2-1-2a: Can the above agreement (about the maximum number of PRBs “at least for unicast”) be applied also to broadcast PDSCH?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic | Y | If the limitation is defined as “process per slot”, then UE can process 25 PRBs per slot and 106 PRBs in 5 slots.  Decoding 20MHz SIB1/OSI/ may take up to 5 slots, but this is clearly less power hungry than UE being active for up to 8x20ms with potential micro-sleeps in between. |
| Nokia, NSB | Y | Since the agreement is about UE receiving / processing capability, it should apply to both unicast and broadcast. |
| FUTUREWEI |  | We should understand the specification impact to SIB1, OSI, RA, and paging first before addressing whether the maximum number for unicast is applicable to broadcast. |
| Lenovo | Y | If a working assumption on how to data buffering can be firstly settled, the discussion will be quite easy for this issue. |
| ZTE, Sanechips | Y | Whether the maximum number of PRBs is only for processing or receiving, from the UE perspective, the same capability should be applied for both broadcast and unicast. |
| vivo | Y | Conditioned on if UE’s post FFT buffering is not further reduced. |
| CATT | Y but need clarification | If we would like to do so, we need to clarify that no matter how ‘receive/process’ is explained, sharing broadcast PDSCH (can be larger than 5 MHz, from networks view) is not precluded. |
| Spreadtrum | Y |  |
| DOCOMO | Y | In our understanding, in terms of the scheduling by gNB, the number of RBs for resource allocation can be larger than 5MHz for broadcast PDSCH. However, in terms of UE reception/processing, it should not exceed 5MHz. In this sense, the above agreement should be applied even for broadcast PDSCH. |
| Sharp | Y |  |
| SONY | Y | If the “maximum number of PRBs” relates to “process per slot”, the UE could receive a 20MHz broadcast PDSCH and process that in 4 slots (for a 5MHz “process per slot” capability). As long as the following broadcast PDSCH does not occur within 4 slots of the previous broadcast PDSCH, the UE can decode broadcast PDSCH.  In addition to consider what the UE can receive / process, we also need to consider what the gNB transmits. If the UE can only receive / process 5MHz, does that mean that the gNB needs to transmit a broadcast PDSCH within 5MHz (and perform physical channel processing accordingly) or can the gNB transmit a broadcast PDSCH within 20MHz and the UE performs brute-force puncturing of 15MHz of that bandwidth to then actually process 5MHz? |
| Qualcomm | Y | Same receiving/processing capability should be applied for both unicast and broadcast. |
| NEC |  | Yes if “process” is selected. |
| MediaTek | Y for “process per slot.”  More discussion if “receive per slot” | We share a similar view with Nordic that this can be applied to broadcast PDSCH if it is agreed as “process per slot.”  On the other hand, if it is “receive per slot,” what does it actually mean? Does it mean UE is forbidden to receive 20MHz of SIB1 in one slot? In addition, is UE assumed to support and perform soft combining of multiple SIB1 receptions from different slots? Soft combining of SIB1 is at the cost of UE power consumption and UE’s initial access latency performance and should not be assumed for UE by default by companies. Some more clarification on “receive” may be needed for broadcast PDSCHs. |
| Panasonic | Y | The same capability should be applied for both broadcast and unicast as both need to be handled by UE. Although broadcast allows the later processing (as no HARQ feedback), the amount of the buffering requirement would be the same. |
| Samsung | Y | The same maximum number of PRBs should be applied for both unicast and broadcast. |
| CMCC | Y | It is true for UE’s processing capability of the RB numbers no matter option 1 or option 2 is chosen for SIB1, OSI, paging. |
| Intel | Y | We prefer to have unified behavior for broadcast PDSCH and unicast PDSCH. So, for both PDSCHs, UE only does for channel estimation, demodulation in 5MHz. What is the assumption for post-FFT buffer can be discussed separately. |
| Sequans | Y | We need to clarify the [process/receive] aspect first. If the restriction is on PRBs “receive per slot”, then we share the same concern expressed by Mediatek, SONY. |
| Ericsson |  | We prefer to come back to this question after settling the “receive/process” issue. |
| LGE | Y | As we understand it, receive/process is from UE perspective. So, for UE complexity reduction, the same should apply for broadcast PDSCH. |
| MediaTek | Y for “process per slot” | If [receive/process] is resolved as “process per slot,” we can agree to extend the above agreement to broadcast PDSCH. |
| Huawei, HiSilicon | Y for “process per slot” |  |
| Nordic | Y | If defined as “process per slot” |
| Xiaomi3 | Y for “process per slot” |  |

**FL6 High Priority Question 2-1-3a:**

* **For UE BB bandwidth reduction, for unicast PDSCH, which option is preferable?**
  + **Option 1: A UE is not expected to receive a DL assignment in DCI with a resource allocation spanning a bandwidth of more than 5 MHz**
  + **Option 2: A UE is not expected to receive a DL assignment in DCI with a resource allocation spanning a bandwidth of more than 20 MHz**
* **Note: In both options, the maximum number of PRBs in the resource allocation corresponds to ~5 MHz**

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| **Company** | **Option** | **Comments** | |
| FUTUREWEI | Option 1 | We are assuming the RIV spans 20MHz (no optimization) | |
| vivo | Option 2 | For broadcast PDSCH especially for SIB1, the resource allocation can span a bandwidth of more than 5MHz and UE can receive/buffer 20MHz. Then same reception/buffering capability can be applied to unicast PDSCH. | |
| MediaTek | Option 2 | Our preference is and has been PR3.  We don’t see the additional <1% (contributed by post-FFT buffer & DL Rx processing block) or < 0.5% (contributed by DL Rx processing block) complexity reduction provided by BW3 compared to PR3 is worth of sacrificing scheduling flexibility and frequency diversity gain. Please note that the 1% (or 0.5%) complexity reduction in just in paper. In real-world implementation, it would be even smaller.  Again, we would like to hear more justification (other than the less than 1% complexity reduction) from proponents for BW3. | |
| Intel | Option 1 | Based on the discussions, Option 2 may mean 20MHz post-FFT buffer which is not preferred for complexity reduction. | |
| DOCOMO | Option 1 | We share the same view with Intel. | |
| MediaTek2 | Option 2 | Because proponents for Option 1 claim that Option 1 achieves a better complexity reduction than Option 2 as presented in TR, we respectfully request the claimed complexity reduction to be actually implemented into the specifications. We cannot accept an option that does not bring any benefit to UE, e.g. no complexity reduction and no UE power saving gain, while it commands UE to support new designs for no benefits foreseen. Therefore, we would like to add some sub-bullets (in red color) under Option 1 to strive for UE complexity reduction at least in specification (in paper).   * **Option 1: A UE is not expected to receive a DL assignment in DCI with a resource allocation spanning a bandwidth of more than 5 MHz**   + **Support at least one of the following solutions to make the reduction of post-FFT buffering to 5MHz possible for UE:**     - **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)**     - **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)**     - **Other solutions are not precluded**   Regarding the Note in Question 2-1-3a, it is relevant if Option 2 is agreed. We prefer to remove it for now and come back to it after Option 1 vs Option 2 is resolved. | |
| Qualcomm | Option 1 | During the study item, we have observed that the complexity reduction gain for BW3 option over PR3 (we agree that it is not significantly large). But we have not sufficiently studied the benefits of PR3 over BW3. Scheduling flexibility or frequency diversity were mentioned above but we are not fully justified how significantly PR3 helps scheduling flexibility compared to BW3 and how large the frequency diversity gain of PR3 is compared to BW3. Gain looks marginal to us especially in real implementation.  We currently have slight preference on BW3 but are open to discuss if there are any significant benefits of PR3 over BW3. | |
| Spreadtrum | Option 2 | We have the similar observations as MTK, i.e., the complexity differences between BW3 and PR3 are very small (almost zero).   * For post-FFT buffering, both BW3 and PR3 mean 20MHz post-FFT buffer at least for few symbols (the time for DCI reception and decoding). After DCI is decoded, the UE can only buffer the scheduled PRBs (up to 5Mhz PRBs). * For receiver processing block, the complexity difference between BW3 and PR3 may depend on the implementation algorithms. In general, we think the complexity difference between data extraction within 5MHz and data extraction within 20MHz may be small. * Further optimizations, e.g., cross-slot scheduling and pre-configuration, are beneficial to both BW3 and PR3.   Considering two options are very close on cost/complexity reduction and PR3 can potentially provide more scheduling flexibility, we are fine with PR3 for progress.  Also, we are open and would like to hear more views for the complexity differences between BW3 and PR3. | |
| Lenovo | Option 1 | We have same view with QC. | |
| NEC | OK with either option | With assumption option 1 does not exclude PRB allocation at any frequency location within 20MHz BW. | |
| Xiaomi3 | Option 1 | With the reduced peak data rate, there is no need to schedule unicast PDSCH more than 5MHz during RRC connected states. From our point of view, one-shot processing is enough in the baseband even though the post-FFT buffering is 20MHz, which wouldn’t introduce any processing delay. Besides, for the RIV field design, we share the same view as FUTUREWEI that no optimization is needed. | |
| ZTE, Sanechips | Option 1 | From the perspective of peak data rate, there is no requirements for exceeding 5MHz. From the perspective of performance, there is no much additional diversity gain for 20MHz bandwidth scheduling compared with 5MHz. Therefore, for Rel-18 RedCap UE, there is no need to support the DL resource allocation larger than 5MHz in unicast.  Further, we understand, this proposal is used to discuss the gNB DL resource assignment and the post-FFT buffer is a separate issue. For example, the 20MHz post-FFT buffer size can also be assumed for option 1. To be clearer, the following note can be considered for option 1.   * **For UE BB bandwidth reduction, for unicast PDSCH, which option is preferable?**   + **Option 1: A UE is not expected to receive a DL assignment in DCI with a resource allocation spanning a bandwidth of more than 5 MHz**     - **Note: it does not mean 5MHz post-FFT buffer size is assumed** | |
| Nordic | Option 1 | For unicast, and here we understand that distributed VRB is not allowed. | |
| Panasonic |  | We are not sure the question is related to 1) the assigned resource is always within physically contiguous 5MHz or not 2) the maximum FDRA field size (or BWP size) is 5MHz or 20MHz  For (1), our view is the assigned unicast PDSCH resource can be more than physically contiguous 5MHz but less than 20MHz. The maximum number of PRBs in the resource allocation corresponds to ~5 MHz.  For (2), our view is maximum is 20 MHz. | |
| vivo2 |  | @ DCM, QC, we see for you are fine with FL **High Priority Proposal 2-3-1b.** But still mentioned about the more cost can be achieved for BW3 compared to PR3.  We would like to understand, if you support to allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation) for Rel-18 eRedCap, how BW3 can save the cost compared to PR3 and maintain the moderate SIB1 reception performance?  From our understanding, soft combining multiple SIB1 repetitions is more complex compared to just support post-FFT buffer size to 20MHz. If for SIB1 reception, the post-FFT buffer size is 20MHz already, how BW3 can save more cost? | |
| MediaTek3 |  | @ZTE, If we are designing specifications from scratch, I may be able to agree with you. Unfortunately, we are not. Specifications for **Rel-17 RedCap** have been completed and **should serve as a baseline for Rel-18 eRedCap to start with**.  Similar to UL discussion, the more important questions to us are:  (1) **Question 1:** What benefit(s) does this Option 1 bring?  (2) **Question 2:** Can or cannot the current specifications (for Rel-17 RedCap) achieve the identified benefits of Option 1? If not, please explain more.  Finally, **if no additional frequency diversity gain as claimed by ZTE, we think semi-static indication of 5MHz “sub-band” would be sufficient for Option 1**. The dynamic indication proposed by CMCC proposed in should not be further considered for Option 1. | |
| Huawei, Hisilicon | Option 2 | As commented by other companies, the cost reduction difference between Option 1 and Option 2 is small.  We are also fine with Option 1 if post-FFT buffering is confirmed as 20MHz bandwidth. |
| LGE | Option 1 | We share the views from Intel and Qualcomm. We also doubt if we can get a tangible scheduling flexibility from PR3. |
| Ericsson | Option 2 | Due to the similar reasons as highlighted by others — complexity differences between Option 1 and Option 2 are very small, and Option 2 provides more scheduling flexibility.  Note that resource allocation Type 0 for PDSCH, which is currently mandatory for all UEs to support, could also result in a wider allocation than 5 MHz.  Regarding Panasonic’s questions, our understanding is as follows:   * If the assigned unicast PDSCH resource can be more than physically contiguous 5 MHz, this would correspond to Option 2. * The BWP size can be up to 20 MHz, and Question 2-1-3a is not related to this aspect. |
| CMCC | Option 1 | The cost reduction gain of BW3 will be a bit larger when post FFT data buffer can be reduced with either semi-static, cross-slot options.  And the frequency diversity loss is not true for cross slot scheduling, or dynamic indication of semi-static configuration of frequency region of PDSCH/PUSCH.  And we think the channel estimation bandwidth is smaller for BW3 than PR3. For PR3, UE has to do channel estimation of the whole 20MHz, but for BW3, only channel estimation within 5MHz is needed.  Whether frequency resource allocation within 5MHz can be distributed or localized can be further discussed. |
| OPPO | Option 2 | For simplicity and consistent to other aspect like hopping, this Option 2 is more straightforward. |
| CATT | Option 1 | Prefer Option 1 at least for now. This question is more like asking whether BW3 or PR3 is preferred. |
| SONY | Option 1 | Our understanding is that BW3 is lower complexity than PR3.  We would be OK with the sub-bullets from MTK, but think the restriction related to cross-slot scheduling is actually that same-slot scheduling is not supported. Hence we would prefer:   * **Option 1: A UE is not expected to receive a DL assignment in DCI with a resource allocation spanning a bandwidth of more than 5 MHz**   + **Support at least one of the following solutions to make the reduction of post-FFT buffering to 5MHz possible for UE:**     - **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)**     - **Same-slot scheduling for PDSCH is not supported (for unicast and/or broadcast)**     - **Other solutions are not precluded** |
| Nokia, NSB | Option 1 | We have a preference for BW3 as noted in previous round. However, we do not want to mandate semi-static indication or cross-slot scheduling as this would restrict scheduler flexibility / increase complexity and also require considerable standardization effort considering small complexity reduction. Therefore, we are also fine with Option 2 if it is simpler. |
| FL7 | Based on the received responses, the following proposal can be considered.  **High Priority Proposal 2-1-3b: For UE BB bandwidth reduction, a UE is not expected to receive an DL assignment in a DCI with a unicast PDSCH resource allocation spanning a bandwidth of more than ~5 MHz.** | |
| FL8 | The online (GTW) session on Monday 17th October made a SIB1-related agreement with an FFS regarding the *UE post-FFT buffering “assumption”*. Based on the received responses and the discussion in the online session, the following question can be considered.  **High Priority Question 2-1-3c: For UE BB bandwidth reduction, what should be the UE post-FFT buffering “assumption”? Please consider both unicast and broadcast in your answer.** | |
| Xiaomi4 | We support post-FFT buffer size to 20MHz for broadcast channel to guarantee the transmission performance and reduce the latency. We are also fine with 20MHz post-FFT buffering for unicast PDSCH channel since it shares the same design as broadcast channel. | |
| DOCOMO | Our assumption is 5MHz post-FFT data buffer size for both unicast and broadcast.  According to the discussion in RAN plenary, majority of companies supported BW3, which supports post-FFT data buffer size reduction, for Rel-18 RedCap UE BB BW reduction since it can provide good balance of complexity reduction and impacts, and hence the objective in the WID is described based on the definition of BW3. The impacts on performance/co-existence/spec of BW3 have been already much reduced compared to other BW reduction options in SI, i.e., BW1 and BW2. Furthermore, the impacts on BW3 can be further minimized depending on the solution, and we think the impacts on BW3 would be reasonable. This WI aims further complexity reduction from Rel-17 RedCap and we should work to reduce the UE complexity.  In addition, as we commented in the previous round, 1% difference on complexity reduction gain between BW3 and PR3 which was captured in TR is questionable since the assumption on post-FFT buffer was not exactly the same for BW3 among companies. In other words, we believe that the complexity reduction gain on BW3 would be larger than the value which is captured in the current TR if the complexity on the post-FFT data buffering block is surly reduced. Therefore, we still believe the reduction on post-FFT data buffer size is worth to discuss.  If larger size of post-FFT data buffer than 5MHz is supported for either of unicast or broadcast PDSCH/PUSCH, we don’t see the need to restrict the post-FFT data buffering size, i.e., it should be 20MHz for both unicast and broadcast. | |
| MediaTek | **Post-FFT buffering of 20MHz** is more reasonable and **should be assumed for UE** to receive SIB1 that can be allocated up to 20MHz as legacy. We share a similar view with Xiaomi that hence 20MHz post-FFT buffering is assumed for unicast PDSCH.  Again, the assumption for UE to receive only 5MHz out of a 20MHz SIB1 (i.e. partial SIB1 receptions) and performs soft combing of multiple partial SIB1 receptions (with RF retuning for better performance) is **unreasonable**! Even if this assumption could indeed reduce UE’s post-FFT buffering size to 5MHz for some symbols in a slot, this soft-combining approach requires UE (1) additional power consumption (2) longer initial access latency than legacy UEs, and (3) additional implementation changes and verification efforts if Rel-18 eRedcap UE implementation is based on Rel-17 RedCap UE implementation.  @DCM, thanks for sharing your views in detail. I appreciate that you are trying to carry out what you have assumed for BW3 in TR in the WI. But even with BW3 and your suggested direction, **it is still questionable to us whether UE can actually reduce its post-FFT buffering to 5MHz for most of the symbols in a slot.** Can you explain more about your assumptions on UE complexity analysis with BW3 for at least the following aspects:   * Semi-static or dynamic indication (via DCI) of which 5MHz sub-band is allocated? * Cross-slot scheduling? * CSI-RS receptions with BW3 | |
| vivo | We think 20MHz as UE post-FFT buffering assumption is the best solution from the perspective of UE complexity, NW scheduling flexibility, SIB1 performance and specification impacts. Following is the detailed analysis:  We see different assumptions and related UE behaviour in relation to the post-FFT buffering:   * + - 1. UE's post-FFT buffer size is 20MHz, the UE can buffer and process all the resources used for broadcast PDSCH such as SIB1/paging etc. Given broadcast PDSCH does not require HARQ feedback, no need to specify the processing timeline and good coverage performance can be achieved.       2. UE's post-FFT buffer size is 5MHz, UE pcutures the resources that larger than 5MHz. It is not clear how UE knows which 5MHz it should buffer. Solutions like cross-slot scheduling is not supported for broadcast PDSCH based on current specification, semi-statically define the 5MHz location largely restrict NW’s scheduling. In addition, puncturing results in big performance loss for SIB1 and paging. However, compare between 20MHz post FFT buffer size and soft combing with 5MHz post FFT buffer size, soft combining would be more complex for UE. It is noted that soft combining may be workable for SIB1, but cannot work for paging.       3. UE's post-FFT buffer size can be smaller than 20MHz, but larger than 5MHz. UE buffers 20MHz for several symbols before PDCCH decoding is finished and buffer the scheduled resources after decoding PDCCH. For this solution, for shared SIB1 with BW larger than 5MHz, clarification is still needed on which resources within 5MHz UE should buffer. In order to make the post-FFT buffer size reduction meaningful, not the paper work, how many symbols are needed for buffering the 20MHz should be defined. Note that for type 1 CSS without dedicated RRC configuration and for type 0, 0A, and 2 CSS, the monitoring occasion can be any OFDM symbol(s) of a slot.   If 20MHz post FFT buffering size is required, then for unicast PDSCH, then the non-contiguous PRB allocation for unicast PDSCH cross 20MHz can be supported which allows better flexibility for the NW side. But since gNB already knows Rel-18 eRedCap BB bandwidth is 5MHz, then the scheduled number of PRBs for unicast PDSCH should not exceed 5MHz e.g. 25PRBs@15KHz SCS and 11 PRBs@30KHZ SCS. | |
| Panasonic | The assumption for post-FFT buffer is commonly applicable to unicast and broadcast as we assume the same buffer is used. The assumption is used to know/determine the expected performance of PDSCH especially for unicast, paging and RAR. If RAN4 agree it, it also can be used to determine the performance requirements. The broadcast channel with retransmission (SIB1 and OSI) would not require so strict assumption. The broadcast channel without retransmission (paging and RAR) requires more exact assumption.  The assumption of post-FFT buffer is 20 MHz buffer over 1 slot with RE level (I/Q level) buffering. Depending on the decoding speed of DCI, the size can be less than 1 slot but it is not required to discuss the decoding time of DCI. Within 20 MHz, the maximum number of PRBs in the resource allocation corresponds to ~5 MHz. gNB may boost PSD of these assigned PRBs to improve the coverage of these channels.  The actual realization of post-FFT buffering is up to UE implementation as far as RAN4 requirement is satisfied. Therefore, these are "assumption". | |
| Nordic | 20MHz post-FFT buffer will allow UE to process 20MHz SIB1 PDSCH within 5 slots. We fully disagree with statements that 20MHz post FFT buffer will remove all complexity reduction gain. Contribution of post-FFT buffer to complexity reduction has been shown to be small (**1%->0.25%**).  Just for comparison 50% reduction in CCE/BD limits would bring **5->2.5%** reduction 😉 and still would allow to receive all PDCCH candidates for legacy SIB1  Agree that same buffer, if available, can be used for unicast. | |
| Lenovo | For broadcast channel, since the scheduling is mostly based on time domain default A table, where cross-slot scheduling is not supported, the UE may not have time to finish PDCCH decoding before PDSCH reception. Therefore, the UE may not know which frequency domain resources to buffer, so the safest way is buffer all 20MHz data. On the other hand, the default A table supports quite flexible PDSCH starting symbol, and if the gap between the PDSCH starting symbol and PDCCH end symbol is big enough for PDCCH decoding, there is no need for the UE to buffer 20MHz. Even the gap is not big enough, UE might just miss limited number symbols (for PDCCH decoding) to receive the channel, which may lead to only marginal performance loss,  For unicast channel, if preconfigured 5MHz position is allowed or cross-slot scheduling is configured, the UE can buffer only 5MHz, otherwise 20MHz buffering shall be assumed. | |
| CATT | * For unicast PDSCH:   The UE is not expected to buffer more than ~5MHz bandwidth. This can be easily realized by e.g. pre-known 5 MHz range, or cross-slot scheduling.   * For broadcast PDSCH:   The UE can implement one of:   * + Buffering 20 MHz, and try one-slot SIB1 decoding, or adopt soft combining of multiple SIB1 of 20MHz in differnet slot.   + Buffering 5 MHz, and try one-slot SIB1 decoding, or adopt soft combining of multiple SIB1 in same or different 5 MHz in different slot.     - Nomally, the network will not have fast varying resource allocation for SIB1. The UE can try to receive useful 5 MHz based on the FDRA of SI-RNTI DCI in previous SIB1, or same SIB1 in previous periodicity. | |
| Nokia, NSB | We support 20 MHz post-FFT buffer for both unicast and broadcast. For broadcast PDSCH, since SIB1 can be larger than 5 MHz for sharing with legacy UEs, post-FFT buffering should be 20 MHz as cross-slot scheduling / semi-static allocation is not supported by existing specification and implementation. The same capability can also then be used for unicast PDSCH. | |
| FUTUREWEI | The standards should not dictate hardware architecture (e.g. 20 MHz post-FFT buffer); for the same standards requirement, there may be several possible architectures. Secondly, although the requirements are different for connected and idle/inactive states, the same hardware architecture is generally used. Thus, we should not have statements regarding UE post-FFT buffering “assumption” but statements regarding the scheduled transmissions.  In the idle/inactive state, broadcast PDSCH is often one-shot and infrequent. Using lower MCS / TB scaling and enabling VRB-to-PRB mapping helps one-shot performance but increases the number of transmitted PRBs in each slot. If we allow scheduled transmitted PRBs to be distributed within 20 MHz, we need to identify possible expectations that can lower complexity. One of which can be applying the “for the maximum number of PRBs that the UE can process per slot” for broadcast. But we must first examine the impact of that limit to each broadcast case.  We should also consider how to reduce the complexity beyond the “process per slot” in the connected state. We are open to examining scheduling restrictions as well as other reductions. | |
| Ericsson | A Rel-18 RedCap UE should support 20 MHz post-FFT buffer.  The reasons are as follows (we assume same-slot scheduling):   * For both unicast and broadcast PDSCH, at least until PDCCH is decoded, the post-FFT buffer must be 20 MHz. * For broadcast PDSCH, after decoding PDCCH, the post-FFT buffer can be either 5 MHz or 20 MHz.   + For SIB, if 5 MHz post-FFT buffer is assumed, the UE may have to do soft combining of multiple SIB1 transmissions. If, on the other hand, 20 MHz post-FFT buffer is assumed, the UE can receive and buffer up to 20 MHz, but process only 5 MHz chunk of SIB1 per slot.   + For paging, if 5 MHz post-FFT buffer is assumed, the UE may sometimes miss paging if the NW multiplexes large number of paging records in the paging message to a Rel-18 RedCap (as the number of scheduled PRBs may be much larger than 5 MHz in this case). Note that the NW can, if it wants, schedule paging message to the Rel-18 RedCap UE with a few paging records and BW less than 5 MHz. There wouldn’t be any need for RAN1 spec changes in this case (core network signaling would suffice). If, on the other hand, 20 MHz post-FFT buffer is assumed, the UE can receive and buffer up to 20 MHz, but process only 5 MHz chunk of paging message per slot. * For unicast PDSCH, after decoding PDCCH, the post-FFT buffer can be either 5 MHz or 20 MHz. Having 20 MHz BW enables PR3-like solution for unicast PDSCH. As commented before, this would provide better scheduling flexibility. * For unicast PDSCH, the semi-static configuration of the 5-MHz frequency location (as Proposal 2-9c) might be possible. This may help to reduce the post-FFT buffer during decoding of PDCCH. However, such a solution is possible only for unicast PDSCH, but not for broadcast PDSCH. Therefore, the UE anyway must support 20 MHz buffer as the same buffer would be used for buffering unicast PDSCH and broadcast PDSCH.   Based on the above considerations, we think that there are strong reasons why Rel-18 RedCap UEs should support 20 MHz post-FFT buffer. Also, additional cost saving by reducing post-FFT buffer from 20 MHz buffer to 5 MHz buffer would be very small (less than 1%) as shown below.   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | **Complexity reduction** | **FD-FDD 1Rx** | **TDD 1Rx** | **HD-FDD 1Rx** | **FD-FDD 2Rx** | **TDD 2Rx** | **HD-FDD 2Rx** | | BB bandwidth reduction **with** post-FFT buffer reduction | 5.8% | 5.1% | 6.8% | 7.2% | 6.1% | 7.9% | | BB bandwidth reduction **without** post-FFT buffer reduction | 5.17% | 4.63% | 6.08% | 6.25% | 5.46% | 7.02% |   However, we would not be fine with additional processing time relaxations to allow the Rel-18 RedCap UE to process the 20 MHz buffered data (PR3+PT1 is not one of the recommended combinations as per TR 38.865). | |
| Intel | We prefer to not enforce post-FFT buffer to 20MHz since it hurts complexity reduction of UE. Note: the observed complexity reduction gain is not that large, so we should be careful to obsolete a feature. The specification should allow a UE implementation which only support post-FFT buffer of 5MHz. The SIB1 transmission should consider for such low-end UE.  We continuously support **High Priority Proposal 2-1-3b**.  Have said all above, the size of post-FFT buffer can be up to UE implementation. If some UE vendors want to use 20MHz post-FFT buffer for high UE capability, it is definitely doable since it will not cause any negative impact to UE or gNB performance/operation, but the whole design in RAN1 should not base on the assumption of 20MHz post-FFT buffer. | |
| Qualcomm | We understand that the spec does not enforce any specific implementations for a UE behavior, e.g., how to buffer the data. However, for the better/common understanding on the eRedCap UE behavior, we are OK to discuss baseline assumption for the post-FFT buffering.  Considering dynamic indication of resource allocation and same-slot scheduling at least for broadcast channel (e.g., SIB1), our baseline assumption is that UE supports post-FFT buffering of a configured BWP, up to 20MHz. Depending on UE implementation, e.g., DCI decoding speed or UE buffering flexibility, UE may be able to reduce the post-FFT buffering to only allocated RBs after a certain point where DCI information is available at. If 20MHz post-FFT buffering is assumed for broadcast PDSCH, then same assumption is applied to unicast PDSCH as well.  We’d also like to add that 20MHz post-FFT buffering assumption does not necessarily mean any preference between BW3 and PR3, which needs further discussion based on the outcome of this discussion. We also need to discuss whether a broadcast PDSCH with BW larger than 5MHz can be processed over multiple slots as a separate issue. | |
| ZTE, Sanechips | Since the gNB scheduling flexibility should be guaranteed and timeline relaxing is precluded in RAN, we can be open to consider 20MHz post-FFT buffer size without the timeline relaxing.  Based on 20MHz post-FFT buffer size, we still think the maximum number of PRBs for unicast should be within 5MHz, which is aligned with our peak data reduction requirement in the WID. In this case, the timeline relaxing is not needed for unicast. | |
| Spreadtrum | Our understanding for post FFT-buffering is:   * For unicast: X symbols for 20Mhz buffer + (14-X) symbols for 5MHz buffer, X is related to DCI decoding time, and it’s up to UE implementation. * For broadcast: same as unicast, and if the scheduled broadcast PDSCH is larger than 5MHz, after X symbols, it is up to UE to select 5MHz PRBs that need to be buffered and processed.   In addition, we don’t see any buffer differences between BW3 and PR3. For PR3, after the DCI is decoded, the UE only need to extract and buffer ~25PRBs within 20Mhz (i.e., no need to buffer 106PRBs). In this regards, two options are very close on cost/complexity reduction and PR3 can potentially provide more scheduling flexibility. | |
| CMCC | The maximum post FFT buffering bandwidth has been determined the day we agreed that “The other physical channels and signals are still allowed to use a BWP up to the 20 MHz maximum UE RF+BB bandwidth.”. The point is whether we need to do something based on this to further reduce the UE complexity. And we also think the cost reduction gain is under estimated since companies has different understanding on the degree of buffering reduction during SI.  For broadcast PDSCH, UE has to receive and process PDCCH which may be with larger bandwidth up to 20MHz. And before it can still buffer larger bandwidth until successfully decoding PDCCH. And then if the UE wants to reduce its buffer, and it can accept initial access delay then it can choose to buffer part of the bandwidth smaller than 5MHz based on UE implementation. And for other UEs, they can always buffer up to 20MHz based on UE implementation. For paging scheduling, since no repetition, UE can decide whether to buffer the whole paging PDSCH scheduling depending on the scheduling bandwidth.  For unicast PDSCH, surely we can do something to reduce the post FFT data buffer since there is no need to consider sharing with other UEs. Otherwise, there is no need to specify “UE BB bandwidth reduction” part in the WID, only “UE peak data rate reduction” with as hardcoded limit of RB numbers, that is enough.  So the maximum post FFT data buffer for other channels is always 20MHz. And the maximum post FFT data buffer for broadcast PDSCH can based on UE implementation. And the maximum post FFT data buffer for unicast PDSCH can be reduced to be within 5MHz. | |
| LGE | We prefer the specification to support the eRedCap UEs assuming only 5 MHz post-FFT buffering for maximum cost/complexity reduction. Some performance loss may be expected for those UEs but should be acceptable according to the eRedCap study. The same assumption on post-FFT buffering should be reasonable. Therefore, we think the specification should take into account the eRedCap UEs with only 5 MHz post-FFT buffering. | |
| NEC | We support 20 MHz post-FFT buffer. It should be beneficial for co-existence with legacy UE including Rel-17 RedCap UE and network flexibility with small cost of UE complexity. On the other hand, we share similar feeling with FUTUREWEI. We are reluctant to mention about UE implementation. | |
| DOCOMO2 | We have strong concern on complexity/cost saving gain for Rel-18 eRedCap compared to Rel-17 RedCap. If 20 MHz post-FFT data buffering is assumed, this does not mean just to allow distributed allocation across 20MHz, but also allow to receive larger number of PRBs than 5MHz at a time. It is questionable that the meaningful complexity/cost saving from Rel-17 RedCap would be really obtained just restricting the number of processing PRB per unit time.  We have already compromised to support BW3 for UE bandwidth reduction in Rel-18 although our preference was BW1 for its attractive complexity/cost saving gain, and would like to pursue the complexity reduction as much as possible.  If companies really think that complexity/cost saving from Rel-17 RedCap is surely realized regardless of post-FFT data buffer size, we can accept the assumption of 20 MHz post-FFT data buffering for the sake of progress.  @MediaTek  Thanks for your comments. In general, complexity/cost saving and impacts are trade-off thus, we are fine to consider cross-slot scheduling and/or semi-static/pre-defined FDRA especially for unicast PDSCH to reduce post-FFT data buffering size. For CSI-RS, we think a UE can receive CSI-RS up to 20 MHz, regardless of post-FFT DATA buffering size. For paging (mentioned in High Priority Proposal 2-4d), in our understanding, gNB can transmit the PDSCHs which include the same contents associating with multiple PO, and hence the same handling as SIB1 can be applied, i.e., soft-combining for multiple reception attempts. | |

**FL6 High Priority Question 2-1-4a:**

* **For UE BB bandwidth reduction, for PUSCH, which option is preferable?**
  + **Option 1: A UE is not expected to receive an UL grant in DCI with a resource allocation spanning a bandwidth of more than 5 MHz**
  + **Option 2: A UE is not expected to receive an UL grant in DCI with a resource allocation spanning a bandwidth of more than 20 MHz**
* **Note: In both options, the maximum number of PRBs in the resource allocation corresponds to ~5 MHz**

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| **Company** | **Option** | **Comments** | |
| FUTUREWEI | Option 2 | With option 1, we are unclear if intraslot frequency hopping for Msg3 would be allowed when the hop exceeds 5 MHz? | |
| vivo | Option 2 (1st preference)  Option 1 (2nd preference) | We have following understandings on above proposal, if not correct, then further clarification is needed.   * The PUSCH in above proposal does not include the MSG3, MSG3 can be separately discussed, since the UL grant for scheduling PUSCH is in RAR, PDSCH, not DCI. * The resource allocation for PUSCH intends for the FDRA field in the DCI, whether the FDRA can indicate a resource allocation spanning a bandwidth of more than 5 MHz. So, if FH is enabled, the proposal intends for resource allocation per hop. Maybe we can add “per hop in case FH is enabled” at the end of each option.   Option 2 allows non-continuous resource allocation for PUSCH. Support Option 2 does not mean UE can support the non-contiguous PUSCH resource allocation. It depends on UE capability. Per our understanding, currently no RAN4 UE features support the non-contiguous PUSCH resource allocation, even *almostContiguousCP-OFDM-UL* is one optional UE feature. But from the specification perspective, we think non-contiguous resource allocation for PUSCH can be supported. So our 1st preference is Option 2. | |
| MediaTek | Option 2 | With Option 1, our view is that Msg3 intra-slot frequency hopping should be limited to be within 5MHz.  Our understanding is that non-contiguous or contiguous PUSCH resource allocation is a separate discussion which can be indicated by UE capability signalling as legacy. Both Option1 and Option2 allow both contiguous and non-contiguous resource allocation. The difference is the bandwidth span range. | |
| Intel |  | Need clarification on how intra/inter-slot frequency hopping is handled. We prefer to clarify that each hop of PUSCH is limited within 5MHz, then the two hop may be 20MHz BW. | |
| DOCOMO | Option 1 per hop | In our view, regardless of intra-slot or inter-slot FH, each hop should not exceed 5MHz but whether the total bandwidth of 1st and 2nd hop can span larger bandwidth than 5MHz is FFS. Thus, we think at least we can agree on Option 1 with adding “per hop” as follows;  **Option 1: A UE is not expected to receive an UL grant in DCI with a resource allocation spanning a bandwidth of more than 5 MHz per hop** | |
| Qualcomm | Option 1 | For uplink PUSCH, we clarify again that non-contiguous resource allocation is not allowed in the spec (38.214 & 38.101-1) for RedCap UEs regardless of UE capability as we explained in our feedback to **High Priority Proposal 2-6b.** Following what is defined in current spec, we do not see any reason to support option 2.  Regarding the intra-slot frequency hopping, we can solve it by adding “per hop” as proposed by DOCOMO. | |
| Spreadtrum |  | Similar view as other companies, clarifications on FH is needed. DOCOMO’s wording is fine for us. | |
| Lenovo | Option 1 |  | |
| MediaTek 2 | Option 2 | Before jumping into the intra-slot FH discussion, more important questions to us are:  **Question 1: What benefits can Option 1 provide? In what aspects? (e.g. UE complexity, gNB scheduling flexibility, etc.)**  **Question 2: Can current specifications for Rel-17 RedCap achieve Option 1? If not, why not? Please elaborate more details.**  When answering the above questions, please take the following statement in WID into consideration.   * + ***The other physical channels and signals are still allowed to use a BWP up to the 20 MHz maximum UE RF+BB bandwidth.***   I may have missed something. However, with the above specified in WID and also with the understanding that contiguous or non-contiguous PUSCH resource allocation is a separate discussion, I have failed to identify the benefit of Option 1. It would be highly appreciated if any companies can explain to me and help me to move on. | |
| NEC | OK with either option | We assume both options do not exclude FH. | |
| Xiaomi3 | Option 1 per hop | We can’t see the benefit to allocate more resources for PUSCH than the eRedCap UE’s UL processing block can handle. And, if option 2 is adopted, the eRedCap UE also needs to further determine which resources is used to transmit PUSCH, which increases the complexity of UE’s implementation and is not preferred by us.  Thus, we support that, for both distributed and continuous resource allocation, the maximum BW should be limited within in 5MHz for PUSCH, which is the simplest and clearest way. But if frequency hopping is enabled, frequency hopping spanning more than 5MHz shouldn’t be restricted to obtain the frequency diversity gain. | |
| ZTE, Sanechips | Option 1 | We are fine with DOCOMO’s update for option 1. | |
| Nordic | Option 1 | Per hop | |
| Panasonic |  | We are not sure the question is related to 1) the assigned resource is always within physically contiguous 5MHz or not 2) the maximum FDRA field size (or BWP size) is 5MHz or 20MHz  For (1), our view is the assigned PUSCH resource should be limited within physically contiguous 5MHz.  For (2), our view is maximum is 20 MHz. | |
| Huawei, Hisilicon | Option 1 | DFT-s-OFDM waveform for PUSCH requires contiguous resource allocation. CP-OFDM waveform only support almost-contiguous allocation. Therefore, PUSCH should be limited within 5MHz.  For Msg3 with intra-slot hopping, the per-hop bandwidth is confined within 5MHz, but the effective bandwidth across two hops can be more than 5MHz. |
| LGE | Option 1 | Agree with Intel that the clarification how intra/inter-slot frequency hopping is handled is needed. Option 1 per hop as suggested by DOCOMO is fine for us. |
| Ericsson | Option 1 per hop as mandatory  Option 2 as optional | Regarding Panasonic’s questions, our understanding is as follows:   1. If the assigned PUSCH resource should be limited within physically contiguous 5MHz, this would correspond to Option 1. 2. The BWP size can be up to 20 MHz, and Question 2-1-4a is not related to this aspect. |
| CMCC | Option 1 | We are also fine with each hop. Since the RF bandwidth is 20MHz, the total bandwidth of 1st and 2nd hop spanning larger bandwidth than 5MHz is not a problem, and can ensure shared Msg.3 procedure with R17 RedCap. |
| OPPO | Option 2 | If consider the no-contiguous allocation, wider bandwidth would be easier for supporting in specification. |
| CATT | Option 1 | Same answer as previous one. But intra-slot hopping interval is not limited within 5 MHz. |
| SONY | Either is OK |  |
| Nokia, NSB | Option 1 | Agree with Intel on the clarification on frequency hopping. We share similar view that each hop of PUSCH is limited within 5 MHz but the two hops can be up to 20 MHz. |
| FL7 | Based on the received responses, the following proposal can be considered.  **High Priority Proposal 2-1-4b: For UE BB bandwidth reduction, a UE is not expected to receive an UL grant in a DCI with a PUSCH resource allocation spanning a bandwidth of more than ~5 MHz per hop.** | |
| FL8 (info) | Based on the proposal, the online (GTW) session on Monday 17th October made this agreement:  Agreement:  For UE BB bandwidth reduction, a UE is not expected to receive an UL grant in a DCI with a PUSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot or per hop, if applicable. | |
| DOCOMO | Strictly speaking, this agreement does not include the PUSCH scheduled/configured to transmit by higher layers e.g., Msg3 PUSCH scheduled by RAR and/or Type-1 CG-PUSCH configured by RRC signalling. In our view, this agreement should be simply applied to such cases and hence, we propose to make another agreement for the PUSCH scheduled/configured to transmit by higher layers. | |
| Vivo | We are fine to make the similar agreement for PUSCH transmission configured by RRC. | |
| CATT | Just share some initial thinking on the PUSCH not scheduled by UL grant:   * Type 1 CG-PUSCH   Currently, we do not identify any issues to apply this agreement also to Type 1 CG-PUSCH.   * Msg3   Theoretically, if early indication in Msg1 dedicated for Rel-18 eRedCap UE is not applied, the network may not know that Msg3 should be restricted within 5 MHz. However, if payload of Msg3 is very small (e.g. less than 80 bits, no SDT), it is natural to schedule a Msg3 within 5 MHz. It should be easy to leave this to network implementation to guarantee the Msg3 bandwidth within 5 MHz. Maybe OK to also apply this agreement to Msg3, too. | |
| Ericsson | We are also fine with making similar agreements for CG-PUSCH and Msg3 PUSCH. | |
| Intel | We are fine with proposal from DoCoMo | |
| ZTE, Sanechips | Suggestion from DOCOMO makes sense. | |
| MediaTek | For Msg3 rescheduling restriction, **we don’t support DCM’s proposal** because **this requires the support and enabling for separate Msg1 early indication and scheduling restriction for PUSCH including Msg3 is NOT justified.**  For the following two reasons, this whole uplink scheduling restriction confining to 5MHz is **unnecessary** as we commented online in GTW call this Monday.  **Reason 1:** Rel-18 eRedCap needs to support 20MHz uplink transmissions anyway per current WID description.  Per the following description in WID, UE needs to support PUCCH and SRS up to 20MHz per the following statement from WID.   * + *UE BB bandwidth reduction*     - *5 MHz BB bandwidth only for PDSCH (for both unicast and broadcast) and PUSCH, with 20 MHz RF bandwidth for UL and DL*     - ***The other physical channels and signals are still allowed to use a BWP up to the 20 MHz maximum UE RF+BB bandwidth.***   **Reason 2:** The complexity difference between BW3 and PR3 on uplink related modules is basically zero.  Based on TR analysis, the modules directly related to uplink, e.g. UL processing block and FFT/IFFT, there is almost zero difference between PR3 and BW3. In fact, PR3 reaches slightly better complexity reduction on UL processing block than BW3 in some duplex+Rx combinations.  Table: Average UE complexity reduction achieved by BW3 and PR3 for FD-FDD 1Rx (compiled from Table 7.2.2-1 and Table 7.3.2-1   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Reduced UE bandwidth | Rel-15 reference | Rel-17 RedCap | BW3 | PR3 | | RF: Power amplifier | 25% | 24.12% | 24.09% | 24.12% | | RF: Filters | 10% | 5.06% | 5.06% | 5.06% | | RF: Transceiver (incl. LNAs, mixer, and local oscillator) | 45% | 23.76% | 23.76% | 23.76% | | RF: Duplexer / Switch | 20% | 19.52% | 19.52% | 19.52% | | **RF: Total** | **100%** | 72.46% | 72.43% | 72.46% | | BB: ADC / DAC | 10% | 1.30% | 1.27% | 1.26% | | BB: FFT/IFFT | 4% | 0.67% | 0.65% | 0.65% | | BB: Post-FFT data buffering | 10% | 1.05% | 0.67% | 1.01% | | BB: Receiver processing block | 24% | 4.42% | 2.07% | 2.46% | | BB: LDPC decoding | 10% | 1.29% | 0.51% | 0.49% | | BB: HARQ buffer | 14% | 1.46% | 0.45% | 0.43% | | BB: DL control processing & decoder | 5% | 4.73% | 4.52% | 4.55% | | BB: Synchronization / cell search block | 9% | 4.61% | 4.58% | 4.58% | | BB: UL processing block | 5% | 2.69% | 1.69% | 1.66% | | BB: MIMO specific processing blocks | 9% | 4.04% | 3.91% | 3.91% | | **BB: Total** | **100%** | 26.26% | 20.31% | 21.00% | | **RF+BB: Total** | **100%** | **44.74%** | **41.15%** | **41.58%** |   **Observation:** **Rel-18 eRedCap needs to support uplink transmission (PUCCH, SRS, and PUSCH) up to 20MHz anyway and the motivation for scheduling restriction to PUSCH is NOT justified!**  So back the Msg3 issue, if we agree to making this scheduling restriction applicable to Msg3, which again we don’t see a need based on the above rationale, it implies **gNB either needs to confine Msg3 to 5MHz for ALL UEs in the cell or a separate Msg1 early indication needs to be supported and enabled for Rel-18 eRedCap**.  With the above, **we don’t support this proposal.** | |
| LGE | We are also fine with the proposal from DOCOMO. | |

**Separate initial BWP**

Several contributions [9, 14, 15, 24, 28, 32, 33] propose that the initial DL/UL BWP operation framework for Rel-17 RedCap can be reused for Rel-18 RedCap. A few contributions [15, 28] express that there is no need to configure a separate initial BWP for Rel-18 RedCap UEs. One contribution [18] proposes to reuse MIB-configured initial DL BWP for Rel-18 RedCap. One contribution [24] proposes to discuss whether to support more than one initial DL/UL BWP.

**High Priority Proposal 2-2a: For UE BB bandwidth reduction, for a cell supporting both Rel-17 and Rel-18 RedCap UEs,**

* **The Rel-18 RedCap UEs can share the same separate DL/UL BWP as the Rel-17 RedCap UEs.**
* **FFS: whether to support an additional separate initial DL/UL BWP specific to Rel-18 RedCap UEs**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Huawei, HiSilicon | Y | Not sure why additional initial DL/UL BWP specific to Rel-18 RedCap UEs is necessary. But OK for FFS at this stage. |
| Nordic | Y | Hopefully “share” does not preclude R18 specific parameters in that BWP. |
| FL1 | Based on the proposal, the online (GTW) session on Monday 10th October made this agreement:  Agreement:  For a cell supporting both Rel-17 and Rel-18 RedCap UEs,   * The Rel-18 RedCap UEs can share the same separate initial DL/UL BWP as the Rel-17 RedCap UEs. * FFS: whether to support an additional separate initial DL/UL BWP specific to Rel-18 RedCap UEs | |
| Spreadtrum | As we commented at the GTW online, for some band (LTE reframing band or IOT band), maybe a cell can only support R18 RedCap (skip R17 RedCap), and then, how to configure separate initial DL/UL BWP for R18 RedCap needs to be confirmed, new IE for Rel.18 or reuse R17 RedCap IE? This issue can be a part of the FFS in the above agreements. | |
| LGE | In the concerned case from Spreadtrum, we think the same mechanism for configuring a separate initial DL/UL BWP can be reused without an issue. Whether it is a new IE or existing IE since Rel-17 RedCap, can be decided in RAN2. We are not sure if it is part of the FFS, but the agreement above doesn’t seem to affect the discussion on this aspect. I mean we can discuss in RAN1 if needed. | |

**Maximum span for the resource allocation**

Several contributions [10, 11, 16, 19, 21, 22, 25, 28, 29, 30, 32, 33, 34] discuss whether the resource allocation should span a bandwidth of maximum 5 MHz for PDSCH (for both unicast and broadcast) and PUSCH, or support distribution within 20 MHz bandwidth with a limitation of the maximum number of PRBs (at least for PDSCH). One contribution [25] suggests an approach where the PDSCH processing bandwidth is up to 5 MHz whereas the instantaneous PDSCH transmission bandwidth can be wider.

For unicast transmissions, some contributions [8, 9, 15, 33] propose that scheduled bandwidth does not exceed 5 MHz.

For broadcast PDSCH transmissions, some contributions [8, 15, 22, 25, 33] propose that the allocation can be larger than 5 MHz even though the UE only receives 5 MHz, whereas one contribution [24] expresses that the UE should not be expected to receive broadcast channels with wider bandwidth than 5 MHz. One contribution [9] proposes that this should apply for SIB but not for other broadcast transmissions, and a couple of contributions [26, 34] propose that the UE should receive the full bandwidth of some broadcast transmissions (e.g., SIB).

**High Priority Proposal 2-3a: For UE BB bandwidth reduction, for SIB1 (PDSCH) shared between Rel-18 RedCap UEs and other types of UEs, down-select between the following options:**

* **Option 1: Restrict the scheduling of SIB1 to be within 5 MHz**
* **Option 2: Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Y/N** | **Preferred option, if any** | **Comments** |
| Huawei, HiSilicon |  | Option 2 | Since 20Mhz SIB1 exists in current NR network and Rel-18 RedCap UEs are expected to share the same initial BWP with Rel-17 RedCap UEs, Option 1 seems not practical solution. |
| Nordic | Y | Option 2 |  |
| FL1 | Based on the proposal, the online (GTW) session on Monday 10th October made this agreement:  Agreement:  For UE BB bandwidth reduction, for SIB1 (PDSCH) to Rel-18 RedCap UEs, down-select between the following options,   * Option 1: Restrict the scheduling of SIB1 to be within 5 MHz * Option 2: Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation) * FFS: whether 5MHz is assumed to be physically contiguous | | |

**FL4/FL5 High Priority Question 2-3-1a: For the above SIB1 agreement, companies are invited to comment on:**

* **Their preferred option (1 or 2), if any**
* **The potential need for additional SIB1 link simulations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Preferred option, if any** | **Comments (e.g., on simulation needs)** | |
| Nordic |  | Of course, from UE point of view a separate SIB1 in 5MHz would be the best. But we understand that from gNB point of view this would be deployment complication, therefore we can live with Option 2, with understanding that 20MHz post-data buffering will be required at the UE. | |
| Nokia, NSB | Option 2 | Option 2 would allow the gNB to transmit SIB1 to both Rel-18 RedCap and legacy UEs without performance impact to the legacy UEs. If Option 1 is selected, that might mean separate SIB1 to Rel-18 UE may need to be supported since there is a large performance degradation when SIB1 is restricted to 5 MHz. This would introduce additional overhead and additional implementation complexity.  We don’t see the need for additional SIB1 link simulations as we already performed comprehensive analysis for SIB1 in the SI phase. | |
| FUTUREWEI | Option 2 | For operation in a legacy system, option 2 should be expected.  It is unclear what additional link simulation results can provide from the results in the study phase. | |
| Lenovo | Option 2 |  | |
| ZTE, Sanechips | Option 2 | Whether 5MHz or 20MHz post-FFT buffer size is assumed, the scheduling of SIB1should be possible to be larger than 5MHz, which can avoid the impacts on network or legacy UE.  As for the SIB1 link performance enchantment, we can further discuss it when we have further outcome about the post-FFT buffer size. | |
| Vivo | Option 2 | Based on our replies to **High Priority Question 2-1-1a,** it is questionable from both implementation and benefits perspective that UE’s post FFT buffering can be further reduced considering other DL transmissions can be within 20MHz BW. If it is cannot be further reduced, we do not see the need to restrict gNB’s scheduling, option 2 should be selected. | |
| CATT | Option 2 | Option 1 is only useful for separate SIB1, which is no consensus.  Even under Option 2, the network may choose to transmit a SIB1 smaller than 5MHz, if the payload is small. | |
| Spreadtrum | Option 2 | For SIB1 (PDSCH) shared between Rel-18 RedCap UEs and other types of UEs, option 2 is preferred.  For additional SIB1 link simulations, as we already simulated several essential cases (i.e., SIB1 PDSCH>5MHz or <=5MHz), we don’t think additional link simulation is needed. Is there any other cases will change the general results and observations for SIB1 performance? | |
| DOCOMO | Option 2 | In our understanding, Option 1 has two sub-options as follows;   * Opt.1-1: Separate SIB1 within 5MHz for Rel-18 RedCap UE * Opt.1-2: Shared SIB1 within 5MHz between legacy and Rel-18 RedCap UE   SIB1 is periodically transmitted, and hence Opt.1-1 increase the NW overhead. In addition, how the separate SIB1 can be scheduled needs to be discussed for Opt.1-1, thus it is not preferable from such perspective. For Opt.1-2, if SIB1 is restricted within 5MHz even for legacy UEs, it would have impacts on current deployment and/or performance of SIB1 for legacy UEs would be degraded largely.  Accordingly, we prefer Option 2 and UE can perform soft-combining for multiple reception attempts to improve the link performance. | |
| Sharp |  | From perspective of UE, option 1 is better. UE can read the SIB without additional effort. It may need a separate SIB1 or gNB may always schedule a SIB not exceeding the bandwidth of 5MHz in a cell which support eRedCap UE. We can live majority’s view if option 2 is selected. | |
| SONY | Option 2 | While option 1 is better for the UE, option 2 is better for the network and is probably the more realistic option. | |
| Qualcomm | Option 2 | If option 1 is chosen, EITHER it brings too much restriction on NW scheduler when SIB1 is shared between Rel-18 UEs and other types of UEs OR separate SIB1 has to be configured for Rel-18 UEs, which will introduce additional overhead. | |
| NEC | Option 2 | Option 2 enables network to share SIB1 among non-RedCap, Rel-17 RedCap and Rel-18 RedCap UE. To share SIB1 would be preferable at least to avoid increase of resource overhead and network energy consumption. | |
| MediaTek | Option 2 if “process per slot”  Option 1 if “receive per slot” | Again, if SIB1 is larger than 5MHz and if “process per slot” is agreed in Question 2-1-1a, we are fine with Option2 considering not impacting on legacy UEs. In this way, eRedCap UE can receive 20MHz of SIB1 in one slot and *process* 5MHz per slot in the following slots.  On the other hand, if UE is assumed to be able to *receive* 5MHz per slot, we prefer Option 1. The reasons are (1) to align with the assumptions companies have for UEs, and (2) to avoid UE will be forced to perform soft combining of SIB1. | |
| Panasonic |  | According to the coverage evaluation in the TR, performance of SIB1 with > 5 MHz received by an eRedCap (5 MHz) UE is better than bottleneck channel in most scenarios. Even if performance is concerned, the eRedCap UE can perform combining of multiple receptions (up to implementation). Therefore, Option 2 is acceptable for SIB1 and OSI.  On the other hand, the critical discussion would be paging and RAR, where the combining of multiple receptions is not possible. If RAN1 concludes option 1 for paging and RAR, to take option 1 for SIB1 and OSI is also natural choice.  In order to avoid PBCH usage for the indication of eRedCap dedicated SIB1, SIB1 should be shared by eRedCap UEs and all other UEs. If option 1 is taken, the shared SIB1 is operated as option 1. | |
| Samsung | Option 2 | For SIB1 PDSCH, we think no any enhancement is needed. SIB1 PDSCH performance loss due to truncation receiving can be compensated by UE implementation. | |
| CMCC | Option 2 | SIB1 is not the bottleneck and UE can also do soft combining based on implementation. | |
| Intel | Option 1 | Based on the evaluation in SI phase, SIB1 transmission within 5MHz can provide 2-4 dB gain over partial reception of SIB1 in e.g., 48 PRBs. Roughly speaking, to achieves same coverage, the required number of repetitions of the former option is about half of the latter one. As a result, Option 2 may NOT even save resource overhead at all. Taking SCS 30kHz as example, whenever gNB transmits one more SIB1 repetition of e.g., 48PRBs, only 11 PRBs are actually useful with remaining 37 PRBs simply wasted.  We don’t think further simulation is necessary since we already done a lot in the SI phase. | |
| Sequans | Option 2 | Option 2 is more reasonable for SIB1 shared between R18 RedCap UE and legacy UE. | |
| Ericsson | Option 2 | * Option 2 should be supported. Regarding Option 1, restricting a shared SIB1 to be within 5 MHz would mean increasing the MCS of the SIB1. This would lead to co-existence issues as it might cause SIB1 link performance loss also for other types of UEs. The MCS would need to be higher also for a dedicated SIB1 with BW restricted to be within 5 MHz. Also, since SIB1 transmissions are frequent and periodic, the network overhead would be significantly higher for Option 1. * Simulations for SIB1 with soft combining of multiple SIB1 repetitions available within the 160 ms SIB1 periodicity/TTI should be carried out. This would help to understand better (1) whether any enhancements/restrictions should be specified for SIB1 and (2) determine which among the 4 options for the maximum number of PRBs for a broadcast PDSCH should be specified (as in Q2-1-2a). | |
| LGE | Option 1 | Option 1 is preferred to avoid the potential UE complexity that may be required if the UE ought to handle the performance loss by UE implementation. | |
| MediaTek |  | Option 1 if BW3 is agreed or “receive” is agreed in [receive/process].  Option 2 if “process per slot” is agreed in [receive/process].  Don’t see a need to run additional SIB1 link simulations. | |
| Huawei, Hisilicon | Option 2 | To share SIB1 with legacy UEs, option 2 is preferred. | |
| Nordic |  | Same view as MTK. | |
| FL6 | Based on the received responses, the following proposal can be considered.  **High Priority Proposal 2-3-1b: Revise the following agreement as follows:**  For UE BB bandwidth reduction, for SIB1 (PDSCH) ~~to Rel-18 RedCap UEs, down-select between the following options~~,   * ~~Option 1: Restrict the scheduling of SIB1 to be within 5 MHz~~ * ~~Option 2:~~ Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation) * ~~FFS: whether 5MHz is assumed to be physically contiguous~~ | | |
| **Company** | **Y/N** | | **Comments** |
| FUTUREWEI | Y | |  |
| vivo | Y | |  |
| MediaTek |  | | Firstly, we would like to invite companies to share their assumption on UE’s post-FFT buffer size about this proposal.  **Question 1:** If Proposal 2-3-1b is agreed, what is your understanding on UE’s post-FFT buffer size?   * (1) 5MHz for the remaining 14-X-Y symbols in a slot   + X: # of PDCCH symbols   + Y: # of symbols for PDCCH decoding * (2) 20MHz for all 14 symbols in a slot   **Question 2:** If your answer is (1), do you assume UE to perform soft combining of SIB1?  Finally, we would like to add a note to Proposal 2-3-1b to clarify this proposal may require 20MHz post-data buffering at UE as pointed out by Nordic.  **Note: This may require 20MHz post-data buffering at UE.** |
| Intel |  | | We are fine to follow majority view to support SIB1 sharing. One clarification question, by ‘allow … (as in legacy operation)’, does it mean any SIB1 repetition would be shared by eRedCap UE and legacy UE? Or alternatively, some SIB1 repetitions are shared while other SIB1 repetitions may target eRedCap UE only? |
| DOCOMO | Y | | We agree with Ericsson’s observation. |
| MediaTek2 |  | | We would like to update our proposed Note as follows:  **Note: This requires 20MHz post-FFT buffering at UE.**  Some companies may claim that only 5MHz post-FFT buffering is required. UE can perform soft combining of multiple SIB1 receptions to receive a SIB1 larger than 5MHz. However, this requires UE’s implementation changes and additional verification efforts. In addition, sorry for repeating myself, soft combing of SIB1 is at the cost of UE power consumption and initial access latency. Therefore, in order to support this proposal with SIB1 than 5MHz, UE would rather to equip 20MHz post-FFT buffer rather than performing soft combining of partial receptions of SIB1. |
| Qualcomm | Y | | Support FL proposal. |
| Spreadtrum | Y | |  |
| Lenovo | Y | |  |
| NEC | Y | |  |
| Xiaomi3 | Y for 20MHz post-FFT buffering at UE | | We agree with MediaTek to add the note for this proposal. |
| ZTE, Sanechips | Y | |  |
| Nordic | Y | | We believe UE has a choice of combining or buffering, but that can be left up to implementation. |
| Panasonic | Y | |  |
| Huawei, Hisilicon | Y | | Rel-18 RedCap UEs should be able to share the legacy SIB1 with non-RedCap UEs and Rel-17 RedCap UEs.  Support MediaTek’s note for post-FFT buffering. |
| LGE | Y (as it is) | | We can follow the majority view for this proposal, but can’t if the note on the post-FFT buffering is to be added. We think agreeing on this proposal should not mandate any UE implementation (either combining or buffering) yet and also should not mean any follow-on specification work to compensate the performance loss. |
| Ericsson | Y | | We agree with Huawei that Rel-18 RedCap UEs should be able to share the legacy SIB1 with non-RedCap UEs and Rel-17 RedCap UEs.  We agree with Nordic that the choice of combining or buffering for SIB1 can be left up to implementation. |
| CMCC | Y | | UE of course can combine SIB1 on different repetition occasions. This does not has to be bundled with 20MHz post -FFT buffering. |
| OPPO |  | | We suggest make more specific value of bandwidth, if we go this direction. E.g. 10MHz could be considered. We wonder if 20MHz processing capability is mandatory, then there is little room form unicast optimization since they may shared with broadcast. |
| CATT | Y | | When soft combining among repetitions are implemented, we do not think 20MHz post-FFT buffering is mandated. |
| SONY | Y | |  |
| Nokia, NSB | Y | | We agree other companies that Rel-18 RedCap UEs should be able to share the legacy SIB1 with legacy UEs. We think it should be up to UE implementation how to handle this so we don’t think a note on 20 MHz post-FFT buffering is needed. |
| FL7 | Based on the received responses, the same proposal can be considered again.  **High Priority Proposal 2-3-1b: Revise the following agreement as follows:**  For UE BB bandwidth reduction, for SIB1 (PDSCH) ~~to Rel-18 RedCap UEs, down-select between the following options~~,   * ~~Option 1: Restrict the scheduling of SIB1 to be within 5 MHz~~ * ~~Option 2:~~ Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation) * ~~FFS: whether 5MHz is assumed to be physically contiguous~~ | | |
| FL8 (info) | Based on the proposal, the online (GTW) session on Monday 17th October made the following agreement. The FFS is addressed in the new Question 2-1-3c.  Agreement:  Replace the agreement on SIB1 (PDSCH) for UE BB bandwidth reduction with the following:  For UE BB bandwidth reduction, for SIB1 (PDSCH),   * Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation) * FFS: UE post-FFT buffering “assumption” | | |

**FL1 High Priority Proposal 2-4a: For UE BB bandwidth reduction, for paging channel (PDSCH) shared between Rel-18 RedCap UEs and other types of UEs, down-select between the following options:**

* **Option 1: Restrict the scheduling of paging channel to be within 5 MHz**
* **Option 2: Allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Company** | **Y/N** | **Preferred option, if any** | | **Comments** |
| Huawei, HiSilicon | Y | Option 1 | | Paging is not periodic signaling as SIB1. Performance loss caused by option 2 needs careful consideration. |
| Nordic | Y | Option 2 | |  |
| MediaTek | Y | Option 2 | | Our view is that transmission bandwidth for all broadcast PDSCHs should be allowed up to 20MHz as legacy operation. UE BB bandwidth reduction does not mean transmission bandwidth reduction at gNB. |
| FUTUREWEI | Y |  | | Both options can further be discussed. |
| Nokia, NSB | Y | Option 2 | | We share similar view as MediaTek. Option 2 would allow the gNB to page both Rel-18 RedCap and legacy UEs in the same message without performance impact to the legacy UEs. The gNB also would not need to be aware what UE type it is paging.  We do not see the need for the network to be aware of or have separate broadcast transmission for Rel-18 RedCap versus legacy UEs. |
| Qualcomm | Y |  | | Need further discussion between two options for paging. |
| Lenovo | Y | Option 2 | | It is not expected to introduce restrictions to legacy UEs. On the other hand, paging performance was not evaluated during SI. As HW mentioned, the performance loss might need to be considered. |
| China Telecom | Y |  | | Fine with the current proposal. It needs down-selection for paging after further discussion. |
| Sharp | Y |  | | It can be same as SIB1 |
| CATT | Y |  | | Same handling to agreed Proposal 2-3a can be applied. |
| Vivo | Y | Option 2 | | We think Option 1 can be realized by NW implementation for example, currently the PO occasion is determined by UE ID, NW can configure different/separate PO occasions for R18 eRedCap UE and other UEs. Then the restriction for paging channel to be within 5 MHz is only for Rel-18 RedCap UEs. No impacts on other UE types.  In addition, similar as for SIB1 discussion, following FFS should be added:  FFS: whether 5MHz is assumed to be physically contiguous |
| ZTE, Sanechips | Y | Option 2 | | Impacts on legacy UE should be avoided. And performance loss issue by Rel-18 RedCap UE incomplete receiving can be further discussed. |
| DOCOMO | Y, but | Option 2 | | We have a similar clarification question as SIB1 discussed on GTW session whether this proposal preclude the case where the paging PDSCH resources are not shared between Rel-18 RedCap and other types of UE.  In our view, it is not preferable to restrict the paging PDSCH BW for legacy UEs, thus we support option 2 so far. As commented by some companies, it should be noted that these options are from gNB scheduling perspective and we think Rel-18 RedCap receive the PDSCH with 5MHz post-FFT data buffering even if option 2 is supported. |
| Spreadtrum | Y | Option 2 | |  |
| SONY | Y |  | | Both options should be discussed. From a UE perspective, we would prefer option 1, but we appreciate that option 2 has network benefits. |
| CMCC | Y |  | | Paging performance has not be evaluated, if shared paging with larger than 5MHz bandwidth can not be correctly decoded, separate paging search space can be configured. |
| Panasonic | Y |  | | As the SIB1 agreement made on Monday, we would propose to add the FFS below:  FFS: whether 5MHz is assumed to be physically contiguous |
| Xiaomi |  |  | | Before discussing it, we think it is necessary to clarify whether the cost of post-FFT buffering will be reduced. If not, as analysis in our contribution, the cost of eRedCap will be increased about 1% compared with cost reduction of post-FFT buffering; while, the transmission performance can be guaranteed with HARQ combination. Based on this, option 2 can be adopted without any spec efforts. Otherwise, to guarantee the transmission performance, we support to involve option 1 and it is necessary for gNB to acknowledge whether it is a eRedCap UE before separate paging PDSCH is scheduled. |
| Ericsson | Y | Option 2 | | Similar view as CATT. Also, further enhancements/restrictions (for non-shared case), if any, can also be discussed under Q2-8a.  We think it can be left to gNB whether or not to transmit a paging message containing a paging record for a Rel-18 RedCap UE on a PDSCH with bandwidth > 5 MHz or < 5MHz. We do not see a need to specify explicit restrictions. |
| Samsung | Y | Option 2 | | Same handling as Proposal 2-3a. |
| NEC | Y | Option 2 | |  |
| LGE | Y | Option 1 | | But we share the view that we need further discussion with the two options. |
| MediaTek2 | Y | Option 2 | | For the case when paging is *shared* between legacy UEs and eRedCap, we support transmission bandwidth of paging can be larger than 20MHz to reduce impact on legacy UEs.  For the case when *dedicated* paging can be configured and transmitted to R18 eRedCap, we share a similar understanding with Nokia and Xiaomi that gNB first needs to be able to distinguish which paging messages are for R18 eRedCap UEs. This requires more discussion on the specification impact and real-deployment impact. Even if we can make such an agreement to ensure gNB gets this information from core NW, we are not sure this is a practical assumption in field when R18 eRedCap is being deployed. |
| Sequans | Y |  | | Agree with proposal at this point. |
| Intel | Y |  | | Further discussion is necessary. Option 1 provide better link performance. Irrespectively of the selected option, at UE side, UE only has 5MHz capability for reception according to the WID. |
| FL2 | Based on received responses, the following updated proposal can be considered, where the wording is aligned with the earlier agreement for SIB1.  **High Priority Proposal 2-4b: For UE BB bandwidth reduction, for paging channel (PDSCH) ~~shared between~~ to Rel-18 RedCap UEs ~~and other types of UEs~~, down-select between the following options:**   * **Option 1: Restrict the scheduling of paging channel to be within 5 MHz** * **Option 2: Allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation)** * **FFS: whether 5MHz is assumed to be physically contiguous** | | | |
| OPPO | Y | Option 1 | | We think narrow band paging would be sufficient. Also OK with updated in red. |
| Nordic | Y |  | | The fact is that for paging gNB should be aware of UE capas already. So tend to agree with Oppo that here narrow-band paging should not be an issue. |
| Nokia, NSB |  | Option 2 | | We are OK with the FFS but we are still concern about the removal of the text on sharing, as this can imply we have separate paging to Rel-18 RedCap UE.  First, we have not agreed that Rel-18 RedCap UE can be separately paged from other UEs. Second, if the paging channel is only to Rel-18 UE, then it doesn’t make sense to support Option 2.  If it is the common understanding that proposal 2-4b covers the case where paging is shared with other UEs, then we are OK with the proposal. |
| FUTUREWEI | Y |  | |  |
| Apple |  | Option 2 | | First, the paging occasion is determined based on equation and known parameters, which is deterministic instances at UE side. In our opinion, Opt.2 means UE would use 20MHz ‘RF+BB’ for the paging occasion, including post-FFT buffering etc. |
| Sharp | Y |  | |  |
| Lenovo | Y |  | |  |
| Sierra Wireless | Y |  | |  |
| Spreadtrum | Y |  | |  |
| DOCOMO | Y |  | | We support this proposal for now. In our understanding, whether the paging is shared between Rel-18 RedCap and legacy UEs can be discussed further for Option 1, but the paging is shared for Option 2 (i.e., no separate operation of paging for Rel-18 RedCap). For Option 2, it is up to gNB whether the paging PDSCH span larger bandwidth than 5MHz, and it should be discussed further how Rel-18 RedCap UE receives the paging which exceeds 5MHz and/or performance loss compensation if needed. |
| SONY | Y |  | | Proposal is fine. |
| MediaTek |  | Option 2 | | We do share a similar view/concern with Nokia that the aspect of “shared” or “separate” needs to be discussed eventually. And we prefer to add back “**shared between**” to the proposal and agree that at least **shared paging messages should be supported** first. Whether/how to support separate paging can be FFS.  Even if gNB can already know UE’s type for paging as claimed by some companies, we don’t see why we need to mandate gNB *always* send separate paging messages for eRedCap and non-eRedCap UEs. In field, most of the time, the number of UEs pages in a cell is not large and the paging PDSCH is less than 5MHz. In this case, gNB can send a shared paging message to eRedCap and other types of UEs without causing any problem. On the other hand, if there are many UEs to be paged and if ***gNB can indeed know UE types for paging message***, gNB can simply group paging messages for Rel-18 RedCap UEs and confine it to 5MHz PDSCH transmitted separately for eRedCap UEs.  To us, if gNB can indeed know UE types for the UEs it is paging, how to send paging messages can be *almost* up to gNB’s implementation (Of course, this proposal is helpful to eRedCap UEs for what to expect). On the other hand, if gNB cannot know UE types for paging, then it is not clear to us how separate paging messages can be supported. Therefore supporting *separate* paging messages requires more discussion.  With the above, we propose the following two alternatives for revising the proposal. Either of them should be supported and we support Alt-1.   * **Alt-1: Add the deleted red text (e.g. “shared between”) back to the main bullet of Proposal 2-4b.** * **Alt-2” Add the following Note to Proposal 2-4b.**   + **Note: This proposal does not imply separate paging for eRedCap is supported. Shared or separate paging needs further discussion.** |
| Panasonic | Y |  | |  |
| CATT | Y in general |  | | We also think the current proposal includes the case when paging is shared between R18 RedCap UEs and other UEs. If this is incorrect understanding, we need to add ‘shared…’ back.  The FFS in fact should be a sub-bullet under Option 1 only. In case of Option 2, since the scheduling bandwidth is already larger than 5MHz, why does the UE still care about whether the PRBs are continuous or not? But anyway, this is not a big issue, so fine to leave it unchanged. |
| Vivo |  | Option 2 | | We prefer Rel-18 eRedCap UE’s post-FFT data buffering size is 20MHz, both options are possible, and NW can decide how to allocate the resource for paging. |
| Qualcomm | Y |  | | We are ok to make it open for now for further discussion on paging PDSCH. |
| Samsung | Y | Option 2 | |  |
| NEC | Y | Option 2 | |  |
| LGE | Y | Option 1 | | Share the view with OPPO and Nordic. Okay with the update. |
| Sequans | Y |  | | We understand the proposal includes and leaves open both shared and separate paging options. |
| ZTE, Sanechips | General Y | Option 2 | | We understand only in shared paging case, the paging bandwidth can be larger than 5MHz for coexistence. Therefore, this proposal is for shared paging case and the separate paging case can be further discussed.  Following updates is suggested:  ‘**shared between’** should be added back and following note can be added  FFS: whether/how to support separate paging for Rel-18 RedCap UE |
| CMCC | Y | Option 2 | | We give our analysis for different scenarios in the following table. It can be seen that if 5MHz is enough to decode the Paging PDSCH, it seems no problem for either eRedCap or other UEs. If 5MHz is not enough for correct decoding, maybe gNB has to separate eRedCap’s paging and group them to a small TBS (maybe long latency since it needs to be transmitted in next PO.)  However, this also depends on whether VRB to PRB interleave is enabled.  Among the two options, option 2 gives gNB more flexibility.  gNB can decide whether to scheduling paging within 5MHz.   |  |  |  | | --- | --- | --- | | Scenario | Content of PO | Analysis | | case 1: gNB can know whether the paging is for R18 eRedCap | PO with R18&R17 RedCap paging | if paging PDSCH can be decoded correctly within 5MHz for R18 eRedCap,then no problem for R17 RedCap if gNB schedule it within 5MHz, if not, then there will be coverage issue for R18 eRedCap, and scheduling should based on R17 RedCap. | | PO with only R18 eRedCap paging | of course, gNB can schedule the paging within 5MHz | | case 2: gNB does not know the target UE type of each specific paging | PO with at least one kinds paging | As long as the 5MHz PDSCH can be decoded, scheduling within 5MHz, seems OK; if not, there will be performance impacts for legacy UEs. | |
| Ericsson | Y | Option 2 | | Our understanding is that P2-4b does not forbid sharing of paging between Rel-18 RedCap and other types of UEs. |
| Intel | Y |  | |  |
| Xiaomi2 |  | Both are OK | | We share the same view as vivo that 20MHz for post-FFT data buffering size is preferred by us. But, we are also fine with separate paging design. |
| FL3 | Based on received responses, the following updated proposal can be considered.  **High Priority Proposal 2-4c: For UE BB bandwidth reduction, for paging channel (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:**   * **Option 1: Restrict the scheduling of paging channel to be within 5 MHz** * **Option 2: Allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation)** * **FFS: whether 5MHz is assumed to be physically contiguous** * **FFS: whether paging channel is always shared or can be separate** | | | |
| FL4 | Based on the proposal, the online (GTW) session on Wednesday 12th October made this agreement:  Agreement:  For UE BB bandwidth reduction, for paging channel (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:   * Option 1: Restrict the scheduling of paging channel to be within 5 MHz * Option 2: Allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation) * FFS: whether 5MHz is assumed to be physically contiguous | | | |
| FL8 | Based on the received responses, the following revision of the agreement can be considered, which is in line with the corresponding SIB1-related agreement from Monday 17th October. The FFS is addressed in the new Question 2-1-3c.  **High Priority Proposal 2-4d: Replace the agreement on paging channel (PDSCH) for UE BB bandwidth reduction with the following:**  **For UE BB bandwidth reduction, for paging channel (PDSCH),**   * **Allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation)** * **FFS: UE post-FFT buffering “assumption”** | | | |
| **Company** | **Y/N** | | **Comments** | |
| Xiaomi4 | Y | | We support the post-FFT buffer size is the same as the maximum Bandwidth of the RF channel for eRedCap UEs. | |
| DOCOMO | Y | |  | |
| MediaTek |  | | Unlike SIB1 and broadcast OSI, paging is not periodic and not repeated (except for NR-U). It hence requires UE to equip 20MHz post-FFT buffering to receive a paging message larger than 5MHz. The FFS in Proposal 2-4d should be replaced by the Note: It requires 20MHz post-FFT buffering at UE. We are also fine with Xiaomi’s revision.  **For UE BB bandwidth reduction, for paging channel (PDSCH),**   * **Allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation)** * **Note: This assumes 20MHz post-FFT buffering at UE.**   @DCM, Could you clarify how UE could receive paging larger than 20MHz based on your response to previous FL’s question that “*Our assumption is 5MHz post-FFT data buffer size for both unicast and broadcast.*”? Do you assume UE can and should perform soft combing for paging reception? | |
| Vivo | Y | | Same understanding as Xiaomi and we support the note added by MTK. | |
| Panasonic | N | | For paging PDSCH, retransmission is not supported. Thus, soft-combining cannot be performed. Therefore, reception performance loss when an eRedCap UE punctures the subset of the shared paging PDSCH should carefully be considered. Based on our post-FFT buffer assumption, our view is following.   * **Allow the scheduling of paging channel to be physically larger than 5 MHz but less than 20 MHz. The maximum number of PRBs in the resource allocation corresponds to ~5 MHz. The gNB may power-boost the used PRBs.**   Separate paging PDSCH for eRedCap can be considered but considering RAN2 workload and resource overhead, we are rather negative. | |
| Nordic |  | | For paging gNB should know UE’s capability, this allows separate paging. But if gNB sees separate paging as big burden, same treatment as for SIB1 can apply. | |
| Lenovo | Y | |  | |
| CATT |  | | We are a little hesitant to support. In fact, unlike SIB1, the network may be aware that it is paging a Rel-18 eRedCap UE. So it is practical to restrict paging (PDSCH) within 5 MHz. Note that non-RedCap UE, Rel-17 RedCap UE can still share a <5MHz paging (PDSCH) within Rel-18 eRedCap UE. | |
| Nokia, NSB | Y | | We support sharing of paging channel between Rel-18 RedCap and legacy UEs. It’s not clear to us whether the gNB would know the type of UE it is paging without further information from the AMF. Also, this scheduling capability is agreed already for SIB1 so it should be available for other broadcast channels. | |
| FUTUREWEI |  | | We can support the scheduling of paging > 5 MHz. If we allow scheduling of PRBs across 20 MHz and the same process / slot limit, we can also apply this limit to paging. We should not include statements specifying architecture (UE post-FFT buffering “assumption”). | |
| Ericsson | Y | | We are fine with the proposal.  We would also be fine with considering this proposal after the discussion on post-FFT buffer is settled. If 20 MHz post-FFT buffer can be assumed, we think that paging for Rel-18 RedCap UEs can be scheduled with larger than 5 MHz. If only 5 MHz post-FFT can be assumed, the proposal could be a WA so that companies can study until RAN1#111 the coverage impacts for paging (considering that soft combining as for SIB1 is not available for paging). | |
| Intel |  | | We prefer Option 1 since repetitions of paging PDSCH is not supported in NR. If the paging PDSCH are shared, it means link performance of paging for eRedCap UE is worse (10dB if reusing SIB1 TBS as example) than legacy UE, which cannot be compensated. The network can know the UE type of an eRedCap UE after the UE is camped to the network. Consequently, it is practical for gNB to send a paging PDSCH for eRedCap UE or for legacy UE separately. | |
| Qualcomm |  | | If NW does not know the UE’s capability for the paging, we are OK with the FL proposal. But our understanding is that the NW can be aware of the UE’s capability for the paging procedure, and the NW can schedule the paging PDSCH based on its PDSCH BW capability. In this case, we may need to discuss further whether paging PDSCH is restricted within 5MHz or it is allowed to be larger than 5MHz. | |
| ZTE, Sanechips | Y | | Paging performance can be guaranteed by gNB implementation when paging is shared. For example, the performance of PDSCH with spanned more than 5MHz can be guaranteed by the low code rate and power boosting. | |
| Sharp | N | | For idle UEs, the RAN can learn about the bandwidth limits of the UE through a higher-layer IE, such as UERadioPagingInfomation. For inactive UEs, the RAN can identify the type of UE by the UE context. Therefore, gNB should schedule paging PDSCH no wider than 5MHz for the eRedCap UE to avoid unnecessary negative effects on paging reception. | |
| Spreadtrum |  | | It is likely that the gNB already knows the UE’s capability when paging the UE. The gNB can limit the paging PDSCH within 5MHz for R18 RedCap.  As mentioned by many companies that if paging is larger than 5MHz, the loss cannot by compensated, since the soft combining is not available for paging . Therefore, we prefer to confirm the “**UE post-FFT buffering assumption for broadcast**” first, and then discuss this issue. | |
| CMCC | Y | | It is our understanding that allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation) does not always mean gNB will schedule paging larger than 5MHz.  When gNB is aware of the paging for R18 eRedCap, it can decide the bandwidth and the VRB-to-PRB mapping type.  We are also open for separate paging PDCCH. | |
| LGE | FFS | | Assuming that gNB is aware of the eRedCap device type already, we think the paging can be transmitted within 5 MHz. Whether it is shared with non-eRedCap, or it is a separate paging for eRedCap can be decided by gNB. | |
| NEC | Y | |  | |

**FL1 High Priority Proposal 2-5a: For UE BB bandwidth reduction, for other broadcast PDSCH than SIB1 and paging (e.g., OSI, RAR), down-select between the following options:**

* **Option 1: Restrict the scheduling of broadcast PDSCH to be within 5 MHz**
* **Option 2: Allow the scheduling of broadcast PDSCH to be larger than 5 MHz (as in legacy operation)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Company** | **Y/N** | **Preferred option, if any** | | **Comments** |
| Huawei, Hisilicon | Y | Option 1 | |  |
| Nordic | N |  | | OSI can follow SIB1, but RAR may need to be confined to 5MHz, so those two should not be coupled together |
| MediaTek |  | Option 2 | | Our view is that transmission bandwidth for all broadcast PDSCHs should be allowed up to 20MHz. UE BB bandwidth reduction does not restrict transmission bandwidth at gNB. |
| FUTUREWEI |  |  | | Both options can be discussed. We are okay to separate both. |
| Nokia, NSB | Y | Option 2 | | Similar comment as in 2-4a.  We do not see the need for the network to be aware of or have separate broadcast transmission for Rel-18 RedCap versus legacy UEs. |
| Qualcomm | N |  | | We share the same view with Nordic that SI and RAR needs to be discussed separately. Option 2 is preferred for OSI following SIB1. However, if separate early indication is supported for Rel-18 eRedCap UE, option 1 is preferred for RAR. |
| Lenovo | Y | Option 2 | | It is not expected to introduce restrictions to legacy UEs. |
| China Telecom | Y |  | | Fine with the current proposal. It needs down-selection after further discussion. Maybe OSI and RAR can be considered separately if necessary. |
| CATT | Y |  | | Same handling to agree Proposal 2-3a can be applied.  Also OK to handle OSI with SIB1, leaving RAR here for further discussion. |
| vivo | Y | Option 2 | | Share MTK’s views. In addition, similar as for SIB1 discussion, following FFS should be added:  FFS: whether 5MHz is assumed to be physically contiguous |
| ZTE, Sanechips |  |  | | Agree to discuss OSI and RAR separately.  For OSI, repetition can be used for performance compensation. Therefore, option2 is preferred.  For RAR, the performance loss may be acceptable since the TBS is small. And further discussion is needed. |
| DOCOMO |  |  | | We are fine to discuss OSI and Msg2/4/B separately. |
| Spreadtrum |  |  | | For OSI, we also think it can follow SIB1.  For RAR, it is related to early indication. If early indication is supported and indicated, the RAR should be within 5 MHz, otherwise, the RAR can be larger than 5 MHz. |
| SONY | Y |  | | Both options should be discussed. |
| CMCC | Y |  | | Our first preference is not to restrict the bandwidth of shared broadcast PDSCH. However the performance of of other SIBs has not been evaluated, further discussion is needed. |
| Panasonic | Y |  | | As the SIB1 agreement made on Monday, we would propose to add the FFS below:  FFS: whether 5MHz is assumed to be physically contiguous |
| Xiaomi |  |  | | We have the same comments as in **FL1 High Priority Proposal 2-4a.** |
| Ericsson | Y | Option 2 | | Ok with Nordic’s and CATT’s suggestion that OSI can be handled in a similar way as SIB1.  Also, note that there is on-demand transmission of OSI. So, if there is a mechanism for gNB to know that a Rel-18 RedCap UE is requesting OSI, it’s possible for gNB to schedule OSI within 5 MHz, without specifying any explicitly restrictions. |
| Samsung | Y | Option 2 | | Same handling as Proposal 2-3a. |
| NEC | Y | Option 2 | | RAR would be FFS. |
| LGE | Y | Option 1 | | But we share the view that we need further discussion with the two options. |
| Sequans | Y |  | | Support proposal for later down-select.  Fine to split OSI and RAR discussion. |
| Intel | Y |  | | Both options can be discussed. Irrespectively of the selected option, at UE side, UE only has 5MHz capability for reception according to the WID. |
| FL2 | Based on received responses, the following proposals can be considered, where the wording is aligned with the earlier agreement for SIB1.  **High Priority Proposal 2-5b:**  **For UE BB bandwidth reduction, for OSI (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:**   * **Option 1: Restrict the scheduling of OSI PDSCH to be within 5 MHz** * **Option 2: Allow the scheduling of OSI PDSCH to be larger than 5 MHz (as in legacy operation)** * **FFS: whether 5MHz is assumed to be physically contiguous**   **For UE BB bandwidth reduction, for RAR (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:**   * **Option 1: Restrict the scheduling of RAR PDSCH to be within 5 MHz** * **Option 2: Allow the scheduling of RAR PDSCH to be larger than 5 MHz (as in legacy operation)** * **FFS: whether 5MHz is assumed to be physically contiguous** | | | |
| OPPO | Y | Option 1 | | We think 5MHz band for other broadcast channel would be sufficient. Update is fine. |
| Nordic | Y |  | | Option 2 for OSI, Option 1 for RAR |
| Nokia, NSB |  | Option 2 | | Similar comment as in 2-4b. We are concern on the added text **“to Rel-18 RedCap UEs”** as this can imply we have separate OSI/RAR to Rel-18 RedCap UE.  First, we have not agreed that Rel-18 RedCap UE can have separate OSI/RAR from other UEs. Second, if the OSI/RAR is only to Rel-18 UE, then it doesn’t make sense to support Option 2.  If it is the common understanding that proposal 2-5b covers the case where OSI/RAR is shared with other UEs, then we are OK with the proposal. |
| FUTUREWEI | Y |  | |  |
| Sharp | Y |  | |  |
| Lenovo | Y |  | |  |
| Spreadtrum | Y |  | |  |
| DOCOMO | Y |  | |  |
| SONY | Y |  | | Proposal is fine. |
| MediaTek |  | Option 2 | | Similar comments as in Proposal 2-4b. **For both OSI and RAR**, we think **“shared between” should be added back and be supported first**.  For RAR, arguments for paging can be applied RAR in general. If companies cannot support shared RAR, we would like to propose the following two alternatives (similar to our proposal to 2-4b) for revising Proposal 2-5b. Either of them should be supported and we support Alt-1.   * **Alt-1: Add the deleted red text (e.g. “shared between”) back to the main bullet of Proposal 2-5b.** * **Alt-2” Add the following Note to Proposal 2-5b.**   + **Note: This proposal does not imply separate paging for eRedCap is supported. Shared or separate paging needs further discussion.** |
| Panasonic | Y |  | |  |
| CATT | Y |  | | We also think the current proposal includes the case when OSI is shared between R18 RedCap UEs and other UEs. If this is incorrect understanding, please correct us.  Similar comment on FFS as in 2-4b, but fine to leave it unchanged for now. |
| vivo |  | Option 2 | | We prefer Rel-18 eRedCap UE’s post-FFT data buffering size is 20MHz, both options are possible, and NW can decide how to allocate the resource for paging. |
| Qualcomm | Y |  | | Option 2 is preferred for OSI following SIB1.  Option 1 is preferred for RAR, if separate early indication is supported for Rel-18 eRedCap UE. |
| Samsung | Y |  | | For broadcast PDSCH except Msg2/Msg4/MsgB, we prefer option 2. For Msg2/Msg2/MsgB, we prefer option 1. Regarding the OSI PDSCH here, it should be clarified if it is broadcast PDSCH or unicast PDSCH for on-demand OSI case. |
| NEC | Y |  | | Option 2 for OSI, FFS for RAR. |
| LGE | Y | Option 1 | | Share the view with OPPO. Okay with the update. |
| Sequans | Y |  | |  |
| ZTE, Sanechips |  |  | | We have similar concern as Nokia, suggest to add a Note as follows:  Note: it does not mean separate OSI or RAR is supported. |
| CMCC | Y |  | | We also think current proposal include shared case. If not shared, then option 1 is enough. |
| Ericsson | Y | Option 2 for OSI  No strong preference for RAR | |  |
| Intel | Y |  | |  |
| Xiaomi2 | Y |  | | We have the same comments as in **FL1 High Priority Proposal 2-4a.** |
| FL3 | Based on received responses, the following proposals can be considered.  **High Priority Proposal 2-5c:**  **For UE BB bandwidth reduction, for OSI (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:**   * **Option 1: Restrict the scheduling of OSI PDSCH to be within 5 MHz** * **Option 2: Allow the scheduling of OSI PDSCH to be larger than 5 MHz (as in legacy operation)** * **FFS: whether 5MHz is assumed to be physically contiguous** * **FFS: whether OSI is always shared or can be separate**   **For UE BB bandwidth reduction, for RAR (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:**   * **Option 1: Restrict the scheduling of RAR PDSCH to be within 5 MHz** * **Option 2: Allow the scheduling of RAR PDSCH to be larger than 5 MHz (as in legacy operation)** * **FFS: whether 5MHz is assumed to be physically contiguous** * **FFS: whether RAR is always shared or can be separate** | | | |
| FL4 | Based on the proposal, the online (GTW) session on Wednesday 12th October made this agreement:  Agreement:  For UE BB bandwidth reduction, for broadcast OSI (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:   * Option 1: Restrict the scheduling of OSI PDSCH to be within 5 MHz * Option 2: Allow the scheduling of OSI PDSCH to be larger than 5 MHz (as in legacy operation) * FFS: whether 5MHz is assumed to be physically contiguous   For UE BB bandwidth reduction, for RAR (PDSCH) to Rel-18 RedCap UEs, down-select between the following options:   * Option 1: Restrict the scheduling of RAR PDSCH to be within 5 MHz * Option 2: Allow the scheduling of RAR PDSCH to be larger than 5 MHz (as in legacy operation) * FFS: whether 5MHz is assumed to be physically contiguous | | | |
| FL8 | Based on the received responses, the following revision of the agreement can be considered, which is in line with the corresponding SIB1-related agreement from Monday 17th October. The FFS is addressed in the new Question 2-1-3c.  **High Priority Proposal 2-5d: Replace the agreement on broadcast OSI (PDSCH) and RAR (PDSCH) for UE BB bandwidth reduction with the following:**  **For UE BB bandwidth reduction, for broadcast OSI (PDSCH),**   * **Allow the scheduling of broadcast OSI (PDSCH) to be larger than 5 MHz (as in legacy operation)** * **FFS: UE post-FFT buffering “assumption”**   **For UE BB bandwidth reduction, for RAR (PDSCH),**   * **Allow the scheduling of RAR (PDSCH) to be larger than 5 MHz (as in legacy operation)** * **FFS: UE post-FFT buffering “assumption”** | | | |
| **Company** | **Y/N** | | **Comments** | |
| Xiaomi4 | Y | | The similar comments for SIB1 and paging | |
| DOCOMO | Y for OSI | | We are fine for OSI.  Regarding RAR, we think it is pre-mature to agree on Option 2. More specifically, the down-selection between Option 1 and 2 for RAR is related to the discussion for separate early indication of Rel-18 RedCap and we prefer to discuss further for RAR considering such aspects. | |
| MediaTek |  | | For OSI, similar to our comments in the GTW1 call on Monday, we think it is more reasonable to replace the FFS with the Note: This may require 20MHz post-FFT buffer at UE. Again, UE would rather to equip 20MHz post-FFT buffering than performing soft combining of partial reception (5MHz) of SIBs.  **For UE BB bandwidth reduction, for broadcast OSI (PDSCH),**   * **Allow the scheduling of broadcast OSI (PDSCH) to be larger than 5 MHz (as in legacy operation)** * **Note: This may require 20MHz post-FFT buffering at UE.**   For RAR, similar our comments to paging, it requires 20MHz post-FFT buffering at UE because RAR is not periodic.  **For UE BB bandwidth reduction, for RAR (PDSCH),**   * **Allow the scheduling of RAR (PDSCH) to be larger than 5 MHz (as in legacy operation)** * **Note: This assumes 20MHz post-FFT buffering at UE.** | |
| Vivo | Y | |  | |
| Panasonic | N | | For OSI, we support the proposal as it can be same with SIB1.  For RAR PDSCH, retransmission is not supported. Thus, soft-combining cannot be performed. Therefore, reception performance loss when an eRedCap UE punctures the subset of the shared RAR PDSCH should carefully be considered. Based on our post-FFT buffer assumption, our view is following.   * **Allow the scheduling of paging channel to be physically larger than 5 MHz but less than 20 MHz. The maximum number of PRBs in the resource allocation corresponds to ~5 MHz. The gNB may power-boost the used PRBs.**   Separate RAR PDSCH for eRedCap can be considered but considering RAN2 workload and resource overhead, we are rather negative. | |
| Nordic | Y for OSI, N for RAR | | This because for RAR, UE (based on current agreements) would not be able to meet the existing timeline (N1+N2+0.5ms) for legacy K2 for MSG3 scheduling.  If 20MHz would be the choice, the timeline must be relaxed for the R18 RedCap UEs. | |
| Lenovo | Y | |  | |
| CATT | Y | | Fine with the current form. It is premature to add such note. | |
| Nokia, NSB | Y | | Similar view as in 2-4d. We should allow sharing of broadcast channel between Rel-18 RedCap and legacy UEs. Since this scheduling capability is agreed already for SIB1 so it should be available for other broadcast channels. | |
| FUTUREWEI |  | | We should separate the proposals as the timing needs for OSI and RAR are different.  We can support the scheduling of OSI > 5 MHz. If we allow scheduling of PRBs across 20 MHz and the same process / slot limit, we can also apply this limit to OSI. We should not include statements specifying architecture (UE post-FFT buffering “assumption”).  For the scheduling of Msg2, we need to consider the timing requirements as well as the transport block size (TBS). For example, with the lowest MCS (0.2343) / TB scaling factor (0.25), with 25 RBs for 15 kHz SCS, the TBS is less than 256. If this TBS is typical, then the same process/slot limit can be used. But we need further studies. | |
| Ericsson | Y for OSI  FFS for RAR | | We think OSI can be handled in the same way as SIB1 (note: there is already a corresponding agreement for SIB1).  RAR can be discussed after the discussion on post-FFT buffer is settled, but we would also be ok to support the proposal. | |
| Intel |  | | Broadcast OSI (PDSCH) can be handled like SIB1, hence the FL proposal is fine  For RAR (PDSCH), the proposal is fine too. Since the TBS of RAR is normally small, it is up to gNB to just schedule RAR PDSCH within 5MHz to avoid impact to eRedCap UE. | |
| Qualcomm | Y for OSI | | We agree that the agreement for SIB1 can be also applied to OSI.  For RAR PDSCH, NW is aware of the UE’s capability if separate early indication is supported for Rel-18 eRedCap UE and so NW can schedule the RAR PDSCH according to indicated capability. Therefore, it is premature to conclude that spec allows the scheduling of RAR PDSCH to be larger than 5 MHz at this time. | |
| ZTE, Sanechips | Y | | For RAR, RAR performance can be guaranteed by gNB implementation via the low code rate and power boosting. Also scheduling within 5MHz is possible for the gNB to guarantee the RAR performance. Therefore, there is no need to restrict the paging scheduling only within 5MHz.  For OSI, it is similar with SIB1. | |
| Sharp |  | | We are fine with the same handling for OSI and SIB1.  For RAR PDSCH (msg2) , if early indication is still needed for msg3 scheduling, we don’t see the benefit of allowing scheduling wider band for msg2. | |
| Spreadtrum | Y for OSI  FFS for RAR | | For RAR, in addition to the post-FFT buffer issue mentioned by some companies, RAR may depend on the early indication (if introduced). If early indication for BB BW reduction is enabled and is indicated by the UE, the scheduling of RAR (PDSCH) should be limited within 5 MHz to avoid the puncturing of RAR. | |
| CMCC | Y | | Similar handling of OSI as SIB1 and similar handling of RAR as paging. Maybe a note can be added for RAR that: for RAR without Msg1 early indication. | |
| LGE | Y for OSI, FFS for RAR | | Okay to handle the broadcast OSI in the same way as SIB1. We prefer FFS for RAR, as it is related to the discussion on separate early indication as well as post-FFT buffering. | |
| NEC | Y for OSI | | FFS for RAR | |

**FL1 High Priority Question 2-6a: For UE BB bandwidth reduction, can distributed resource allocation spanning more than 5 MHz be supported for unicast PDSCH/PUSCH? Please elaborate in the Comments field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Huawei, HiSilicon |  | Clarification is suggested for any difference between the proposal and the PR3 defined in the TR. |
| Nordic | N | Not OK with this proposal for PUSCH, PUSCH must be contiguous. For PDSCH PR3 would make sense, as R18 RedCap could be then multiplexed with R17 RedCap in frequency domain. |
| MediaTek2 (updated with blue) | ~~N~~  Y for PDSCH  N for PUSCH | We share a similar view with Nordic. For PDSCH, PR3 vs BW3 should be revisited in RAN1. For PUSCH, we support contiguous resource allocation confining to 5MHz, i.e. BW3.  If UE complexity is not in fact reduced more with BW3 (than PR3), we think PR3 is a better choice for providing scheduling flexibility and frequency diversity gain. |
| FUTUREWEI | N | We picked BW3 not PR3 and this is the main difference |
| Nokia, NSB | N | Our preference is BW3 so we do not support distributed resource allocation spanning more than 5 MHz. |
| Qualcomm | N | We prefer to keep resource allocation confined within 5MHz BW (BW3) as captured in WID. |
| Lenovo | N | It is not clear if 5MHz here is physically contiguous or not. But anyway, it is not supported to have unicast PDSCH/PUSCH spanning more than 5MHz. |
| China Telecom | N | We see no need to support distributed resource allocation spanning more than 5 MHz for unicast PDSCH/PUSCH. |
| Sharp | N |  |
| CATT |  | PUSCH does not have post-FFT buffering issue, so the cost does not care too much about whether the resource allocation is continuous or not. Again, remind that current NR already supports CP-OFDM (non-continuous PRB allocation) in PUSCH…  But for PDSCH, spanning more than 5 MHz are likely to increase post-FFT buffering than BW3. That’s why BW3 is initially adopted when WID is written.  It is naturally preferred to have unified solution for PDSCH and PUSCH.  Consequently, ‘distributed resource allocation spanning more than 5 MHz’ is not preferred for both PDSCH and PUSCH. HOWEVER, frequency hopping interval of PUSCH should be allowed to expand 5 MHz, where each hop is within 5 MHz. |
| vivo | Y | Although the WID text for BB bandwidth reduction uses BW3 wording, as discussed in RAN#97, the real definition needs to be figured out in RAN1. So PR3 is still one candidate. About companies’ concern on non-contiguous resource allocation for PUSCH, we think even if PR3 is supported for both DL and UL, it does not mean UE support the non-contiguous PUSCH resource allocation. It depends on UE capability. Currently no RAN4 UE features support the non-contiguous PUSCH resource allocation, even almostContiguousCP-OFDM-UL is one optional UE feature. But just from the specification perspective, we think non-contiguous resource allocation for PUSCH can be supported. |
| ZTE, Sanechips | N | We do see the need to support distributed resource allocation spanning more than 5 MHz. |
| DOCOMO | N | To ensure the complexity reduction gain, we support the resource allocation confined within 5MHz for both PDSCH and PUSCH. |
| Spreadtrum | Y for PDSCH  N for PUSCH | For PDSCH, we think both PR3 and BW3 are acceptable, since the differences are quite small. In addition, from resource allocation point of view, BW3 is actually a subset of PR3. If we cannot make consensus on further limitation, PR3 can be a baseline to make progress.  For PUSCH, contiguous resource allocation is preferred. |
| SONY | N | We understood that the WID specified BW3 support, not PR3. |
| CMCC | N | Both unicast PDSCH and PUSCH is within 5MHz, e.g. BW3. Distributed resource allocation is possible within 5MHz. |
| Panasonic |  | The WID does not clarify which BW3 or PR3 is adopted. There is no sentence such as “The resource allocation spans a bandwidth of maximum 5 MHz” or “The resource allocation spans a bandwidth of maximum 20 MHz (maximum UE channel bandwidth)” It should be revisited in RAN1.  At least for PDSCH, distributed resource allocation spanning more than 5 MHz (PR3) should be allowed for better scheduling flexibility. Even if BW3 is adopted, the additional complexity reduction is not so significant although it requires the additional techniques discussed in 2-9a or 2-10a.  For PUSCH, it should be contiguous within 5MHz as said by Nordic. |
| Xiaomi |  | Share the same view as Huawei that further clarification is needed.  Besides, another issue needs to be considered is whether frequency hopping spanning more than 5MHz is supported for PUSCH with contiguous resources allocation. From our point of view, frequency hopping spanning more than 5MHz can be achieved without any additional efforts to the eRedCap UE’s implementation. So, frequency hopping shouldn’t be limited within 5MHz. |
| Ericsson |  | Similar view as Nordic.  Distributed allocation of PDSCH allows more scheduling flexibility and frequency diversity/scheduling gain, although it (very) slightly reduces the cost saving gain.  PUSCH is typically contiguous. For non-contiguous PUSCH, the support of *almost contiguous UL CP-OFDM* (Feature 2-7 defined in TR 38.822) or *resource allocation Type 0 for PUSCH* (Feature 5-2 defined in TR 38.822) features are optional with capability signaling. |
| Samsung | N | Distributed resource allocation spanning more than 5 MHz couldn’t bring additional gain on complexity reduction. Frequency selective gain from spanning more than 5MHz can be achieved by frequency hopping of 5MHz. |
| LGE | N | Our understanding is that we specify BW3, and revisit PR3 in the next RAN plenary meeting. While we are specifying BW3, we prefer to avoid complicating things by mixing up BW3 and PR3. |
| Sequans |  | N for PUSCH.  For PDSCH, we’d like to understand better the tradeoff between post-FFT buffering complexity and scheduling gain |
| Intel |  | We prefer to allow distributed FDRA in 20MHz subjected to a limit of 25 or 11 PRBs. However, if majority companies want to limit to continuous 5MHz, we are fine to go with it. |
| FL2 | Based on received responses, the following proposal can be considered. The PDSCH case can be revisited once other aspects (e.g., resource allocation) have progressed further.  **High Priority Proposal 2-6b: For UE BB bandwidth reduction, distributed resource allocation spanning more than 5 MHz is not supported for PUSCH.** | |
| OPPO | Y | We see the clarification for any difference between the proposal and the PR3 defined in the TR needed as suggest by Huawei. But since FL-2 capture majority, the updated direction is Ok.  But more useful conclusion would mean the RBs for PUSCH is within 5MHz physical bandwidth. |
| Nordic | Y | This is a baby step forward. |
| Nokia, NSB | Y | We are OK with this proposal. |
| FUTUREWEI | Y with comment | First, it is unclear whether intra-slot frequency for Msg3 is allowed.  Second, we suggest a clarification  **For UE BB bandwidth reduction, distributed resource allocation spanning more than 5 MHz within a slot is not supported for PUSCH.** |
| Apple | Y | Prefer the FL proposal. |
| Sharp | Y | We are OK with this proposal. |
| Lenovo | Y | To avoid any misunderstanding, suggest to revise to “**For UE BB bandwidth reduction, ~~distributed~~ PUSCH resource allocation spanning more than 5 MHz is not supported ~~for PUSCH~~.”.**  And maybe good to add “**FFS: whether 5MHz is assumed to be physically contiguous”** |
| Spreadtrum | Y |  |
| DOCOMO | Y | While we still believe that the distributed resource allocation should not be assumed even for PDSCH, we can support this proposal.  In addition, we support FUTUREWEI’s update. In our view, especially for inter-slot FH case, each hop should not span larger bandwidth than 5MHz but the frequency location of 1st/2nd hop should be allowed to allocate within 20MHz. Therefore, “distributed resource allocation spanning more than 5 MHz” in this proposal should intend the restriction within a slot. |
| SONY | Y | OK with the proposal as it stands.  The issue of distributed resource allocation for PDSCH is more significant in terms of complexity reduction than the distributed resource allocation for PUSCH. |
| MediaTek | Y but … | Generally fine with FL proposal. But just want to clarify that “distributed” does not imply “non-contiguous” PUSCH resource allocation. Maybe “distributed” is not needed? Or maybe how about the following?  **For UE BB bandwidth reduction, PUSCH resource allocation with more than 5MHz bandwidth span is not supported.** |
| Panasonic | Y |  |
| CATT | Maybe OK but need clarification | 1) Similar question as FUTUREWEI, does it consider the case of frequency hopping (including intra-slot and inter-slot)? In our view, the hopping interval can still be larger than 5 MHz (but within BWP), with each hop within 5 MHz.  2) Does it preclude non-continuous PRB allocation within 5 MHz? By default, our understanding is that current spec will be followed unless explicitly stated, so non-continuous PRB allocation for PUSCH can still be optionally supported (but not ‘forbidden’). |
| Vivo | Y | Fine with the proposal, but better to clarify whether the PUSCH includes MSG3 or not. |
| Qualcomm | Y | We are OK with this proposal.  For correcting any misunderstanding of non-contiguous resource allocation for PUSCH, I’d like to clarify how the current spec is written. In short, the latest spec does not allow non-contiguous resource allocation for PUSCH for CP-OFDM if the data BW is not greater than 20MHz regardless of UE capability.  In 38.214 (section 6.1.2.2.1), it is stated that:  *In frequency range 1, only ‘almost contiguous allocation’ defined in [8, TS 38.101-1] is allowed as non-contiguous allocation per component carrier for UL RB allocation for CP-OFDM.*  Also 38.101-1 (section 6.2.2) defines that “almost contiguous allocation” is only allowed if the number of allocated RBs (including gaps) is larger than 106/51 RBs (20MHz) for 15/30 KHz SCS. This means that almost contiguous allocation is not supported for Rel-17/18 RedCap UEs.  So correct interpretation of the spec is that resource allocation type-0 is supported for PUSCH but non-contiguous resource allocation (including almost contiguous allocation) is NOT supported for PUSCH for Rel-17/18 RedCap UEs. |
| Samsung | Y | We are fine with the proposal. |
| NEC | Y |  |
| LGE | Y | We prefer to take PDSCH and PUSCH together, but can live with the updated proposal for the sake of progress. |
| Sequans | Y | Fine with the proposal. We are also fine to remove “distributed” as it is a bit confusing. Also fine to clarify “within a slot”. |
| ZTE, Sanechips |  | OK with MTK’s update |
| CMCC | Y | It is not necessary to emphasize distributed resource allocation in the main bullet, and can be deleted |
| Ericsson | Y | We propose the following update:  **High Priority Proposal 2-6b: For UE BB bandwidth reduction, distributed resource allocation spanning more than 5 MHz is not supported for PUSCH for a baseline Rel-18 RedCap UE.**  There is no reason to forbid distributed allocation for Rel-18 RedCap Ues indicating optional support for, e.g., *almost contiguous UL CP-OFDM* (Feature 2-7 defined in TR 38.822) or *resource allocation Type 0 for PUSCH* (Feature 5-2 defined in TR 38.822) features. |
| Intel |  | We prefer to separately discuss PUSCH with or without frequency hopping. The FL proposal is unclear whether the total PRBs of two hops can be more than 5MHz. In our understanding, if hopping is configured, the restriction applies to each hop respectively. In other words, if we check total PRBs of the two hops, it can exceed 5MHz. Therefore, we suggest the revision as below.  **High Priority Proposal 2-6b: For UE BB bandwidth reduction, distributed resource allocation spanning more than 5 MHz is not supported for PUSCH without frequency hopping or each hop of PUSCH with frequency hopping.** |
| Xiaomi2 | Y | For PUSCH, we are fine with the proposal which just follows the definition of Option BW3 in TR.865. Besides, it should be emphasized that frequency hopping spanning more than 5MHz is another question out of this scope.  For PDSCH, whether distributed resource allocation refers to RA type 0? If so, we prefer to take PDSCH and PUSCH together and the revised version provided by Lenovo is more preferred by us. |
| Huawei, Hisilicon |  | For PUSCH, compared with distributed resource allocation spanning more than 5 MHz, we think intra/inter-slot frequency hopping more than 5 MHz with each hop confined within 5MHz is more preferred. At least, Msg3 with intra-slot hopping should be clarified. |

**Aspects related to impacts on broadcast channels**

Some contributions [15, 30] express that it should be possible to share broadcast PDSCH transmissions (e.g., SIB, OSI, RAR, Paging) between Rel-18 RedCap UEs and other UEs, and a few contributions [22, 29, 35] indicate that it is not necessary to specify coverage enhancements for channels that already support multiple transmissions (e.g., SIB1), since the UE implementation can rely on combination of the transmissions.

Some contributions [18, 24, 32] express that further discussion is needed regarding whether these broadcast PDSCH transmissions can be shared or may need to be separate. Some contributions [10, 14, 15, 20, 24, 33] propose to study whether further optimizations/enhancements for broadcast PDSCH are needed. One contribution [11] proposes to either restrict the bandwidth of the resource allocation of broadcast PDSCH transmission to 5 MHz or clarify the UE behavior when this bandwidth is larger than 5 MHz.

**FL1 High Priority Question 2-7a: For UE BB bandwidth reduction, considering the conclusions in TR 38.865 clause 8.2.4, should any enhancements or restrictions be specified to compensate for SIB1 link performance loss?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Huawei, HiSilicon |  | Potential enhancement for SIB1 can be studied. But it seems too early to state that specification impact is needed. |
| Nordic |  | We could leave it up to implementation |
| FUTUREWEI | N | Compensation for SIB1 performance was not part of the WID |
| Nokia, NSB |  | We would like to study further potential enhancements for broadcast channels. |
| Qualcomm |  | We suggest discussing potential enhancements for broadcast channels. |
| Lenovo |  | SIB1 performance can be improved by UE implementation. There is no strong motivation to specify enhancements. |
| China Telecom |  | Potential solutions to compensate SIB1 link performance loss can be studied if it is consensus. |
| Sharp | Y | The performance degradation in TR 38.865 is mainly for cases where allocated bandwidth of SIB is larger than 5MHz. if the scheduling of SIB1/OSI for eRedCap is allowed to be larger than 5 MHz, further enhancement can be considered. |
| CATT |  | ‘Decoding enhancements’ can be up to UE implementation.  ‘Restrictions to be specified’ is not preferred by us currently. |
| Vivo |  | Whether SIB1 has link performance loss depends on the interpretation of the 5 MHz BB bandwidth for SIB1 buffer/reception, process in case the resource allocation for SIB1 exceeds 5MHz. |
| ZTE, Sanechips |  | For 5MHz buffer capability, SIB1 performance can be be improved.by soft combining. However, the UE may need to know which 5MHz PDSCH data should be combined before combing decoding.  For 20MHz buffer capability, SIB1 performance can be be improved.by implementation. |
| DOCOMO |  | We are supportive to discuss potential enhancements for SIB1 link performance compensation. |
| Spreadtrum |  | We are open, but it seems too early to conclude this. |
| SONY |  | Performance enhancement can probably be left to implementation. We are also OK to consider enhancements / restrictions to compensate for SIB1 performance loss. |
| CMCC | N | Soft combining is already supported and it is better than the bottleneck channel of R17 RedCap. |
| Panasonic |  | It should be up to UE implementation. |
| Xiaomi | N | We can leave it to UE implementation by HARQ combination without reducing the cost of post-FFT buffering. |
| Ericsson | N | We do not see a need to specify any enhancements/restrictions for SIB1. As shown in our contribution ([R1-2210283](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2210283.zip)), Rel-18 RedCap UEs can achieve the same SIB1 link performance as Rel-17 RedCap UEs by soft-combining multiple SIB1 transmissions within the 160 ms TTI. |
| Samsung | N | Compensation for SIB1 performance loss can be up to UE implementation. |
| NEC | N | In our opinion, RAN1 should strive for no enhancements nor specification impacts by utilizing existing features, e.g. relying on retransmissions. |
| LGE | N | Out of the study phase, no recommendation was made on the link performance enhancement because there was no outstanding coverage issue for the cases under study. In our view, there is no need to further study on this aspect. |
| MediaTek |  | For initial access/idle/inactive mode, enhancements/restrictions may not be needed. For connected mode, RAN1 may need to discuss whether eRedCap UEs are required to decode SI-RNTI PDSCH simultaneously with C-RNTI PDSCH in FR1. |
| Intel |  | Potential enhancement to SIB1 can be studied since we identify more than 10dB loss without any special handling. |
| FL2 | Based on received responses, it seems that SIB1 performance needs to be better understood before it can be decided whether any enhancements or restrictions are needed. | |
| OPPO | Y | Agree FL-2 make it on-hold. |
| Nordic | N | We should have some concrete action. Is the intention here to have new round of simulations? |
| MediaTek | Y | Agree with FL. This can be discussed after we have more common understanding *at least* about SIB1 *transmission*. |
| CATT |  | OK but… is there something new other than the SI outcome? |
| LGE | Y | We hope, in this way, we could deprioritize the discussion on this topic. |
| Samsung |  | We don’t want to open another round of discussion on performance of SIB 1. We prefer to have conclusion that “eRedcap and legacy UEs shall share the same SIB1”. We two copies of SIB 1 lead in too much overhead. Then, we can discuss whether to restrict the transmission, or rely on implementation for SIB 1 reception, considering the performance. |
| Intel | N | We don’t think additional simulations help since more than 10dB loss was already identified in SI phase compared with legacy SIB1 transmission. We prefer to start discussion on pros/cons of different proposal. Relying on existing SIB1 transmission can be one option. |
| Xiaomi2 |  | Agree with LGE to deprioritize this discussion. |

**FL1 Medium Priority Question 2-8a: For UE BB bandwidth reduction, should any enhancements or restrictions be specified to compensate for link performance loss for other broadcast PDSCH transmissions than SIB1?**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
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**Scheduling optimizations for reducing post-FFT buffer complexity**

Several contributions [14, 17, 20, 21, 23, 28, 35] propose to consider whether the frequency location for PDSCH and/or PUSCH within the BWP can be indicated by semi-static configuration of the UE. A few contributions [14, 24, 29] propose to study solutions to facilitate post-FFT buffer reduction. For example, one contribution [23] proposes to consider DCI-based PRB subset switching to maintain frequency diversity, whereas one contribution [15] expresses that the UE can be dynamically allocated any frequency location within the BWP without any optimization.

**FL1 High Priority Proposal 2-9a: For UE BB bandwidth reduction, it is FFS whether/how to support semi-static indication of frequency location for PDSCH within the DL BWP for reducing the post-FFT buffer complexity.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| MediaTek |  | If BW3 (i.e. PDSCH resource allocation confining within 5MHz) is to be agreed, our view is that semi-static indication or pre-defined in spec should be supported. Considering it is the first meeting in WI, we have the following way-forward proposal:   * **Proposal:** If BW3 is agreed, down-select from the following options for eRedCap UEs to determine which 5MHz “sub-band” is allocated for a unicast PDSCH   + Option 1: eRedCap UE knows which 5MHz “sub-band” is allocated for a unicast PDSCH before it decodes corresponding PDCCH     - Option 1a: semi-static indication by RRC     - Option 1b: pre-defined in specification   + Option 2: same slot unicast PDSCH scheduling, i.e. K0=0, is not supported by eRedCap UE.   Our understanding is that the 1% more complexity reduction that BW3 provided mainly was resulted from the assumption that UE had known which 5MHz “sub-band” would be scheduled beforehand, and post-FFT buffer size and DL receiver block reached more complexity reduction with BW3 than with PR3. If BW3 cannot reach more complexity reduction than PR3, we don’t see why to support a the more restricted BW3. |
| FUTUREWEI |  | Both semi-static indication and cross-slot scheduling (proposal 2-10a) are approaches to reduce post-FFT buffer complexity. Both approaches have benefits and limitations. For semi-static indication, the network can use same-slot scheduling but the network may be restricted to using certain resources. From the UE side, the post-FFT buffer complexity is higher than with cross-slot scheduling as the UE must process both PDCCH and PDSCH (within a known region) in the same slot. We can consider “whether/how to support semi-static indication of frequency location” moving forward. |
| Nokia, NSB | N | In our view we do not see the need to support semi-static indication of frequency location for PDSCH within the DL BWP. In our view the potential complexity reduction would be small. However, this would restrict scheduler flexibility / increase complexity and also require considerable standardization effort. |
| Qualcomm | N | At least for SIB1 PDSCH, a UE has to support dynamic indication of frequency location if SIB1 PDSCH is shared between Rel-18 UEs and other type of UEs. Therefore, UE anyway has to support post-FFT buffering for 20MHz BWP until the DCI is correctly decoded. Then we do not understand how the semi-static indication of frequency location can reduce the post-FFT buffering complexity. Also semi-static indication of PDSCH frequency location limits the scheduling flexibility. We prefer to have dynamic indication of the actual resources inside the configured BWP. |
| Lenovo | Y | Semi-static indication of frequency allocation for PDSCH has benefits including post-FFT buffer complexity reduction and potential DCI size reduction. |
| China Telecom |  | The necessity and benefits should be studied and evaluated before making the final decision. |
| Sharp | Y | We support the proposal. It is beneficial for UE to reduce the size of the post-fft buffer. |
| CATT | Y | Agree with MTK and FUTUREWEI.  If optimization to reduce post-FFT data buffering is NOT further considered, we need to revisit why not adopt PR3 instead of BW3. |
| Vivo |  | We wondered how this solution works for Rel-18 RedCap UEs in RRC\_idle/inactive mode. How does RRC\_idle/inactive RedCap UEs know the frequency location for PDSCH? |
| ZTE, Sanechips |  | In connected mode, semi-static indication of frequency location for PDSCH can be considered.  After receiving SIB1, semi-static indication via SIB1 is also feasible for other broadcast channels.  For SIB1, we may need to further discuss, since semi-static indication is not available.  Additionally, dynamic indication or other solutions should not be precluded currently. |
| DOCOMO |  | For reducing the post-FFT data buffer complexity, we think at least the following four options can be considered for PDSCH reception;   * Opt.1: semi-static FDRA/pre-defined FDRA * Opt.2: cross-slot scheduling * Opt.3: soft-combining of multiple reception * Opt.4: puncturing of one-shot reception   Therefore, semi-static indication of frequency location can be one potential technique for post-FFT data buffering BW reduction but we think other techniques also should be considered. In our understanding, if the PDSCH resources are shared between Rel-18 RedCap and legacy UEs, e.g., for broadcast PDSCH, Opt.1/2 cannot be supported since these operations are not supported for legacy UEs. Thus, how to reduce post-FFT buffer complexity can be discussed separately for broadcast and unicast PDSCH. |
| Spreadtrum | Yes with comments | For SIB1, it seems unlikely to reduce the post-FFT buffering complexity. But in connected mode, semi-static indication of frequency location maybe benefit. Considering the payload size for UE-specific PDSCH in connected mode is larger than SIB1, there may be opportunities to lower the total post-FFT buffering, in addition, semi-static indication is benefit to the power consumption.  We prefer to further check and study it. |
| SONY | Y | Semi-static indication further reduces post-FFT buffer complexity.  We are OK with the proposal from Mediatek, but don’t necessarily agree with all of their argumentation. |
| CMCC | N | For broadcast PDSCH, whether to restrict of the bandwidth is still open, if option 2 of 2-3a to 2-5a is chosen, dynamic indication is supported for these channel.  For unicast PDSCH, if the PDSCH span does not exceed 5MHz, the following three options can be studied.   * Option 1: dynamic indication of PDSCH within 20MHz, no post FFT data buffer benefit but flexible scheduling to maintain frequency diversity gain. * Option 2: semi-static indication of frequency location of PDSCH. There is post FFT data buffer benefit, but the frequency diversity gain loss. * Option 3: dynamic indication of RRC configured sub-BWPs or RB subsets. This can achieve the benefit of option 1 and option 2.   Since this is the first meeting of WI, we prefer to keep design open.  So we propose to modify the proposal to,  **For UE BB bandwidth reduction, it is FFS whether/how to support semi-static indication or dynamic indication of predefined frequency locations for PDSCH within the DL BWP for reducing the post-FFT buffer complexity.** |
| Panasonic | Y | The discussion related to 2-4a/2-5a/2-6a should be stable before discussing whether to support this indication. |
| Xiaomi | N | We think it is not necessary to semi-static configure the bandwidth location for PDSCH if post-FFT buffering for 20MHz BW is supported by eRedCap UEs. |
| Ericsson |  | This can be discussed after the outcome of the discussion in Q2-6a. If a PR3-like solution is specified, semi-static indication would not have any benefits in terms of post-FFT buffer size reduction. |
| Samsung | Y | We are fine with the proposal. It is beneficial for complexity reduction of post-FFT data buffering. |
| NEC | N | Considering almost comparable complexity reduction gain of BW3 and PR3, complexity reduction gain by post-FFT data buffering would be moderate. Therefore, in our opinion, from scheduling flexibility and standardization efforts perspective, legacy dynamic resource allocation by DCI across 20 MHz BW at maximum would be preferable instead of introducing semi-static resource allocation. |
| LGE | Y | The current proposal covers only the semi-static approach which is okay per say. In addition, we would like to also consider other approaches, e.g., predefined in the spec, cross-slot scheduling. As a whole, we support the techniques to reduce post-FFT buffer. |
| Intel | Y | We share similar view with Lenovo that semi-static indication of frequency allocation for PDSCH is beneficial for reduced post-FFT buffer and reduced DCI size. |
| Nordic | N | Since reduction of post-FFT buffer advantage has been providing less than 1% of benefit. |
| FL2 | Based on the responses to Proposals 2-9a and 2-10a, the following proposal can be considered.  **High Priority Proposal 2-9b: For UE BB bandwidth reduction, it is FFS whether/how to support ~~semi-static indication of frequency location for PDSCH within the DL BWP for~~ reducing the post-FFT buffer complexity.** | |
| OPPO |  | We see lot of justification needed for introducing this.  And also it will greatly restrict the scheduling flexibly, we need consider the cost of it.  We also don’t see a general FFS is needed in FL-2. |
| Nordic |  | Cost is high in terms of restriction and specification effort, benefit close to zero. Moreover, UE capability to buffer whole slot is the best solution for sharing broadcast with legacy UEs. |
| Nokia, NSB | N | In the SI phase, the additional complexity reduction from reducing post-FFT buffering was found to be quite small. However, the standardization effort, scheduling restriction, and implementation effort is likely to be considerable. Therefore, we do not see the need to further study this. |
| FUTUREWEI | N | Companies mentioned several possible approaches to reduce post-FFT buffer complexity. By making all approaches FFS, then the UE BB bandwidth reduction technique is PR3 if no approach is agreed. It is contrary to the selection of BW3 at RAN for the WID ... we can refine the definition but should not define BW3 to be PR3. |
| Lenovo | Y |  |
| Spreadtrum | Y |  |
| DOCOMO | N | We share the same view with FUTUREWEI.  In addition, the difference of complexity reduction gain between BW3 and PR3 captured in TR, i.e., around 1%, is questionable since the assumption for complexity estimation was not exactly the same among companies as captured in the note of TR. We have a strong concern that further complexity reduction compared to Rel-17 RedCap cannot be ensured if post-FFT buffer bandwidth is still 20MHz like PR3.  Based on the RAN guidance, we should discuss based on BW3, i.e., aim to reduce post-FFT buffer, and hence we suggest to modify the proposal as follows;  **For UE BB bandwidth reduction, it is FFS ~~whether/~~how to support ~~semi-static indication of frequency location for PDSCH within the DL BWP for~~ reducing the post-FFT buffer complexity.** |
| SONY | N | The issue is not whether the post-FFT buffer complexity can be reduced or not, it is whether it can be further reduced. Hence, we think the proposal is not correct. The proposal could be updated as:  **For UE BB bandwidth reduction, it is FFS whether/how to support ~~semi-static indication of frequency location for PDSCH within the DL BWP for~~ further reducing the post-FFT buffer complexity.** |
| Panasonic | Y |  |
| CATT | Y | Reducing the post-FFT buffer complexity is the most critical advantage of BW3 compared to PR3. We support to study. If we do not study how to support it, we should choose the wording of PR3 to draft the WID at the beginning. |
| Vivo |  | We share Nordic and Nokia’s views that the additional complexity reduction from reducing post-FFT buffering is less than 1% but large standardization effort, scheduling restriction are expected. Therefore, we do not think it is worthwhile to reduce the post-FFT buffer complexity. |
| Qualcomm | N | As mentioned in proposal 2-9a and 2-10a, we do not see sufficient benefits of semi-static indication of frequency location and cross-slot scheduling for PDSCH compared to required implementation/spec impacts. We do not see any motivation to study further on this. |
| Samsung | N | We think candidate solution of reducing the post-FFT buffer complexity is not clear from this proposal. All of candidate solutions should be listed here, e.g., semi-static indication of 5MHz frequency location for PDSCH, cross-slot scheduling for PDSCH. |
| NEC | Y | We are OK to discuss. Our preference is no support of reducing the post-FFT buffer complexity for small complexity reduction gain. |
| LGE | N | Similar view with FUTUREWEI.  Rather than making all the approaches FFS, we prefer to list the potential approaches mentioned so far and agree to support one or more approaches to reduce post-FFT buffer. |
| ZTE, Sanechips |  | To avoid the impression that 20MHz post-FFT buffer is supported by default and only 5MHz buffer needs to be discussed, we suggest to use the following version.  **For UE BB bandwidth reduction, it is FFS whether/how to support 5MHz or 20MHz post-FFT buffer.** |
| CMCC |  | We share similar view as FUTUREWEI, both BW3 and PR3 have been evaluated during SI. And BW3 is recommended for WI not PR3, however, it seems now PR3 is re-chosen and replace BW3.  Maybe we should first clarify which one we are specifying now, then lot of the issues can be resolved. Our preference is BW3. |
| Ericsson | Y |  |
| MediaTek | N | My apologies that I had missed the case about the same-slot dynamic scheduling for SIB1 which eRedCap likely needs to support anyway (as pointed out by QC). Of course, we can also discuss how to enhance SIB1 transmission/configuration so that further post-FFT buffer reduction can be achieved.  Right now, we are not sure if this updated proposal is a right direction to go. **We prefer not to have this FFS proposal** to reduce post-FFT size.  Our intention is to get a common understanding about what post-FFT buffer size that companies have assumed for eRedCap UE. We have not been able to see how eRedCap can actually reduce its post-FFT buffer size to 5MHz for most symbols in a slot. Furthermore, we have been wondering why some companies wanted to support BW3 instead of PR3 besides the argument that BW3 showed better complexity reduction than PR3 which is not even more than 1%. (@Nokia, Futurewei, and Docomo: just wondering why you supported BW3 instead PR3 if you also agree <1% reduction is marginal?)  The reasons we think eRedCap UEs will likely have a post-FFT buffer of 20MHz for *most* (if not *all*) of the symbols in a slot are:   1. As mentioned by several companies, at most 1% reduction was observed for BW3 than PR3 in TR which is very marginal and could be less in real product implementation. We share a similar view with vivo and think eRedCap UEs will support 20MHz post-FFT buffer anyway. 2. Even with BW3, if UE cannot know which 5MHz “sub-band” is allocated for a PDSCH in slot n in advance before it decodes the scheduling PDCCH in the *same* slot, the post-FFT buffer needs to be 20MHz for at least the first X+Y symbols in a slot.    * Note: Y would be larger than its counterpart for eMBB (and Rel-17 RedCap) since this is supposed to be an eRedCap UE with further reduced capability. 3. For the rest (14-X-Y) symbols in a slot, can we simply assume that UE only needs 5MHz post-FFT buffer? **How about CSI-RS reception**? 4. (Depending on product definition, eRedCap UE may need to support LTE-NR dual-mode and have a capability of 20MHz anyway.) |
| Intel |  | Post-FFT buffer reduction is one aspect for complexity reduction of BW3 in TR, hence an enhancement which reduces post-FFT should be supported. In this early stage, we prefer to study all following solutions for broadcast and unicast PDSCH   * Opt.1: semi-static configuration of the 5MHz frequency location for PDSCH * Opt.2: dynamic indication of the 5MHz frequency location for PDSCH with post-FFT buffer reduction after PDCCH is decoded * Opt.3: cross-slot scheduling * Other solutions are not precluded |
| Xiaomi2 |  | We share the same view as Nordic, Nokia and vivo that it is not worthwhile to reduce the post-FFT buffer complexity with large spec impact. |
| Huawei, Hisilicon |  | Similar view as vivo, standardization effort to reduce post-FFT buffering is not preferred. |
| FL3  FL4  FL5 | Based on received responses, the following updated proposal can be considered.  **High Priority Proposal 2-9c: For UE BB bandwidth reduction, the following solutions are FFS:**   * **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)** * **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)** * **Other solutions are not precluded.** | |
| Nordic |  | It is bit unclear what these solutions are solving. First we should have consensus that “solution to reduce post data buffering” is needed  **High Priority Proposal 2-9c: For UE BB bandwidth reduction, if reduction of post-FFT data buffering is supported, the following solutions ~~are FFS~~ can be considered:**   * **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)** * **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)** * **Other solutions are not precluded.** |
| Nokia, NSB | N | Same view as in last round. We don’t need to study further given small complexity reduction but considerable standardization effort, scheduling restriction, and implementation effort. |
| FUTUREWEI | Y | The solutions of semi-static configuration and cross-slot scheduling are beneficial, and we would prefer them to be supported. But we as ok with at least FFS. |
| Lenovo | Y | But, we need to make a working assumption firstly on how UE perform post FFT data buffering. If there is no need to reduce the buffering, we don’t need to debate this issue. |
| ZTE, Sanechips |  | We think the update from Nordic would be a meaningful starting point, since the original proposal just lists some FFS.  We understand the reduction of post-FFT buffering is mainly focused on the 5MHz bandwidth and 20MHz bandwidth, it is more preferred to add the bandwidth for the the post-FFT buffering to make it clear.  Additionally, we do not think cross-slot scheduling is available for SIB1 scheduling, since default A used for SIB1 scheduling only supports same-slot scheduling. However, it may be possible to decode the DCI with a appropriate scheduling delay, e.g., several symbols.  Therefore, we have the following updates:  **High Priority Proposal 2-9c: For UE BB bandwidth reduction, if reduction of post-FFT data buffering bandwidth is supported, the following solutions ~~are FFS~~ can be considered:**   * **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)** * **Appropriate ~~Cross-slot~~ scheduling delay for PDSCH (for unicast and/or broadcast)** * **Other solutions are not precluded.** |
| Vivo | N | The proposal seems imply that we will specify at least one solution for reducing the post FFT buffering. Let’s first get consensus on whether it is possible and worthwhile to further reduce post data buffering considering the impacts on SIB1. |
| CATT | Y | Agree to list them as FFS.  It is fair to say, detailed investigation/discussion can be meaningful as long as we agree to go with BW3 for the purpose of reducing post-FFT data buffering (than PR3). |
| Spreadtrum | Y | We are positive to further check and study it.  For clarification mentioned by Nordic, we have a little bit different understanding. For UE BB bandwidth reduction UE, the post-FFT data buffering is already reduced, the issue discussed here is try to further reduce the post-FFT data buffering, therefore, we can try the following wording:  **High Priority Proposal 2-9c: For UE BB bandwidth reduction, the following solutions are FFS for further reducing the post-FFT buffer complexity:**   * **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)** * **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)** * **Other solutions are not precluded.** |
| DOCOMO | Y | We support to discussion for reducing post-FFT buffer. We are fine to consider the listed technique as potential solution and also we think other solution such as puncturing and/or soft-combining can be a possible solution. |
| Sharp | Y | We are ok with the FFS |
| SONY | Y | We agree with the point made by Spreadtrum. We think that BW3 already provides reduction of post-FFT data buffering, even with same-slot scheduling. However, semi-static configuration or cross-slot scheduling would provide further reduction of post-FFT data buffering.  On the cross-slot scheduling bullet, it is not really the case that cross-slot scheduling would reduce post-FFT data buffering, it is that “precluding same-slot scheduling” would reduce post-FFT data buffering.  Since this is a list of FFS items, we are OK considering them further. |
| Qualcomm | N | Any efforts to reduce post-FFT buffering (e.g., semi-static indication of data BW or cross-slot scheduling) do not provide sufficient complexity reduction gain but bring large spec impacts and additional UE implementation complexity in other ways.  As mentioned by companies, we have to discuss first whether further post-FFT buffering reduction is required or not. |
| NEC | N | Share view with Nokia. |
| MediaTek |  | As replied in Question 2-1-1a, we would like RAN1 to further discuss whether to support PR3. And we have the following proposal (copied to here)   * **Proposal: RAN1 discuss and decide whether bandwidth span of PDSCH resource allocation can be larger than 5MHz for eRedCap UEs before RAN#98e.**   + **If bandwidth span of PDSCH resource allocation is agreed to be confined within 5MHz, at least one of the following approaches should be adopted to strive for further reducing UE’s baseband complexity:**     - **Semi-static configuration of the 5-MHz frequency location for at least for unicast PDSCH. FFS: broadcast PDSCH.**     - **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)** |
| Panasonic | Y with update | In order to clarify the current situation, we agree to confirm current status is FFS on the listed points. Besides, this discussion is also related to the issue “BW3 or PR3”. When no solution was adopted after discussion, Option PR3 would be supported in our view.  We propose to modify the description on “Cross-slot scheduling for PDSCH (for unicast and/or broadcast)”. It should rather be described as “not support same-slot scheduling” or “always cross-slot scheduling”. Just “cross-slot scheduling” itself does not make the difference on the post-FFT buffer. |
| Samsung | Y | We are fine with the proposal. |
| CMCC |  | We want to add another sub-bullet solution, dynamic indication of semi-static configuration of the 5-MHz frequency location for PDSCH(for unicast and/or broadcast), since it can maintain the frequency diversity and scheduling flexibility.  **High Priority Proposal 2-9c: For UE BB bandwidth reduction, the following solutions are FFS:**   * **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)** * **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)** * **Dynamic indication of semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)** * **Other solutions are not precluded.** |
| Intel | Y | We agree such study is beneficial. We slightly prefer the updated proposal from CMCC. |
| Ericsson | Y |  |
| LGE | Y | This is just FFS. We should at least study solutions to reduce post-FFT buffer for the benefit of BW3 over PR3. Whether to adopt some of the techniques can be decided considering the whole picture including the spec impact and coexistence. |
| MediaTek |  | We think Proposal 2-9d can be discussed after or together with the discussion on BW3 vs PR3.  If PR3 is agreed, we don’t need to discuss Proposal 2-9d. On the other hand, if BW3 is agreed, we think PUSCH frequency hopping in uplink and CSI-RS bandwidth in downlink should be considered under Propopsal 2-9d. |
| Huawei, HiSilicon |  | The cost reduction by post-FFT buffer reduction is limited, standardization effort for it is not preferred.  OK to discuss PR3 first. |
| Nordic |  | Based on comments, let us refine  **High Priority Proposal 2-9c: For UE BB bandwidth reduction, if further reduction of the post-FFT buffer complexity is supported, the following solutions can be considered:**   * **Semi-static configuration of the 5-MHz frequency location for PDSCH (for unicast and/or broadcast)** * **Cross-slot scheduling for PDSCH (for unicast and/or broadcast)** * **Other solutions are not precluded.**   Our opinion is that further reduction of complexity with these methods is insignificant. |
| Xiaomi3 | N | We propose to deprioritize this discussion until whether the post-FFT buffer complexity is reduced reaches a consensus. |

Some contributions [14, 16, 17, 26] bring up the possibility to use cross-slot scheduling (rather than same-slot scheduling) for unicast and/or broadcast for the purpose of facilitating reduction of the post-FFT data buffering.

**FL1 High Priority Proposal 2-10a: For UE BB bandwidth reduction, it is FFS whether/how to support cross-slot scheduling for PDSCH (for unicast and/or broadcast) for reducing the post-FFT buffer complexity.**

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| **Company** | **Y/N** | **Comments** |
| MediaTek |  | As commented in the above, if BW3 is agreed, we think UE should be able to know which 5MHz “sub-band” is allocated for a unicast PDSCH **before** it decodes the corresponding PDCCH, i.e. we support Option 1 (1a or 1b) in our proposal in the comments to FL1 High Priority Proposal 2-9a in the above. However, we are open to discuss cross-slot scheduling for now. |
| FUTUREWEI |  | As we commented above, cross-slot scheduling allows processing of PDCCH and PDSCH in separate slots, lowers post-FFT buffer complexity, and provides the network flexibility to manage which resources to schedule. While current specifications indicate that broadcast PDSCH need same-slot scheduling, there are techniques to manage same slot-scheduling and should be discussed. We support “whether/how to support cross-slot scheduling” moving forward. |
| Nokia, NSB | N | We do not want to mandate cross-slot scheduling as this would restrict scheduler flexibility / increase complexity and also require considerable standardization effort. In our view the potential complexity reduction would be small. |
| Qualcomm |  | Cross-slot scheduling is already supported for unicast PDSCH in current spec so we do not need to discuss unicast PDSCH here. Then the proposal would be only for broadcast PDSCH with default TDRA table. We do not have preferences on supporting cross-slot scheduling for broadcast PDSCH as we have to consider the coexistence scenario that SIB1 PDSCH shared between Rel-18 UEs and other type of UEs. |
| Lenovo |  | Similar view with Nokia, we don’t want to mandate cross-slot scheduling. |
| China Telecom |  | The same view as Proposal 2-9a. The necessity and benefits should be studied and evaluated before making the final decision. |
| Sharp |  | eRedCap UE can reuse R16 cross-slot scheduling for unicast PDSCH. For broadcast PDSCH, cross-slot scheduling can be discussed separately for SIB1/OSI/msg2/msg4/paging PDSCH. |
| CATT | Y | Same comments above. Agree with MTK and FUTUREWEI.  If optimization to reduce post-FFT data buffering is NOT further considered, we need to revisit why not adopt PR3 instead of BW3. |
| Vivo |  | Cross-slot scheduling for unicast data is already supported by current specification, so we do not need to discuss it for unicast data. But for broadcast PDSCH, cross-slot scheduling is not supported by current specification, increases NW scheduler complexity and seems not within the WID scope. |
| ZTE, Sanechips |  | For SIB1, only default A is supported and cross slot scheduling is not supported in default A. Considering SIB1 may be shared with Rel-18 RedCap UE and other types of UE, cross-slot scheduling for SIB1 should not be supported.  For unicast, cross-slot scheduling is already supported as a optional feature. To reduce the post-FFT buffer complexity, we may need to only support the cross-slot scheduling feature. However, from our understanding, same slot scheduling is mandatory due to SIB1 receiving, therefore, it is not possible to only support the cross slot scheduling. Moreover, same slot scheduling should be supported for lower latency and scheduling efficiency.  Therefore, default cross-slot scheduling should not be a candidate solution for reducing the post-FFT buffer complexity. |
| DOCOMO |  | Similar comment as 2-9a. cross-slot scheduling can be one potential solution to reduce post-FFT buffer complexity, however, for broadcast PDSCH which is shared between Rel-18 RedCap and legacy UEs, it cannot be supported. |
| Spreadtrum | Yes with comments | In our understanding, the current cross-slot scheduling is gNB controlled (disable and enable), but the cross-slot scheduling discussed here can be a kind of default capability if the UE is R18 RedCap.  We are open to further check the differences and the possible benefits of cross-slot scheduling. |
| SONY |  | We assume that cross-slot scheduling would be supported for unicast PDSCH anyway. Isn’t the issue about whether we support same-slot scheduling for unicast PDSCH?  For broadcast PDSCH, we are OK to consider whether anything needs to be done to support broadcast PDSCH. |
| CMCC |  | For unicast PDSCH, as mentioned by Qualcomm, cross slot scheduling is already supported by R16 UE power saving, may be we need to discuss is whether to introduce the cross-slot scheduling feature for R18 RedCap UEs.  For multicast PDSCH, we do not think cross slot scheduling is needed, if introduced, some common channels such as SIB1 can not be shared. |
| Panasonic | Y | The discussion related to 2-4a/2-5a/2-6a should be stable before discussing whether to mandate cross-slot scheduling. |
| Xiaomi | N | Similar view with Nokia. |
| Ericsson | N | We are not fine with mandating cross-slot scheduling for all cases. Furthermore, as Qualcomm has commented, it is already possible for the gNB to configure cross-slot scheduling for unicast PDSCH in connected mode (for power saving purposes). |
| Samsung |  | For unicast PDSCH, cross-slot scheduling has been supported. For broadcast PDSCH, it can depend on channel type. For SIB1/Paging, any enhancement on scheduling is not needed considering sharing the same SIB1/Paging with legacy UE. For Msg2/Msg4/MsgB, scheduling related enhancement can be considered if early capability indication is supported. |
| NEC | N | Share view with Nokia. |
| LGE | Y | The current proposal covers only the cross-slot scheduling aspect which is okay per say. In addition, we would like to also consider other approaches, e.g., semi-static and predefined in the spec. From the two proposals above, 2-9a and 2-10a, we wonder if the “predefined in the spec” approach is also covered or not. If not covered, we would like to include it as an option to further consider. As a whole, we support the techniques to reduce post-FFT buffer. |
| Intel |  | Due to the quite limited available features for complexity reduction, we think it is beneficial to apply cross-slot scheduling for unicast PDSCH and for broadcast PDSCH |
| Nordic | Y | Specification impact could be limited if cross-slot applies to unicast only. |
| FL2 | See Proposal 2-9b. | |
| OPPO |  | After all this features, we realized it is difficult to really saving by those cross-slot scheduling, if we have normal SIB processing timeline which including same-slot, the UE will have the ability, then only cross slot for unicast data would not save the over all processing capability.  Still, same question for Proposal 2-9b. |
| Apple |  | First, the proposal here is to mandate the ‘cross-slot’ scheduling for PDSCH for eRedcap UE. The post-FFT buffer can be reduced assuming UE can decode the PDCCH within a slot (very typical case) and then only extract the REs used for scheduled PDSCH for HARQ buffer. Although the ‘cross-slot’ has been supported for unicast PDSCH since Rel-15, it is up to gNB scheduler to use ‘same slot’ or ‘cross-slot’ for a given PDSCH scheduling. Due to this uncertainty, a UE has to store 20MHz post-FFT samples before DCI decoding completion, which creates additional cost. If ‘cross-slot’ scheduling is mandated for unicast PDSCH and known at UE side, UE can always customize buffer size based on up to 5MHz BB and therefore cost is reduced.  On the other hand, we also agree that depending on whether a shared post-FFT buffer is used for SIB and unicast PDSCH reception, there may or may not have post-FFT buffering benefit by cross-slot scheduling if SIB anyway is allowed to be larger than 5MHz BB. |
| Xiaomi2 |  | This is the same issue as **High Priority Proposal 2-9b.** |

**Frequency-domain resource allocation (FDRA) optimization**

A few contributions [19, 33, 35] suggest that FDRA optimization/enhancement can be considered. One contribution [16] proposes to consider dynamic indication of a 5-MHz region, where the FDRA is defined within this region. One contribution [29] proposes that FDRA for unicast can be based on 5-MHz sub-bands to save DCI overhead. One contribution [24] proposes to discuss potential reuse of spare bits from the FDRA field in the RAR UL grant.

**FL1/FL8 Medium Priority Question 2-11a: For UE BB bandwidth reduction, should any kind of FDRA optimization be considered for further study? Please elaborate your response in the Comments field.**

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| **Company** | **Y/N** | **Comments** |
| Xiaomi4 | N | Don’t support to further optimize the FDRA field. Since the control channel BW remains the same as the R17 RedCap, the coverage of PDCCH for this two kinds of UEs is also similar. Thus, we can’t see the motivation for further enhancement. Besides, for the case of that the R17 RedCap UE and R18 eRedCap UE share the same broadcast channel, the FDRA needs to retain the legacy design and further optimization is not reasonable. |
| DOCOMO |  | We don’t see the strong need to discuss some optimization for FDRA so far, but fine to discuss if sufficient gain is shown. |
| MediaTek | N | Even if BW3 is agreed, we don’t think this optimization is necessary. PDCCH is still allowed up to 20MHz and has no link performance loss. |
| Vivo | N | Firstly, we support the non-contiguous PRB allocation for unicast PDSCH cross 20MHz with the restriction that the scheduled number of PRBs for unicast PDSCH does not exceed 5MHz e.g. 25PRBs@15KHz SCS and 11 PRBs@30KHZ SCS. The FDRA field cannot be reduced.  Secondly, **even if** the resource allocation for unicast PDSCH is restricted to contiguous 5MHz, we do not see the necessity and big gain for this optimization.  For RA type 0, assuming RBG size is 4, the FDRA bit size is 13 bits for 20MHz BW with 30KHz SCS and 9 bits for 5MHz BW with 30KHz SCS.  For RA type 1, the FDRA bit size is 11 bits for 20MHz BW with 30KHz SCS and 9 bits for 5MHz BW with 30KHz SCS.  For RA type 0, the bit size may be further reduced by semi-statically split the 20MHz into 4 subband with 5MHz, but scheduling flexibility will be restricted at the NW side. |
| Panasonic | N | To compress the FDRA bits, a 5 MHz region has to be defined in advance, which degrades the scheduling flexibility. If “Semi-static configuration of the 5-MHz frequency location for PDSCH” or similar technique is supported with the discussion of post-FFT buffer, we can revisit the optimization of FDRA. But at the moment where no scheduling restriction is supported, we do not support it. |
| Nordic | N | We do not see a need for DCI optimizations, except if companies would be willing to discuss PDCCH decoding relaxations. |
| Lenovo |  | We are open to consider FDRA optimizations for R18 RedCap UEs in connected mode. |
| CATT |  | We have negative view for now, but we also think no need to rush to such detailed question. This may also depend on whether BW3 or PR3 is adopted, and depend on the understanding of ‘FDRA optimization’.  For example, the method of ‘pre-known 5 MHz in frequency domain’ is considered for reducing post FFT data buffering of BW3. It may or may not be viewed as ‘FDRA optimization’ |
| Nokia, NSB | N | Our preference is that the UE can be allocated any frequency region within the BWP of up to 20 MHz. Therefore, we do not support FDRA optimization. |
| FUTUREWEI | N | No need for FDRA optimization because there is no performance loss for PDCCH with full 20 MHz bandwidth. |
| Ericsson | N | We prefer to avoid any minor optimizations that complicate the solution unnecessarily. |
| Intel | Y | The FDRA should be limited within 5MHz which saves FDRA field size. Since link performance of eRedCap UE is worse than legacy UE due to BW reduction, it is always beneficial to reduce DCI size for better PDCCH performance.   * For FDRA type 1, about 4 bits can be reduced * For FDRA type 0, we think the RBG size following 20MHz BWP is too large for eRedCap UE. For example, for SCS 30kHz, there are 13 RBG for the BWP of 52PRBs with RBG size=4. With same RBG size, the frequency resource of eRedCap is allocation within 3 RBGs. |
| ZTE, Sanechips | N | Currently we see no strong motivation to support this. |
| CMCC | Open | When the span of frequency allocation bandwidth is within 5MHz to reduce post FFT data buffering, optimization can be considered. |
| LGE | Y | We have a similar view with Intel. Unlike Rel-17 UE with 20 MHz scheduling bandwidth, the number of bits that can be reduced is not small now, so the FDRA field optimization is not considered minor anymore. For the optimization, we should consider the FDRA field in RAR UL Grant, in which case the recovered bits (max [5] bits compared to non-RedCap UEs) may be used to serve other purposes, e.g., to somehow compensate the coverage loss. |

**Other aspects of UE BB bandwidth reduction**

* The same resources within 5 MHz and [≤10 MHz] are used for the duration of the slot [8].
* PUCCH and SRS are restricted to 5MHz, at least when PUSCH is present and FFS when PUSCH is not present; FFS for the 5 MHz restriction of RACH [8].
* Intra-slot or inter-slot frequency hopping within bandwidth larger than 5MHz can be supported for PUSCH (including Msg3 PUSCH) while keeping the 5 MHz maximum BW of each hop [9].
* Simultaneous reception of PDSCH (limited to 5MHz in baseband) and SSB/PDCCH/CSI-RS within the BWP is supported for BWP of up to 20 MHz; simultaneous reception of two PDSCH transmissions (e.g., unicast and broadcast) is supported. FFS UE behavior when total frequency allocation is larger than 5 MHz; simultaneous transmission of PUSCH (limited to 5MHz in baseband) and PUCCH within the BWP is supported for BWP of up to 20 MHz [15].
* The UE behavior for the reception of multiple simultaneous PDSCHs needs to be specified for Rel-18 RedCap UEs [20].
* Decide whether a Rel-18 RedCap UE can process two broadcast PDSCHs or one broadcast PDSCH plus one unicast PDSCH are FDM multiplexed in a slot [16].

# 3 UE peak data rate reduction

According to the WID [1], it should be checked in RAN#98-e whether the UE peak data rate reduction is limited to UEs with UE BB bandwidth reduction only or whether it can be a standalone feature.

* Several contributions [9, 10, 15, 16, 21, 24, 19, 20, 22, 30, 34] express that UE peak data rate reduction should only be supported as an add-on feature to the UE BB bandwidth reduction feature and not as a standalone feature, whereas other contributions [11, 13, 14, 17, 25, 27, 33] express that UE peak data rate reduction should be supported as a standalone feature.
* Some contributions [9, 10, 16, 21, 35] express that specifying a standalone UE peak data rate reduction feature would lead to introduction of multiple new UE types and/or fragment the ecosystem, whereas one contribution [33] expresses that it would not introduce additional UE types, would not have RAN1 specification impact, would facilitate early implementations, and would be beneficial for dual-mode LTE-NR devices, and finally one contribution [27] expresses that it might in fact improve the economies of scale.
* A couple of contributions [26, 35] conclude that the combination of UE BB bandwidth reduction and UE peak data rate reduction (e.g., to *vLayers*·*Qm*·*f* ≥1) would not meet the target of 10 Mbps peak rate indicated in the justification part of the WID [1]. A few contributions [11, 28] propose that the constraint (*vLayers*·*Qm*·*f* ≥ 4) is not relaxed at all. One contribution [27] expresses that the relaxed peak rate constraint shall be chosen such that the peak data is not less than 10 Mbps in downlink and 5 Mbps in uplink (as for LTE Cat-1).
* One contribution [10] expresses that UE peak data rate reduction can be considered as a standalone feature for FR2, whereas another contribution [8] expresses that this would not be in the Rel-18 WI scope.

Regarding the relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for UE peak data rate reduction, the WID [1] suggests that it can be, e.g., 1 instead of 4 and that the parameters (*vLayers*, *Qm*, *f*) can be as in Rel-17 RedCap. Many contributions [9, 10, 11, 13, 14, 16, 17, 22, 25, 27, 30, 32, 33, 34] discuss what the relaxed value ought to be. As mentioned above, some contributions observe that the resulting peak rate will be much lower than 10 Mbps if the UE BB bandwidth reduction feature is combined with the UE peak data rate feature with a relaxed constraint of 1 instead of 4, and some of them suggest that a relaxed constraint of around 3 would be more suitable for meeting the targeted peak rate of 10 Mbps.

Based on the above considerations, the following proposal can be considered, where the square brackets indicate that the values are working assumptions which will be revisited.

**FL1 High Priority Proposal 3-1a:**

* **If UE peak data rate reduction is supported as an add-on to UE BB bandwidth reduction,**
  + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [3].**
* **If UE peak data rate reduction is supported as a standalone feature,**
  + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [1].**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Huawei, HiSilicon |  | OK for the first bullet. However, if two values are supported in the spec, it is unclear how one UE type of Rel-18 RedCap can be achieved considering additionally early identification is required. Therefore, we suggest to put the second bullet as FFS. |
| Nordic | N | We should have single value agreed for R18 RedCap as WID states   * + UE peak data rate reduction     - Relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for peak data rate reduction     - The relaxed constraint is, e.g., 1 (instead of 4).     - The parameters (*vLayers*, *Qm*, *f*) can be as in Rel-17 RedCap. |
| FUTUREWEI |  | We can accept with the “If”, but given the SI conclusion the “add on” is both not so much in question and also falls more clearly in a single UE type. So from that perspective, also ok to just state that standalone is FFS |
| Nokia, NSB | N | Agree with Nordic that we should only have one value. Our preference is to have UE peak data rate reduction as an add-on to UE BB bandwidth reduction as recommended by RAN1 in the TR. |
| Qualcomm | N | We are fine with the proposal for standalone case.  However, for the add-on case, *vLayers*·*Qm*·*f* = 3 does not meet 10Mbps peak rate with 12 PRB for 30KHz SCS so we prefer ***vLayers*·*Qm*·*f* ≥ 3.2.**  **Alternatively**, we can also do like:   * **If UE peak data rate reduction is supported as an add-on to UE BB bandwidth reduction,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ X.**   + **X is the smallest possible value which meets 10Mbps for PDSCH/PUSCH for 15/30KHz SCS.** * **If UE peak data rate reduction is supported as a standalone feature,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [1].** |
| CATT | Y | Maybe we can add a note to move forward:  Note: One of the branches may be deleted/invalid, depending on whether peak data rate reduction is supported as add-on or standalone or both, which is separately discussed. |
| vivo |  | For the first bullet, if UE peak data rate reduction is supported as an add-on to UE BB bandwidth reduction, to relax the constraint from 4 to 3, from our understanding, the cost saving is quite limited. It seems not meaningful to further relax the constraint. But if relax the constraint from 4 to 1, the DL/UL peak data rate will become 2.94Mbps/3.15Mbps for 30KHz SCS. From achieved peak data rate perspective, it can be viewed as a different eRedCap type from the one supporting 10Mbps target data rate.  We are fine with the second bullet. But it does not mean UE peak data rate reduction is supported as a standalone feature, whether to support it should be decided in Dec. RAN plenary meeting. |
| ZTE, Sanechips |  | Similar view as Huawei, FUTUREWEI, and Nokia, we can keep the first bullet for PR1 as add on tech. And for the standalone, keep it as FFS.  For the relaxed constrain value, on one hand, PR1 based on BW3 can reduce the peak data rate to 10Mbps from 13Mbps, and provide quite limited complexity reduction, e.g., less than 0.5%. on the other hand, not all the UEs should target at the 10Mbps peak data rate. For some low end UEs, the requirement for the peak data rate is lower.  Therefore, the constrain value can be further relaxed, e.g., 2, and the SIB transmission should be guaranteed based on the constrain. |
| DOCOMO |  | We share the similar view as HW, FUTUREWEI, Nokia and ZTE to put FFS on the second bullet. The exact value of relaxed constraints can be discussed further based on the number of RBs for 5MHz (i.e., discussion for Proposal 2-1a).  We also support ZTE that the constraint can be further relaxed to lower the peak rate as long as the TBS/payload size for broadcast PDSCH, e.g, SIB1, can be supported. |
| Spreadtrum |  | For the add-on part, we also think the value can be 2.   * If the allowed TBS within a TTI is around 3000bits, the SIB/paging reception in idle mode and the RACH procedure will not be impacted (no additional impacts were expected compared to 5MHz BB reduction only). Further peak rate reduction (smaller than 10Mbps) is benefit to the memory/buffer requirements. As 3000bits corresponding to 6Mbps (30KHz), then the constraint can be relaxed from 4 to 2 for Rel-18 RedCap UEs with 5MHz BB bandwidth.   For standalone part, we share the similar view as HW, FUTUREWEI, Nokia, ZTE and DOCOMO, e.g., to state that standalone is FFS for now. |
| SONY | Y | At this stage, we should consider both the “standalone” and “add-on” cases. The values of “[3]” for add-on and “[1]” for standalone seem reasonable. The values can be tweaked as the WI progresses. |
| CMCC |  | We propose PR1 is an add on feature rather than a standalone. Considering the limited cost reduction gain and one UE type limit. FFS for the second bullet is ok. |
| Panasonic | Y |  |
| Xiaomi |  | We suggest to modify the proposal as follows:  **For UE peak data rate reduction, down-select from the following two situations:**   * **Situation 1: UE peak data rate reduction is supported as an add-on to UE BB bandwidth reduction,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [3].** * **Situation 2: UE peak data rate reduction is supported as a standalone feature,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [1].**   Based on above, situation 1 is more preferred by us. |
| Ericsson | N | For the add-on case, we agree with Qualcomm that a value of 3 would not meet the 10 Mbps peak data rate requirement (even for FDD). One could consider a value of 3.2, however, it would not lead to any meaningful complexity reduction on top of BB bandwidth reduction.  For the standalone case, we have concerns on its implications on UE type definition, early indication, and market fragmentation.  Our preference would be to simply conclude that there is no need to introduce UE peak rate reduction in Rel-18 from RAN1 perspective. |
| Samsung |  | Firstly, we should discuss whether to support PR3 as an add-on and/or standalone feature. Then, the relaxed value of constraint ***vLayers*·*Qm*·*f*** can be further discussed. We prefer to support PR3 as an add-on feature. |
| NEC |  | For the second bullet on SA-PR1, we prefer to discuss whether to support SA-PR1 first. We are also OK to put FFS to the second bullet. |
| LGE | N | We share the same view with Nokia. |
| MediaTek |  | We are fine with the proposal though further relaxation to [3] under first bullet may not seem very attractive in terms of UE’s complexity reduction.  A question for clarification: If this proposal is agreed, does it mean PR1 is supported both as a standalone feature and an add-on feature in R18? Or standalone vs add-on is a separate discussion? |
| Sequans | Y | We are fine with current proposal. Also fine to have standalone bullet as FFS. |
| Intel |  | We are supportive to the proposal. It would be helpful to clarify RAN1 is not intended to support both ‘add-on’ and ‘standalone’, and we prefer ‘add-on’ option. |
| Nordic | Follow up | |  |  | | --- | --- | | constraint | Max TBS /per ms  (15kHz SCS, 156RE in RB) | |  |  | | 4 | 15616 | | 3 | 11784 | | 2 | 7824 | | 1 | 3912 |   In our opinion value 3 meets 10Mbits per second for FD-FDD UE. |
| FL2 | Based on received responses, the following updated proposal can be considered, where the square brackets still indicate that the values are working assumptions which will be revisited.  **High Priority Proposal 3-1b:**  **For UE peak data rate reduction, down-select between the following options:**   * **Option 1: ~~If~~ UE peak data rate reduction is supported as an add-on to UE BB bandwidth reduction.**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [3].** * **Option 2: ~~If~~ UE peak data rate reduction is supported as a standalone feature.**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [1].** | |
| OPPO | N | We would only have one value.  And it seems too early to agree both options. |
| Nordic | N | Even for 11PRB (30kHz SCS), max TB within a slot is 5128 if the constraint is relaxed to 3, this allows for peak rate of 10,256 Mbits in DL  So for baseline 1Rx FD-FDD, UE peak rate of 10Mbits can be met with value 3.  In our opinion down-selection is not technically correct, because if PR1 is standalone feature from BW3, UE can always implement both PR1 and BW3. We already had a consensus that PR1 is recommended to be an add-on to BW3. This is why proposal should be as the following   * + **UE peak data rate reduction is supported at least as an add-on to UE BB bandwidth reduction feature. The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [3].**     - **FFS UE peak data rate reduction is supported as a standalone feature. The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [1].** |
| Nokia, NSB | Y | We are OK to decide between add-on versus standalone as this issue will be discussed in RAN plenary so RAN1’s input/agreement would be very helpful. Our preference is Option 1 as recommended by RAN1 in the TR. In our analysis, the constraint would need to be relaxed to around 3.4, but we can further discuss the exact value. |
| FUTUREWEI | N | The SI conclusion was clear that PR1 would be an add-on, the question is whether it would be an add-on only, or could also be used standalone. The formulation is to downselect between standalone only or add-on only. So again we recommend, if PR1 is used as an add-on the constraint is [3], FFS the standalone case.  If we get stuck here, we are also OK to revisit after the decision on whether standalone is supported (here or at RAN). |
| Apple |  | To be honest, for ‘add-on’ feature, relaxing the product value from 4 to 3.2 is fairly marginal and not bring any meaningful L2 buffer size reduction as well as cost reduction. We really doubt RAN1 should spend efforts to standardize this kind of feature.  On the option of standalone feature, we understand the concern based on the 3GPP discussion history. On the other hand, kindly note that the current spec restriction is ‘ is no smaller than 4’. Even in Rel-15, UE is allowed to report ‘’, ‘’ etc., by selecting different combinations for these three parameters. We never call there are multiple types of UEs in Rel-15. It is our view that we should focus on introducing a useful feature to make eRedcap attractive, instead of blocking a useful mechanism with overstating the potential impact. |
| Sierra Wireless |  | Should consider both options, not downselect. There is limited cost benefit as an add-on feature, but it is meaningful as a standalone feature. |
| Spreadtrum |  | We share the similar understanding as FUTUREWEI, and we are OK with Nordic’s wording suggestions.  To be honest, add-on and standalone should not be treated equally, and we have concern to tangle them together.   * For add-on, according to SI conclusion from 38.865(also mentioned by FW), we suggest to conclude at this stage whether to adopt this feature for Rel-18 eRedCap, and leave constraint value FFS. * For standalone, the story is different from add-on, some other aspects such as early implementation, compact ASN.1, etc were proposed and discussed at RAN#97e meeting. If RAN1 can not reach consensus, it can be FFS in RAN1 or we can discuss standalone later in RAN. |
| DOCOMO | N | We share the similar understanding as Nordic that PR1 should be supported at least as add-on feature for BW3 and PR1 as standalone is FFS. Thus, we are fine with the updates by Nordic. |
| SONY | N | The proposal could lead to BW3 being supported without the PR1 add-on and a standalone PR1 being supported. That would lead to BW3 supporting a data rate of 13.38Mbps in the DL and PR1 supporting a data rate of 10Mbps in the DL (depending on resolution of the square brackets around “[1]”).  We prefer the original proposal 3\_1a. |
| Panasonic | Y | Nordic’s proposal is also fine to us. |
| CATT |  | The new version is in fact doing down-selection between add-on and standalone PR1, but not decoupling the discussion of ‘add-on or standalone’ and ‘the value of constraint’. We still suggest the **original version with the following note:**  **Note: One of the branches may be deleted/invalid, depending on whether peak data rate reduction is supported as add-on or standalone or both, which is separately discussed.** |
| vivo |  | We would like to echo Ericsson’s views in the 1st round. For the add-on case, a value of 3.2 would not lead to any meaningful complexity reduction on top of BB bandwidth reduction.  For the standalone case, the cost reduction could be meaningful, but we understand companies’ concerns on not aligning with the SI recommendation and two Rel-18 eRedCap UE types. Maybe we need to solve this standalone case in next plenary, if RAN1 cannot reach consensus. |
| Qualcomm | N | As mentioned by companies above, down-selection is not aligned with the agreed WID and RAN guideline. We rather prefer the original proposal (**High Priority Proposal 3-1a)** with numbers in brackets and potentially with a note as shown below:   * **If UE peak data rate reduction is supported as an add-on to UE BB bandwidth reduction,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [3].** * **If UE peak data rate reduction is supported as a standalone feature,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ [1].**   + **Note: Whether this option is supported or not will be decided in RAN plenary** |
| Samsung | Y | We are fine with the proposal and prefer option 1. As an add-on feature to UE BB bandwidth reduction, UE peak data rate reduction can be optional. Regarding the relaxed constraint value of ***vLayers*·*Qm*·*f*** , it can be further discussed. |
| NEC | Y | We are OK to down-select between two options. Our preference is option 1. |
| LGE | N | Share the view with FUTUREWEI. Nordic’s update seems better. |
| Sequans | Y | Fine with the proposal. Nordic’s suggestion also makes more sense to us. |
| ZTE, Sanechips |  | It is expected the constraint can be further relaxed to 2, since 10Mbps peak data rate is still quite high for for some use cases, e.g., Industrial wireless sensors with less than 2Mbps peak data rate.  And if the constraint is only relaxed to 3.2, it is true that the further complexity reduction is not attractive.  Therefore, we are OK with the down-selection and the constrain can be relaxed to 2. |
| CMCC | Y | Our preference is option 1. |
| Ericsson |  | It is our understanding that when UE peak rate reduction is an add-on to UE BB bandwidth reduction, the 10 Mbps target data rate cannot be met with *vLayers*·*Qm*·*f* = 3 and maximum number of PRBs = 11 for 30 kHz SCS (as in Option 1 of P2-1b). However, if the maximum number of PRBs is 14 (as in Option 1 of P2-1b), the 10 Mbps target rate can be met.  Qualcomm’s proposal in the previous round to say to *vLayers*·*Qm*·*f* ≥ X, where “X is the smallest possible value which meets 10Mbps for PDSCH/PUSCH for 15/30KHz SCS” would be a better way-forward in our view. |
| Intel | Y | We are OK with FL proposal and the updated proposal from Nordic |
| Xiaomi2 | Y | Fine with the proposal for progress and prefer Option 1.  The original proposal (**High Priority Proposal 3-1a)** is confused for us that whether PR3 could be used as both an add-on and SA solution for eRedCap. |
| Huawei, HiSilicon |  | Generally OK for the first bullet.  If two values are supported in the spec, it is unclear how one UE type of Rel-18 RedCap can be achieved considering additionally early identification is required. Therefore, we suggest to put the second bullet as FFS. |
| FL3 | Based on received responses, the following updated proposal can be considered, where the square brackets still indicate that the values are working assumptions which will be revisited.  **High Priority Proposal 3-1c:**   * **UE peak data rate reduction is supported at least as an add-on to UE BB bandwidth reduction,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ X.**   + **FFS: the value of X to meet the 10-Mbps peak rate target** * **If UE peak data rate reduction is supported as a standalone feature,**   + **The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ Y.**   + **FFS: the value of Y to meet the 10-Mbps peak rate target**   + **Note: Whether this option is supported will be decided in RAN plenary.** | |
| FL4 | Based on the proposal, the online (GTW) session on Wednesday 12th October made this agreement:  Agreement:   * UE peak data rate reduction is supported at least as an add-on to UE BB bandwidth reduction,   + The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ X.   + FFS: the value of X * If UE peak data rate reduction is supported as a standalone feature,   + The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ Y.   + FFS: the value of Y   + Note: Whether this option is supported will be decided in RAN plenary. | |

**FL4/FL5 High Priority Question 3-2a: Companies are invited to comment on the value of X in the above agreement.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nordic | WID says ”The supported peak data rate for Rel-18 RedCap targets to 10Mbps” It does not say “should be larger or smaller than 10Mbps”  38.306 provides only an approximate data rate and it is not mappable to max TBS UE should support.  If *vLayers*·*Qm*·*f* capais used by gNB as max MCS (spectral efficiency) scheduled in max number of PRBs (e.g. 25) with minimum overhead resulting in 156 RE per PRB, then UE must support peak rate of   |  |  | | --- | --- | | 38.306 constraint value | Max TBS  (15kHz SCS, 156RE in RB) | | 4 | 15616 | | 3 | 11784 | | 2 | 7824 | | 1 | 3912 |   This is the real peak rate UE must support. **Constraint value should be between 2 and 3.** |
| Nokia, NSB | In our understanding, there are two views on the target peak data rates when constraint relaxation is supported as an add-on – 10 Mbps or substantially smaller (say ~3 Mbps).  In our view, the WID clearly states the peak data rates should be 10 Mbps. This would mean the constraint is relaxed to ~3 (with exact value depending on how many PRBs we decide to support). We do not support reducing the peak data rates to substantially below 10 Mbps (e.g. constraint is relaxed to 1 to get ~3 Mbps) as this is against the WID. It will also create another R18 RedCap UE type which should be avoided to prevent market fragmentation. |
| FUTUREWEI | The 10 Mbps rate is not a WID objective requirement but a justification target. We are ok with a value of X=3. |
| ZTE, Sanechips | The statement in the WID regarding the target peak data rate doe not mandate that all Rel-18 RedCap UE should satisfy the 10Mbps peak data rate. For example, for Rel-17 RedCap UE, the wearables has the target peak date rate 150Mbps. It does not mean the configuration of 1Rx and 64QAM should be precluded.  Therefore, it is also feasible to relax the constraint to **2**. Based on this constraint, the peak data rate is more aligned with the industrial sensors requirements, and more complexity reduction can be achieved considering that the constraint relaxed to 3 actually has marginal complexity reduction. |
| vivo | We share same view with Nokia, 10 Mbps should be the target, much smaller peak data rate should not be considered. If majority companies prefer to relax the constraint to 3, we are fine with the number 3. |
| CATT | * **The calculation of X depends on the maximum PRB number** 🡨 **This is not clear yet as 4 options are still listed in the latest agreement**. So the detailed value of X is of course uncertain for now. Determiation of X should be done after we have aligned understanding for the maximum PRB number.   + For SCS=30kHz case, if PRB number is 11, we observe that X cannot be reduced much. It will be larger than 3. * Assumptions on TDD (with different TDD config) or FDD or HD-FDD will impact the ’long-term’ data rate. If we want a unified value of X, we suggest focusing the transmission/reception only within ’1 slot’, for both DL and UL, assuming full slot can be used for reception/transmission. |
| Spreadtrum | The X can be 2.  Firstly, we share the same observations as Nordic and ZTE.  Secondly, as we commented in the first round, if the allowed TBS within a TTI is around 3000bits, the SIB/paging reception in idle mode and the RACH procedure will not be impacted (no additional impacts were expected compared to 5MHz BB reduction only), then, there is no additional UE type needs to be introduced. Further peak rate reduction (smaller than 10Mbps) is benefit to the memory/buffer requirements. As 3000bits corresponding to 6Mbps (30KHz), then the constraint can be relaxed from 4 to 2 for Rel-18 RedCap UEs with 5MHz BB bandwidth.  Lastly, as PR1 is only add-on feature, which can be optional, X=2 can potentially provide more flexibility. |
| DOCOMO | The exact value of X should be discussed based on the number of RBs for 5MHz.  We have a similar view as ZTE and Spreadtrum.  It would be beneficial for maximizing the Rel-18 RedCap use cases/target devices to support smaller peak rate than 10 Mbps and we don’t see the need to strictly restrict the lower limit of peak rate unless it overlaps with LPWA. We also believe that such UE which supports smaller peak rate than 10 Mbps does not imply to create another type of UE. Even if the peak rate is bit smaller than the target 10 Mbps, the unified solution/operation would be supported and optimizations are not necessary as long as the TBS for broadcast PDSCH, e.g., SIB1, is covered. In our understanding, the peak rate would be much larger than 10 Mbps depending on the UE capability of MIMO layers, modulation order and/or scaling factor, and we are rather concerned about this since the peak rate would be linearly affect to the memory size as captured in TR.  Therefore, we prefer to consider the relaxed constraints as 1 or 2 for X. |
| SONY | BW3: X = 3 (gives 10Mbps in the DL at 15kHz SCS)  PR1: Y = (0.7 gives 10Mbps in the DL at 15kHz SCS) |
| Qualcomm | For Y, we suggest Y=1 as studied during the study item.  For X, we prefer to keep 10Mbps peak data rate requirement. As the peak rate depends on the number of RBs, we can either wait until the number of RB is decided or we can agree that *X is the smallest possible value which meets 10Mbps for PDSCH/PUSCH with 15/30KHz SCS*.  In either cases, we do not introduce any new values for the parameters, *vLayers*, *Qm*, and *f* other than the ones that are already supported in current spec. |
| NEC | X=3. Rel-18 RedCap UE with lower peak data rate than 10Mbps would not be justified and should be out of scope of NR. |
| MediaTek | We share a similar view with Nokia. Peak data rate is written in WID for a reason, and we need to respect that. Our view is that depending on the final PRB number agreed, the constraint X should be at least 3. |
| Panasonic | We propose to use 10 Mbps as a target peak rate to discuss/decide the X value.  If 10 Mbps can be used as a target, we propose X=3 which would provide 10 Mbps based on the peak rate calculation in 38.306. Otherwise, we are not sure of an alternative criterion to discuss/decide the X value. |
| Samsung | We had a basic question on this peak data rate reduction added on feature.  Does this mean we will have two types of eRedcap UE, with and without peak data rate reduction? Or, we only have one eRedcap UE, who will have this peak data rate reduction. Although, UE can report it can support no reduction, similar as we have 1Rx and 2Rx for Redcap?  If we are aiming to have two type of eRedcap, this value can be smaller, e.g., 1 or 2.  If only one type eRedcap is desired, this value shall be 3.  We would like to hear more view from companies. Or, we can leave this discussion to RAN P, then discuss it with clear guidance |
| CMCC | According to our calculation, to satisfy 10Mbps peak data rate for both DL and UL, even with 12RBs for 30KHz, X>3.2 is required.  **For 15KHz, 25RB**  X=3.2, DL:10.7Mbps, UL:11.45Mpbs;  X=3, DL:10.03Mbps, UL:10.73Mbps.  **For 30KHz, 11RB;**  X=4, DL:11.77Mbps, UL:12.59Mbps;  X=3.2, DL:9.42Mbps, UL:10.07Mbps;  **For 30KHz, 12RB;**  X=3.2, DL:10.27Mbps, UL:10.99Mbps;  X=3, DL:9.63Mbps, UL:10.3Mbps; |
| Intel | We prefer to stick to 10Mbps as the target to avoid potential long discussions. Then, a simple calculation gives X=3 is the most proper value. |
| Sequans | We also support the view that 10Mbps peak data rate should be respected. X of at least 3 (depending on actual PRB number restriction agreed) will satisfy this requirement in the add-on case. |
| Ericsson | The value of X would depend on which among the 4 options for the maximum number of PRBs would be specified.  Based on our calculations (using the peak rate expression in TS 38.306), a value of 2.7 for Option 1 and a value of 3.4 for Option 4 would be reasonable choices.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | ***vLayers*·*Qm*·*f*** | **Option 1** | | **Option 4** | | | **15 kHz SCS**  **(28 PRBs)**  **[Mbps]** | **30 kHz SCS**  **(14 PRBs)**  **[Mbps]** | **15 kHz SCS**  **(25 PRBs)**  **[Mbps]** | **30 kHz SCS**  **(11 PRBs)**  **[Mbps]** | | 4 | DL: 15.0  UL: 16.0 | DL: 15.0  UL: 16.0 | DL: 13.4  UL: 14.3 | DL: 11.8  UL: 12.6 | | 3.5 | DL: 13. 1  UL: 14.0 | DL: 13. 1  UL: 14.0 | DL: 11.7  UL: 12.5 | DL: 10.2  UL: 11.0 | | 3.4 | DL: 12. 7  UL: 13.2 | DL: 12. 7  UL: 13.2 | DL: 11.4  UL: 12. 2 | DL: 10. 0  UL: 10.7 | | 3.2 | DL: 12.0  UL: 12. 8 | DL: 12.0  UL: 12. 8 | DL: 10. 7  UL: 11.4 | DL: 9. 4  UL: 10.0 | | 3 | DL: 11. 2  UL: 12. 0 | DL: 11. 2  UL: 12. 0 | DL: 10. 0  UL: 10. 7 | DL: 8.8  UL: 9. 4 | | 2.7 | DL: 10. 1  UL: 10. 8 | DL: 10. 1  UL: 10. 8 | DL: 9. 0  UL: 9. 7 | DL: 7.9  UL: 8. 5 | |
| LGE | For X, single value is preferred. Can down-select b/w 3 (to meet 10 Mbps peak rate) and a substantially lower value (e.g., 1, perhaps to support wireless sensors and low-end wearables). |
| MediaTek | X should support the peak data rate 10Mbps specified in WID and should be around 3. |
| Huawei, Hisilicon | With the target peak data rate 10Mhz, the constraint should be no less than 3. |
| Nordic | We would have preferred to reduce peak rate to 2 (as we see this would be enough for industrial IoT), but we agree it could result into two types of UEs in the market, one with 10Mbps as originally planned, and then 6.7Mbps. Therefore, we can compromise for 3.  **And I would like to remind that 38.306 is only approximate data rate**, since max TBS is not really specified in NR, UE must target bit more than 10Mbps in practice. |
| Xiaomi3 | Share the same view as Speadtrum. As an add-on solution, X=2 can provide more flexibility for different services with different target data rate requirements. |

# 4 Early indication

**Early indication in Msg1/MsgA PRACH**

Several contributions [8, 10, 12, 18, 19, 21, 22, 28, 29, 33] express that a separate indication in Msg1/MsgA PRACH specifically for Rel-18 RedCap UEs can be supported, whereas other contributions [14, 15, 24, 31, 32, 35] want to study further whether the separate indication should be supported or not. Some contributions [9, 11, 16, 23] express that it is not necessary and/or should not be supported.

A few contributions [20, 27] express that separate early indication in Msg1 can be supported for UE BB bandwidth reduction, whereas the contribution [20] expresses that separate early indication specifically for the combination of UE BB bandwidth reduction and UE peak rate reduction should not be supported. The contribution [27] also expresses that early indication in Msg1 for standalone peak rate reduction needs further study, and that only one separate early indication should be specified for all Rel-18 RedCap UEs.

**Early indication in Msg3/MsgA PUSCH**

Some contributions [9, 15, 16, 22, 28] express that a separate early indication in Msg3 and/or MsgA PUSCH can be supported, whereas a few contributions [24, 35] want to study further whether the separate indication is supported or not. One contribution [11] expresses that the separate indication in Msg3 should not be supported. Another contribution [14] expresses that it should be up to RAN2 to decide whether/how to support Msg3 indication. A couple of contributions [20, 27] express that the separate indication can be supported for UE BB bandwidth reduction, but one contribution [27] wants to study further whether it should also be supported for standalone peak rate reduction.

**FL1 High Priority Proposal 4-1a: Rel-18 RedCap UEs (supporting UE complexity reduction functionality introduced by this WI) can use the same early indication in Msg1/Msg3/MsgA as Rel-17 RedCap UEs.**

* **FFS: whether to also support separate early indication in Msg1/Msg3/MsgA for Rel-18 RedCap UEs**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Huawei, HiSilicon |  | In our view, this proposal is related to FL1 Proposal 2-5a. Therefore, we suggest to make more progress on RAR handling first and the issue of intra-slot hopping of Msg3 (whether the effective bandwidth after intra-slot hopping can exceed 5 MHz) before we discuss this proposal. |
| Nordic | Y | Agree with HW |
| MediaTek |  | More discussion and consensus are needed on broadcast PDSCHs and RACH messages before we can understand whether a separate early indication is indeed needed for Rel-18 eRedCap. |
| FUTUREWEI |  | Our understanding from RAN#97 was that we would at least support the possibility of same early indication, but from the GTW today we should probably craft a full proposal considering hopping, R18 when R17 is not present, etc. rather than have FFS. |
| Nokia, NSB | Y | We support the ability to configure the same early indication to identify both Rel-17 and Rel-18 RedCap UE. We are fine to study further the ability to configure separate early indication for Rel-18 RedCap UE. |
| Qualcomm | N | We prefer to define separate early indication for Rel-18 RedCap UEs in order to allow NW to choose the configuration between separate early indication or same early indication between Rel-18 UEs and Rel-17 UEs. We also agree that we need further discussion on broadcast channels. Rather than agreeing on the current proposal with FFS, it would be good to discuss broadcast channel discussion first and come back to the early indication discussion. |
| China Telecom |  | We think it can support both the same and separate early indication in Msg1/Msg3/MsgA for Rel-18 RedCap UEs for better feasibility. |
| Sharp | Y | We support the proposal. |
| CATT | Y | The proposal is not wrong so we support.  Regarding HW’s comment on frequency hopping, we have similar understanding that frequency hopping interval of PUSCH should be allowed to be >5MHz, where each hop is within 5MHz. |
| vivo |  | We support the main bullet and suggest to remove the entire subbullet, since the WID already says “Check in RAN#98-e regarding:   * Whether or not/how a separate early indication can be supported”   So, we do not need to repeat this point.  Besides, we share same views as other companies that whether to support separate early indication should be discussed after we have common understanding on what Rel-18 eRedCap is. |
| ZTE, Sanechips | Y | When the separate initial BWP is configured with 5MHz bandwidth, it is possible for the Rel-18 RedCap UE and Rel-17 RedCap UE to share the same early indication in Msg1/Msg3/MsgA.  When initial DL BWP is larger than 5MHz, separate early indication for Rel-18 RedCap in msg3 also should be considered to mitigate the impacts on legacy UEs scheduling. |
| DOCOMO | Y | We share the same view as HW. In addition, we would like to clarify whether “Rel-18 RedCap UEs (supporting UE complexity reduction functionality introduced by this WI)”in this proposal implies that the UE supports both or either BW reduction and peak rate reduction feature. |
| Spreadtrum | Y | We are fine with this proposal, and we see the benefit to support separate early indication for Rel-18 RedCap UEs. In addition, the issue may need RAN2’s views. |
| SONY | Y | Agree with other companies that more discussion on broadcast PDSCH / RAR is needed before deciding whether a separate early indication for eRedCap-R18 UEs is needed. |
| CMCC | Y | We think it can share same early indication as R17 since most of initial access procedure can be shared.  For Msg3, since the RF bandwidth is 20MHz, we think supporting intra frequency hopping span more than 5MHz is acceptable as long as the bandwidth of each hop is smaller than 5MHz.  For RAR and Msg3, the payload is limited, so early indication by Msg1 is not necessary, unless critical issue is find considering the fragment of PRACH resources.  Early indication by Msg3 can be further discussed if larger payload of Msg4 is allowed. |
| Panasonic |  | Early indication can be discussed after more eRedCap functions are stabilized. |
| Xiaomi |  | We are fine with the main bullet and support to further study whether separate early indication is needed for eRedCap. |
| Ericsson | Y | We think FFS sub-bullet in the proposal handles the concerns of Huawei/HiSilicon. |
| Samsung | Y | We are fine with the proposal. How to support same/separate early indication can be up to RAN2. |
| NEC | Y | Agree with Huawei. |
| LGE | Y | We think the separate early indication for Rel-18 RedCap should be supported, but the current proposal itself seems okay for now. |
| Sequans | Y | Agree to discuss after progress in proposal 2-5a |
| Intel | Y | Agree with HW to first clarify handling of RAR/msg3 and msg4. |
| FL2 | Based on received responses, this topic can be revisited later. | |

**FL1 Medium Priority Question 4-2a: Is a separate early indication in Msg1 for Rel-18 RedCap UEs needed?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
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**FL1 Medium Priority Question 4-3a: Is a separate early indication in Msg3 for Rel-18 RedCap UEs needed?**

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| **Company** | **Y/N** | **Comments** |
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# 5 Other aspects

**Cell barring**

* Rel-18 RedCap UE shares the same cell access/barring indication and mechanism with Rel-17 RedCap UE. FFS additional cell access/barring indication. Final decision is up to RAN2 [14].
* A broadcasted SI indicating network support for Rel-18 RedCap is needed; network may support Rel-17 RedCap UEs but not Rel-18 RedCap UE [27].
* Introduce a new cell bar and an IFRI field in SIB1 for RedCap UEs [22].

**SSB and CORESET#0**

* FFS introducing new or reused SSB or CORESET#0 for Rel-18 RedCap. FFS how to reuse Rel-15 SSB for Option BW3 [12].
* Reuse Rel-15 SS/PBCH block for cell search and measurements for Rel-18 RedCap [18].
* Specify support of NCD-SSB for RedCap UEs in idle/inactive mode [10].

**Feature group / UE type / capability reporting**

* The basic feature group for Rel-18 RedCap includes BW3 [8].
* RAN1 defines one new Rel-18 RedCap UE type for further UE complexity reduction [15].
* Introduce new UE capability parameter for Rel-18 RedCap UEs that indicates basic functional components [15].
* BB bandwidth for PDSCH and PUSCH is an identification for the new RedCap UE type [22].
* Peak data rate reduction can be reported by the existing capability parameters *vLayers*, *Qm*and *f* [20].
* A single Rel-18 RedCap UE type should be supported for Rel-18 RedCap [12].

**Miscellaneous**

* Discuss whether to specify coverage recovery techniques for RedCap considering normal deployment scenario (i.e., not based on the Urban scenario at 4 GHz with 11 PRBs and DL PSD of 24dBm/MHz) and not considered the 3 dB antenna efficiency loss [24].
* Support/discuss enhancements for common PUCCH especially when the FH for the common PUCCH resources is disabled [24].
* For PUSCH, both CP-OFDM and DFT-s-OFDM should mandatorily be supported by RedCap UEs [30].
* For TDD, only the RF bandwidth for UL and DL needs to be aligned [15].
* Reduce BD/CCE limits for R18 Redcap UEs to half, i.e., 28CCE + 22BD per 15kHz slot, 18BDs per 30kHz SCS; Rel-18 RedCap UE monitors only one common SS per slot [34].
* DCI format sizes are the same as for legacy UEs [34].
* 16QAM is mandatorily supported while 64QAM can be optionally supported by Rel-18 RedCap [25].

# References

|  |  |  |  |
| --- | --- | --- | --- |
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| [8] | [R1-2208387](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208387.zip) | Discussion on details for R18 RedCap complexity techniques | FUTUREWEI |
| [9] | [R1-2208416](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208416.zip) | Discussion on potential solutions to further reduce UE complexity | Huawei, HiSilicon |
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| [11] | [R1-2208653](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208653.zip) | Discussion on UE further complexity reduction | Vivo, Guangdong Genius |
| [12] | [R1-2208775](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208775.zip) | Discussion on UE complexity reduction | China Telecom |
| [13] | [R1-2208842](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208842.zip) | Technologies for further reduced UE complexity | OPPO |
| [14] | [R1-2208986](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2208986.zip) | Discussion on further complexity reduction for eRedCap UE | CATT |
| [15] | [R1-2209004](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209004.zip) | RedCap UE Complexity Reduction | Nokia, Nokia Shanghai Bell |
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| [27] | [R1-2209663](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209663.zip) | Considerations for further UE complexity reduction | Sierra Wireless. S.A. |
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| [29] | [R1-2209741](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209741.zip) | Further UE complexity reduction for eRedCap | Samsung |
| [30] | [R1-2209791](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_110b-e/Docs/R1-2209791.zip) | UE complexity reduction for eRedCap | Panasonic |
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