3GPP TSG-RAN WG1 Meeting #112bis-e Draft R1-2303933

e-Meeting, 17th – 26th April 2023

**Agenda Item: 9.6.1**

**Title: FL summary #1 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]. FLSs from the previous RAN1 meeting can be found in [3, 4, 5, 6], and a RAN1 agreement summary is available in [7].

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.
		- Support additional separate early indication(s) [RAN1, RAN2]
	+ 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#99 regarding:* Whether UE peak data rate reduction for UE is limited only with UE BB bandwidth reduction or standalone
 |

RAN#99 discussed whether UE peak data rate reduction (“PR1”) should be supported as a standalone feature or only in combination with UE BB bandwidth reduction (“BW3/PR3”) and endorsed the following proposal [8], where the different nicknames for the UE complexity reduction features (“PR1” and “BW3/PR3”) originate from TR 38.865 [9].

|  |
| --- |
| **Rel-18 eRedCap UE capable of 20MHz + PR1 and Rel-18 eRedCap UE capable of BW3/PR3 + PR1 are designed/targeted to same peak data rate, i.e., 10Mbps**Note 1: Peak data rate of “Rel-18 eRedCap: UE capable of 20MHz + PR1” and “Rel-18 eRedCap: UE capable of BW3/PR3 + PR1” is same including unicast and broadcast respectively.Note 2: PRB processing capability of “Rel-18 eRedCap: UE capable of 20MHz + PR1” is not limited to “25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS” and it corresponds to PRB size corresponding to 20 MHz.Note 3: The only difference between “Rel-18 eRedCap: UE capable of 20MHz + PR1” and “Rel-18 eRedCap: UE capable of BW3/PR3 + PR1” is Note 2 and *vLayers·Qm·f* in order to have the same peak rate.Note 4: The initial access procedure of Rel-18 eRedCap UE capable of 20MHz + PR1 is realized by following:* Same as Rel-18 eRedCap UE capable of BW3/PR3 + PR1
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This document summarizes contributions [10] – [38] submitted to agenda item 9.6.1 and the following email discussion:

|  |
| --- |
| [112bis-e-R18-RedCap-01] Email discussion on UE complexity reduction by April 26 – Johan (Ericsson)* Check points: April 21, April 26
 |

The issues in this document are tagged and color coded with High Priority or Medium Priority. The issues that are in the focus of the initial round of the discussion are furthermore tagged FL1.

Follow the naming convention in this example:

* *eRedCapFLS1-v000.docx*
* *eRedCapFLS1-v001-CompanyA.docx*
* *eRedCapFLS1-v002-CompanyA-CompanyB.docx*
* *eRedCapFLS1-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 *eRedCapFLS1-v002-CompanyA-CompanyB.docx*.
* CompanyC uploads an empty file named *eRedCapFLS1-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 *eRedCapFLS1-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 [R1-2302258](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_112b-e/Docs/R1-2302258.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.

**FL1 Question 1-1a: Please consider entering contact info below for the points of contact for this email discussion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Point(s) of contact** | **Email address(es)** |
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# 2 UE BB bandwidth reduction

2.0 Earlier agreements

RAN1 has made the following agreements for UE BB bandwidth reduction [7]:

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| --- |
| **Initial BWP**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

Conclusion:There is no consensus to continue discussion on “whether additional separate initial DL/UL BWP specific to Rel-18 RedCap UEs is allowed to be configured by the SIB in the cell”.**Number of PRBs**Agreement:For UE BB bandwidth reduction, for PUSCH, select the following option for the maximum number of PRBs that the UE can transmit per slot or per hop, if applicable:* Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS

For UE BB bandwidth reduction, for PDSCH (for both unicast and broadcast), select the following option for the maximum number of PRBs that the UE can process per slot:* Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS

Note: No intention to change the RAN4 RF specifications about maximum transmission PRB number**PUSCH bandwidth**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.Agreement:For UE BB bandwidth reduction, a UE is not expected to be configured with a CG grant with a PUSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot or per hop, if applicable.Agreement:For UE BB complexity reduction, a UE is not expected to receive an UL grant in a RAR or in a DCI scrambled with TC-RNTI with a Msg3 PUSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot or per hop, if applicable.Agreement:For UE BB complexity reduction, a UE is not expected to perform 2-step RACH with a MsgA PUSCH resource spanning a bandwidth of more than ~5 MHz per slot or per hop, if applicable.**UE post-FFT buffer size**Conclusion:For UE BB complexity reduction, for broadcast and unicast PDSCH, RAN1 does not assume that the UE post-FFT buffer size per slot is smaller than 20 MHz**Unicast PDSCH bandwidth**Agreement:* For UE BB complexity reduction, a UE is able to receive a DL assignment in a DCI with a unicast PDSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot.
* The number of PRB scheduled in DCI is not larger than the maximum number of PRB agreed in previous agreement from 110b-e

**SIB1/OSI transmission**Agreement:For UE BB bandwidth reduction, for SIB1 (PDSCH),* Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation)

Agreement: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)

 Conclusion:For UE BB complexity reduction, broadcast of separate SIB1/OSI (PDSCH) to Rel-18 RedCap UEs is not supported.**Paging bandwidth**Agreement:From RAN1 perspective, for UE BB complexity reduction, for paging channel (PDSCH) to Rel-18 RedCap UEs, allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation). The scheduling of paging PDSCH is allowed to be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.**RAR bandwidth**Agreement:For UE BB bandwidth reduction, for RAR (PDSCH) to Rel-18 RedCap UEs, the scheduling of RAR PDSCH is allowed to be larger than the maximum number of unicast PRBs that the UE can process per slot.* When the scheduling of RAR PDSCH is within the maximum number of unicast PRBs that the UE can process per slot, the legacy time between RAR reception and Msg3 transmission (not smaller than NT,1 + NT,2 + 0.5 ms) is applied.
* When the scheduling of RAR PDSCH is larger than the maximum number of unicast PRBs that the UE can process per slot,
	+ The UE receives the RAR and correspondingly transmits Msg3 if the TDRA for Msg3 in UL grant in RAR indicates that the time between RAR reception and Msg3 transmission is NOT smaller than NT,1 + NT,2 + 0.5 + X ms.
		- FFS: value(s) of X
	+ Otherwise, the UE behavior is up to the UE implementation.
* Note: it does not mean early indication is needed
* Note: it will not be used as example for unicast PDSCH

For the “FFS: value(s) of X”* X = [0.5/0.25 or 1/0.5 or 2/1] ms for 15/30kHz SCS
* Note: Single Value pair for X is to selected for SCSs

**Msg4 bandwidth**Working assumption:* For UE BB complexity reduction, a UE is able to receive a Msg4 PDSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot.
	+ The UE is not required to process a Msg4 PDSCH with a larger number of PRBs than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.

**Simultaneous reception**Conclusion:For UE BB complexity reduction, there is no need to relax the requirements on simultaneous reception of two broadcast PDSCH transmissions for SIB1/OSI/paging/RAR. |

2.1 Max number of PRBs

RAN1 has made the following agreement regarding the maximum number of PRBs for PUSCH and PDSCH [7]:

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| --- |
| Agreement:For UE BB bandwidth reduction, for PUSCH, select the following option for the maximum number of PRBs that the UE can transmit per slot or per hop, if applicable:* Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS

For UE BB bandwidth reduction, for PDSCH (for both unicast and broadcast), select the following option for the maximum number of PRBs that the UE can process per slot:* Option 3: 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS

Note: No intention to change the RAN4 RF specifications about maximum transmission PRB number |

Contribution [37] proposes to revise the agreement by reducing the 25 PRBs to 24 PRBs, so that the same bandwidth is achieved for 15 and 30 kHz SCS, which may simplify the peak rate constraint discussion in Section 3.

**FL1 High Priority Question 2.1-1a: Should the maximum number of PRBs be changed from 25 to 24 PRBs?**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| DOCOMO |  | We don’t see the strong need to revise the agreement. |
| vivo |  | No serious issue found in the agreements for 25PRBs |
| Nordic  | Y | We this as a good idea, it also help with FDM multiplexing with legacy UEs |
| CMCC |  | Fine to keep current agreement. |
| Samsung |  | Needn’t revise the agreement. |
| LG |  | We didn’t find the reason why to revise the agreement is necessary. |
| CATT |  | The motivation is not strong enough to revert the previous agreement. |
| FUTUREWEI |  | Fine with current agreement |
| Intel | N |  |
| Ericsson |  | No strong view — we would be fine with the change. However, we should decide on this before we discuss the value of ‘X’ (the constraint value). |
| ZTE, Sanechips |  | Not necessary. |
| Nokia, NSB | N | We don’t see the need to revise the agreement. |

Contribution [10] proposes to make a similar agreement for 60 kHz SCS as for 15/30 kHz SCS. The WID [1] says that “both 15 kHz SCS and 30 kHz SCS are supported” but does not say anything explicit about 60 kHz SCS. The contribution proposes to select 6 PRBs as the maximum number of PRBs for 60 kHz SCS.

**FL1 Medium Priority Question 2.1-2a: Should UE BB bandwidth reduction be supported for 60 kHz SCS? How?**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | N |  |
| CATT |  | It seems out of scope and lack of study during SI phase. But if the specification impact is marginal, we can accept. |
| Intel |  | We are open for SCS 60kHz |
| Ericsson | Y (preferred) | We do not think there is any strong reason to preclude 60 kHz SCS.  |
| Nokia, NSB |  | Given that bandwidth limitation is only in the baseband for unicast PDSCH/PUSCH, we think 60 kHz SCS can be supported since impact is small. |

2.2 Random access timeline

RAN1 has made the following agreement regarding the RAR bandwidth and Msg3 timeline [7]:

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| Agreement:For UE BB bandwidth reduction, for RAR (PDSCH) to Rel-18 RedCap UEs, the scheduling of RAR PDSCH is allowed to be larger than the maximum number of unicast PRBs that the UE can process per slot.* When the scheduling of RAR PDSCH is within the maximum number of unicast PRBs that the UE can process per slot, the legacy time between RAR reception and Msg3 transmission (not smaller than NT,1 + NT,2 + 0.5 ms) is applied.
* When the scheduling of RAR PDSCH is larger than the maximum number of unicast PRBs that the UE can process per slot,
	+ The UE receives the RAR and correspondingly transmits Msg3 if the TDRA for Msg3 in UL grant in RAR indicates that the time between RAR reception and Msg3 transmission is NOT smaller than NT,1 + NT,2 + 0.5 + X ms.
		- FFS: value(s) of X
	+ Otherwise, the UE behavior is up to the UE implementation.
* Note: it does not mean early indication is needed
* Note: it will not be used as example for unicast PDSCH

For the “FFS: value(s) of X”* X = [0.5/0.25 or 1/0.5 or 2/1] ms for 15/30kHz SCS
* Note: Single Value pair for X is to selected for SCSs
 |

The contributions express the following preferences regarding the value for X:

* Contributions [10, 13, 16, 21, 30, 33] propose X=0.5/0.25.
* Contributions [11, 13, 16, 24] propose X=0.5/0.25 or X=1/0.5.
* Contributions [15, 18, 19, 22, 29, 31] propose X=1/0.5.
* Contributions [20, 32] propose X=1/0.5 or X=2/1.
* Contributions [12, 15, 17, 26, 36, 38] propose X=2/1.
* Contribution [27] proposes X=0.5/0.25 if Msg1 indication is supported, otherwise X=1/0.5 or X=2/1.

Other proposals expressed in the contributions:

* Contribution [11] proposes to adopt the timing relaxation also for PR1-only UEs.
* Contribution [21] proposes to clarify what X should be used if DL and UL use different SCS.
* Contributions [12, 13, 26, 30] propose to introduce similar timing relaxation for similar cases.
* Contributions [10, 18, 21] propose to support PUSCH TDRA configuration specific to Rel-18 eRedCap UEs.
* Contributions [21, 29] propose to consider larger Δ value(s) in case RAR PDSCH bandwidth is larger than 5 MHz

Companies are invited to reply to the following questions.

**FL1 High Priority Question 2.2-1a: Please indicate a preferred option for X [ms] for 15/30 kHz SCS:**

* **Option 1: X = 0.5/0.25**
* **Option 2: Either X = 0.5/0.25 or X=1/0.5, with a preference for X=0.5/0.25**
* **Option 3: Either X = 0.5/0.25 or X=1/0.5, with no preference between them**
* **Option 4: Either X = 0.5/0.25 or X=1/0.5, with a preference for X=1/0.5**
* **Option 5: X = 1/0.5**
* **Option 6: Either X = 1/0.5 or X=2/1, with a preference for X=1/0.5**
* **Option 7: Either X = 1/0.5 or X=2/1, with no preference between them**
* **Option 8: Either X = 1/0.5 or X=2/1, with a preference for X=2/1**
* **Option 9: X = 2/1**
* **Option 10: Other (elaborate in comment field)**

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| --- | --- | --- |
| **Company** | **Option (1-10)** | **Comments** |
| DOCOMO | Option 1 | Considering the number of valid entries on default PUSCH TDRA table, smaller value is preferred for X to ensure the flexibility on TDRA configuration. |
| vivo | Option 1 | Change/enhance default TDRA table is not preferred, so smaller values can have less limitations on the usable TDRA table entries.  |
| Nordic  | Option 4 |  |
| CMCC | Option1 | Considering the impact of larger X on the flexibility of PUSCH TDRA configuration and the access latency of other kinds of UEs, comparatively small X is preferred. |
| SONY | 5 | We think that the processing timeline for X=0.5/0.25 is too short, especially when considering the channel estimation processing requirements. We would not assume that the channel estimation processing requirements are much much less than the LDPC processing requirements. |
| Samsung | Option 8 |  |
| LG | Option 9 | Among the propose candidate values for X, option 9 seems to be more accommodating than the other aggressive values considering the perspectives of many companies designing modem solutions. |
| CATT | Option 1 | Option 1 is our first preference. The most time-consuming procedure should be PDCCH blind detection, not PDSCH processing. |
| FUTUREWEI |  | EI needs to be available regardless of the answer to this question. Currently our preference after reading the contributions is Option 5, but we are willing to hear more arguments |
| Intel | Option 9 or 8 | We prefer to leave more freedom for implementation. X=2/1 is preferred, but we are fine with X=1/0.5 if majority supports it.  |
| Ericsson | Option 1 | As discussed in our contribution [R1-2302298](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302298.zip), larger values for X would lead to fewer valid entries in the default TDRA table, and consequently, limiting the network scheduling flexibility. Specifying the smallest value, i.e., Option 1, would help to minimize this impact. Also, specifying Option 1 would help to minimize the impact to other RedCap UEs (e.g., Rel-17 RedCap UEs and PR1-only UEs) if the additional separate indication is not configured (or supported) and/or if the additional indication is common for both BW/PR3+PR1 UEs and PR1-only UEs |
| ZTE, Sanechips | Option 4 | A slight preference on X=1/0.5.Additionally, it is needed to be clarified that without msg1 early indication, the specified value X is meaningless, since the gNB is not aware of the timeline relaxing and msg3 scheduling would not be impacted any. |
| Nokia, NSB | Option 4 |  |

**FL1 Medium Priority Question 2.2-2a: What other cases are there that also need a similar timing relaxation? (Contributions [12, 13, 26, 30] mention several such potential cases.)**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | The following cases can be considered:* The time within which the UE shall be ready to retransmit a PRACH when it has not received a response within the RAR window for the previous PRACH attempt, as described in TS 38.213 Clause 8.2.
* Random access procedure for 2-step RACH (the X and Y values for 2-step RACH can be the same as that for 4-step RACH).
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2.3 Separate early indication

RAN#98e added an objective to support additional separate early indication(s) for UE BB bandwidth reduction [1]:

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| --- |
| * 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.
		- Support additional separate early indication(s) [RAN1, RAN2]
 |

RAN2#121 made the following agreements regarding support of additional separate early indication(s) [39]:

|  |
| --- |
| * Introduce Msg3/MsgA PUSCH based early indication for Rel-18 eRedCap. FFS how to implement this in the spec (e.g., new LCIDs or not).
* We will wait for RAN1 progress to see if there is a need for a Msg1 early indication for eRedCap.
 |

So, additional early indication in Msg3 will be supported, but it remains to decide whether to also support it in Msg1.

* Contributions [10, 11, 12, 15, 17, 18, 19, 21, 22, 23, 25, 26, 27, 28, 30, 32, 33, 35, 36] propose to support additional early indication in Msg1.
* Contribution [29] proposes to support early indication in Msg1 at least when the corresponding early indication for Rel-17 RedCap UEs is not configured.
* Contributions [24, 31] propose to support early indication in Msg1 only when the corresponding early indication for Rel-17 RedCap UEs is not configured.
* Contribution [13] proposes to support early indication in Msg1 only when the cell does not support Rel-17 RedCap UEs.
* Contributions [16, 38] express that additional early indication in Msg1 should not be supported.

Other proposals expressed in the contributions:

* Contributions [10, 12, 21, 33] propose to support additional early indication in MsgA PRACH, whereas contributions [16, 38] express that additional early indication in MsgA PRACH should not be supported.
* Contribution [26] proposes to discuss whether the early indication can be different for PR1-only UEs and BW3/PR3+PR1 UEs. Contributions [10, 26, 27] express that they can be different, whereas contribution [11] expresses that they cannot be different.

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

**FL1 High Priority Question 2.3-1a: For 4-step RACH, should a network-configurable additional early indication in Msg1 be supported?**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| DOCOMO | Y | As summarized by moderator, clear majority see the necessity/benefit to support the Msg1-based separate early indication. Whichever the X value for the timeline extension between RAR PDSCH and Msg3 PUSCH is selected, the available TDRA configuration is significantly impacted. If additional separate early indication using Msg1 is not supported, Msg3 PUSCH TDRA is largely restricted even for legacy UEs which is not desired from efficiency and flexibility perspective.No drawback has been identified from RAN1 perspective, and hence there is no reason not to support Msg1-based additional early indication at least from RAN1 perspective. |
| vivo | N | Many companies discussed about the benefits for network-configurable additional early indication specific for Rel-18 eRedCap UE. But less companies discussed about the necessity. gNB is given enough flexibility from both scheduling timing and resource allocation perspective. And there is no restriction for NW to schedule RAR larger than 5MHz with legacy timing. For such case, R18 eRedCap UE capable of BW3/PR3+PR1 behavior is left to UE implementation. In addition, based on RAN#99 conclusion that the initial access procedure of Rel-18 eRedCap UE capable of 20MHz + PR1 is realized the same as Rel-18 eRedCap UE capable of BW3/PR3 + PR1. For 18 eRedCap UE capable of 20MHz + PR1, the additional early indication would not bring any benefits and even results in such RedCap UE performance loss. So, introducing additional MSG1 based early indication is not only non-necessary, but also have drawbacks.  |
| Nordic  | Y |  |
| CMCC | N | Our first preference is no additional early indication in Msg1 for R18 RedCap UEs. For R18 RedCap UEs, the scheduling of RAR PDSCH is allowed to be larger than the maximum number of unicast PRBs that the UE can process per slot, For uplink transmission of Msg3, R18 RedCap UE does not expect Msg3 PUSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot or per hop. Since Msg.3 usually has a smaller TBS such as 56 or 72 bits, the scheduling of Msg3 is likely to be within 11RB/12RB. Besides, although R18 RedCap UEs require larger timeline between RAR and Msg3 and have more restriction on K2 value configuration, legacy UEs are not impacted when R18 RedCap share the same early indication in Msg1 with R17 RedCap UEs. Thus, there is no need to distinguish R17 RedCap and R18 RedCap UEs for RAR and Msg3 scheduling. And also considering that RACH indication has been used by quit a few features, it will be further fragmented if early indication is introduced for R18 RedCap by Msg1, and the PRACH collision will be increased. So we think early indication of R18 RedCap by Msg.1 is not needed for R18 RedCap.  |
| SONY | Y | Msg1 early indication allows the RAR – Msg3 timeline for R18 UEs to be properly accounted for. PRACH fragmentation should not be an issue when this early indication is configurable. |
| Samsung | Y | Early indication in Msg1 should be supported. |
| LG | Y | Early indication in Msg1 for eRedCap should be supported to schedule the proper TDRA value for Message 3 transmission. |
| CATT | N | The gNB scheduling can address BW restrictions/TDRA for Msg2 and/or Msg3.BTW, we do not want separate early indication in Msg1 becomes an excuse of introducing Rel-18 specific separate initial BWP. |
| FUTUREWEI | Y | No good reason to rob the network of the flexibility to use this when it wants to. |
| Intel | Y | If early identification by msg1 is not supported, gNB cannot know proper scheduling for RAR & msg3. If gNB tries to be conservative, it hurts the performance of legacy UEs.  |
| Ericsson | Y | As we discuss in our contribution [R1-2302298](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302298.zip), for Rel-18 eRedCap UEs (with UE BB bandwidth reduction) the need for separate early indication in Msg1 can be motivated by the following reasons:1. If the PDSCH conveying RAR messages to Rel-17 RedCap and Rel-18 eRedCap UEs is wider than 5 MHz, the Rel-18 eRedCap UEs might be unable to handle the legacy minimum time between RAR PDSCH and Msg3 PUSCH (as discussed in previous section). If it is desired to apply timing relaxation for Rel-18 eRedCap UEs alone, i.e., if a common timing relaxation for both Rel-17 RedCap and Rel-18 eRedCap UEs is not desired, then a separate Msg1 indication for Rel-18 eRedCap UEs is needed.
2. If it is desired to use different bandwidths for RAR PDSCH, i.e., larger than 5 MHz for Rel-17 RedCap UEs and equal to or smaller than 5 MHz for Rel-18 eRedCap UEs (so that the legacy minimum time is followed), then a separate Msg1 indication is needed. This might happen if there are many Rel-17 RedCap UEs attempting random access (and hence, larger RAR bandwidth due to RAR multiplexing of RARs) and TBS scaling is used to recover coverage of (1-Rx) Rel-17 RedCap UEs.
3. If Msg3 PUSCH is to be scheduled with a wider bandwidth than 5 MHz for Rel-17 RedCap UEs (e.g., for RA-SDT) but with a smaller bandwidth than 5 MHz for Rel-18 eRedCap UEs, then a separate Msg1 indication is needed.

A potential separate Msg1 indication would be configurable by the network. Therefore, support of a separate Msg3 indication might also be useful for the cases when separate Msg1 indication is not configured (e.g., to minimize PRACH fragmentation), and Msg4 or Msg5 is to be scheduled with larger bandwidth than 5 MHz for Rel-17 RedCap UEs coming from RRC idle state. Note that it is not possible to schedule Msg3, Msg4, and Msg5 with larger than 5 MHz for Rel-18 eRedCap UEs. |
| ZTE, Sanechips | Y | 1. Whether fragmentation is an issue depends on the network. Therefore, configurable is needed.
2. Without msg1 early indication, the timeline relaxing for RAR processing is meaningless. UE implementation is more convenient.
3. Without msg1 early indication, msg3 in RA-Based SDT would be impacted, since the msg3 TBS in SDT is as large as tens of thousands bits according to the current spec.
 |
| Nokia, NSB |  | No strong view but we are OK to have separate Msg1 early indication. |

**FL1 Medium Priority Question 2.3-2a: For 2-step RACH, should a network-configurable additional early indication in MsgA PRACH be supported?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | N | Use LCID in PUSCH part is enough |
| Ericsson | Y |  |
|  |  |  |
|  |  |  |

**FL1 Medium Priority Question 2.3-3a: Companies are invited to comment on whether potential separate initial early indications for Rel-18 eRedCap UEs (as discussed in the previous questions) would apply to BW3/PR3+PR1 UEs only or also to PR1-only UEs.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nordic  | BW3/PR3+PR1 + PR1 share the initial access, based on RAN guidance. So answer is Yes. |
| Ericsson | As we discuss in our contribution [R1-2302298](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302298.zip), the additional separate early indication(s) are only really needed for UEs support UE BB bandwidth reduction (BW3/PR3), which is the reason why the objective on additional separate early indication(s) has been listed under UE BB bandwidth reduction in the WID. If the additional separate early indication(s) are used also for UEs that only support UE peak data rate reduction (PR1), then this may increase the implementation and testing burden on the network side. For a network to implement support for UEs supporting UE peak data rate reduction, the network implementation of the initial access procedure may now need to be updated to consider that the accessing UE might be a UE that supports not only UE peak data rate reduction but also UE BB bandwidth reduction.Some simple means should be considered that will enable a phased approach in the network implementation. If the network can distinguish early on whether the UE is a UE that supports both UE BB bandwidth reduction and UE peak data rate reduction, or a UE that only supports UE peak data rate reduction, the initial burden for network implementation and testing will be significantly smaller – this can be achieved by specifying that the additional separate early indication in Msg1 only concerns those UEs that support UE BB bandwidth reduction. However, if this would not be desired, an alternative approach is to specify that access control/barring is separate for UEs that support UE BB bandwidth reduction and UEs that only support UE peak data rate reduction – this will ensure that the network implementation only allows access to UEs for which full support has been implemented on the network side. Adopting one of these options also helps from IODT point of view. In our contribution, we have the following proposal:**Proposal: Support at least one of the following options to ensure that gNB knows whether to expect access by UEs supporting UE BB bandwidth reduction:*** **Option 1: Additional separate early indication in Msg1 only concerns UEs that support UE BB bandwidth reduction.**
* **Option 2: Access control/barring is separate for UEs that support UE BB bandwidth reduction and UEs that only support UE peak data rate reduction.**

The discussion and decision about the above proposal can potentially also be left up to RAN2. |
|  |  |
|  |  |

2.4 Separate initial BWP

RAN1 has made the following agreement regarding separate initial BWP(s) [7]:

|  |
| --- |
| 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

Conclusion:There is no consensus to continue discussion on “whether additional separate initial DL/UL BWP specific to Rel-18 RedCap UEs is allowed to be configured by the SIB in the cell”. |

The contributions express the following views regarding separate initial BWP:

* Contributions [11, 16, 18] express that there is no need for additional separate initial BWP.
* Contribution [26] expresses that RAN1 should not discuss it further unless RAN2 asks for RAN1 input.
* Contribution [13] proposes to support separate initial BWP for Rel-18 eRedCap UEs only when the cell does not support Rel-17 RedCap UEs.
* Contributions [31, 33] propose to support separate initial BWP for Rel-18 eRedCap UEs for the case when the separate initial BWP introduced for Rel-17 RedCap UEs is not configured, and/or for the case when Rel-17 RedCap UEs are barred in the cell.

Companies are invited to reply to the following question. Note that the question concerns the potential need for a separate initial BWP rather than an additional separate initial BWP in the sense that a separate initial BWP for Rel-17 RedCap UEs and an additional separate initial BWP for Rel-18 eRedCap UEs are not configured simultaneously.

**FL1 Medium Priority Question 2.4-1a: Companies are invited to comment on the potential need for a separate initial BWP for Rel-18 eRedCap UEs in case a separate initial BWP for Rel-17 RedCap UEs is not configured, and/or Rel-17 RedCap UEs are not supported in the cell, and/or Rel-17 RedCap UEs are barred in the cell.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nordic  | “initial BWP for Rel-17 RedCap UEs is not configured”should be sufficient the only criteria here. |
| CATT | The same as Rel-17 case: If Rel-18 RedCap UE is not barred, and Rel-17 separate initial BWP is not configured, then Rel-18 RedCap UE use legacy initial BWP. |
|  |  |

**FL1 Medium Priority Question 2.4-2a: Companies are invited to comment on whether a potential separate initial BWP for Rel-18 eRedCap UEs (as discussed in the previous question) would apply to BW3/PR3+PR1 UEs only or also to PR1-only UEs.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nordic  | Same initial access, same initial BW for both. |
|  |  |
|  |  |

2.5 Simultaneous reception

RAN1 has made the following conclusion regarding simultaneous reception of two broadcast PDSCH transmissions [7]:

|  |
| --- |
| Conclusion:For UE BB complexity reduction, there is no need to relax the requirements on simultaneous reception of two broadcast PDSCH transmissions for SIB1/OSI/paging/RAR. |

For simultaneous reception of multiple broadcast channels, 38.214 clause 5.1 specifies the following:

|  |
| --- |
| The UE in RRC\_IDLE and RRC\_INA20IVE modes shall be able to decode two PDSCHs each scheduled with SI-RNTI, P-RNTI, RA-RNTI or TC-RNTI, with the two PDSCHs partially or fully overlapping in time in non-overlapping PRBs. |

For simultaneous reception of a unicast channel and a broadcast channel, 38.214 clause 5.1 specifies the following:

|  |
| --- |
| On a frequency range 1 cell, the UE shall be able to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI and, during a process of P-RNTI triggered SI acquisition, another PDSCH scheduled with SI-RNTI that partially or fully overlap in time in non-overlapping PRBs, unless the PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI requires Capability 2 processing time according to clause 5.3 in which case the UE may skip decoding of the scheduled PDSCH with C-RNTI, MCS-C-RNTI, or CS-RNTI. On a frequency range 2 cell, the UE is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI if in the same cell, during a process of P-RNTI triggered SI acquisition, another PDSCH scheduled with SI-RNTI partially or fully overlap in time. The UE is expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI during a process of autonomous SI acquisition.  |

The contributions express the following views regarding simultaneous reception of unicast and broadcast channels:

* Contributions [16, 21, 26, 30, 33, 36] express that there is no need to relax the current requirements.
* Contributions [12, 13] express that no relaxation is needed if the total bandwidth is <5 MHz, otherwise one of the transmissions may be prioritized (e.g., unicast prioritized over broadcast).
* Contributions [10, 15, 31] express that SI can be prioritized over unicast (as in FR2).
* Contributions [17, 38] express that RAR should be prioritized over unicast and unicast over SI/paging.
* Contribution [18] express that unicast should be prioritized if needed.
* Contribution [11] expresses that the UE may skip unicast if needed.

Companies are invited to reply to the following question.

**FL1 High Priority Question 2.5-1a: Is there a need for some specification changes (e.g., regarding prioritization for processing and decoding) for simultaneous reception of unicast and broadcast PDSCH transmissions? Please elaborate in the comment field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| DOCOMO | N | There is no timeline requirement on reception of broadcast PDSCH for SI, thus the broadcast PDSCH can be proceeded across multiple slots. Therefore, it should be up to UE implementation how to proceed the two PDSCHs, i.e., there is no issue if a UE is implemented to be able to proceed both PDSCHs within the processing timeline for HARQ-ACK transmission for the unicast PDSCH, otherwise, a UE should be implemented to proceed the unicast PDSCH first. |
| vivo | FFS | We see many companies proposed “no additional UE behaviour or relaxation of the requirement is needed”. But we wondered whether they have the same understanding. Currently, there seems three interpretations for “no additional UE behaviour or relaxation of the requirement is needed”.* Interpretation 1: Reasonable UE implementation should prioritize the reception of unicast PDSCH, reception of broadcast PDSCH can be skipped.
* Interpretation 2: Reasonable UE implementation should prioritize the reception of unicast PDSCH, whether to receive the broadcast PDSCH is up to UE implementation.
* Interpretation 3: Reasonable UE implementation should prioritize the reception of unicast PDSCH firstly, use remaining BB capability for the decoding of broadcast PDSCH for SI acquisition, which enables simultaneous reception of both PDSCHs.

So, which one is the correct understanding? |
| Nordic  | Y | We prefer to leave this up to implementation, for the case when total scheduled number of PRBs is >5MHz. So UE can prioritize what to receive. This would be typically in this orderRAR (UL may be out of synch) > unicast > Paging (typically not configured in RRC connected) |
| CMCC | N | Based on spec mentioned by FL, broadcast here means PDSCH scheduled with SI-RNTI. Then it can be up to UE implementation, unicast can be prioritized over PDSCH scheduled with SI-RNTI if HARQ feedback is required. If broadcast also includes PDSCH scheduled with RA-RNTI, prioritizing PDSCH scheduled with RA-RNTI over unicast can still up to UE implementation. |
| SONY | Y | Our preference is that the priority of channels for decoding is clear, which suggests that it is defined in the spec. |
| Samsung | Y | We think unicast PDSCH should be prioritized. |
| LG | N | We agree DOCOMO |
| CATT | N | Same understanding as DOCOMO.  |
| FUTUREWEI |  | We can support something to be done after considering other views |
| Intel | Y | The behavior should be clarified which may result in spec changes. At least the following two case should be discussed* The relaxed decoding of RAR may overlap with a unicast PDSCH. Both PDSCHs have defined timelines.

Further, since the unicast PDSCHs may be frequently scheduled, the decoding of a broadcast PDSCH may consistently collide with unicast PDSCHs and end up with rather long delay, which may lead unexpected performance impacts. |
| Ericsson |  | We would be fine with specifying some prioritization order, e.g., as for FR2. We would also be fine with no relaxation (i.e., the existing procedure applies). If there is no relaxation, it is our understanding that the UE may first decode unicast PDSCH and then broadcast PDSCH (so as to meet the unicast timeline and as SI acquisition is not subject to any specified timeline). |
| ZTE, Sanechips | Y | If gNB does not know how the UE process unicast and broadcast, e.g., RAR, at the same time, then the subsequent scheduling would be impacted. |
| Nokia, NSB | N | We think there is no need for specification changes as UE needs to process unicast transmission to meet the timeline. For broadcast transmission, there is no timeline so it can be processed later.  |

2.6 SI PDSCH bandwidth

RAN1 has made the following agreement regarding the PDSCH bandwidth for SI and paging [7]:

|  |
| --- |
| **SIB1/OSI transmission**Agreement:For UE BB bandwidth reduction, for SIB1 (PDSCH),* Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation)

Agreement: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)

 Conclusion:For UE BB complexity reduction, broadcast of separate SIB1/OSI (PDSCH) to Rel-18 RedCap UEs is not supported.**Paging bandwidth**Agreement:From RAN1 perspective, for UE BB complexity reduction, for paging channel (PDSCH) to Rel-18 RedCap UEs, allow the scheduling of paging channel to be larger than 5 MHz (as in legacy operation). The scheduling of paging PDSCH is allowed to be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS. |

Contribution [31] proposes to clarify the agreements for SI PDSCH in a similar way as the agreement for paging.

**FL1 Medium Priority Proposal 2.6-1a: Update the agreements for SI PDSCH with the clarification as follows:**

* **For UE BB bandwidth reduction, for SIB1 (PDSCH),**
	+ **Allow the scheduling of SIB1 to be larger than 5 MHz (as in legacy operation). The scheduling of SIB1 PDSCH is allowed to be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.**
* **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). The scheduling of OSI PDSCH is allowed to be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | OK |  |
| LG | Y  | The update is OK  |
| CATT | Y | OK |
| Intel | Y |  |
| Ericsson | Y |  |
| ZTE, Sanechips | Y |  |
| Nokia, NSB | Y |  |

2.7 Msg4 PDSCH bandwidth

RAN1 has made the following agreement regarding the Msg4 PDSCH bandwidth [7]:

|  |
| --- |
| Working assumption:* For UE BB complexity reduction, a UE is able to receive a Msg4 PDSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot.
	+ The UE is not required to process a Msg4 PDSCH with a larger number of PRBs than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.
 |

The contributions express the following views regarding the above working assumption on Msg4 PDSCH bandwidth:

* Contributions [10, 11, 13, 18, 19, 20, 21, 24, 25, 26, 32, 33, 37] propose to confirm the working assumption.
* Contributions [12, 15] propose to confirm the working assumption with a minor modification (replacing “required to process” with “required to receive” or “expected to process”, respectively).
* Contribution [31] proposes to await further RAN2 progress on additional early indication in Msg3/MsgA PUSCH (to see whether the indication is always present as for Rel-17 RedCap) before confirming the working assumption.

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

**FL1 High Priority Proposal 2.7-1a: Confirm the following working assumption:**

* **For UE BB complexity reduction, a UE is able to receive a Msg4 PDSCH resource allocation spanning a bandwidth of more than ~5 MHz per slot.**
	+ **The UE is not required to process a Msg4 PDSCH with a larger number of PRBs than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| DOCOMO | Y | The UE behavior after receiving DCI scheduling Msg4 which indicates larger number of PRBs than 25/12 for 15/30 kHz SCS can be further clarified. |
| vivo | Y  |  |
| Nordic  | OK to confirm |  |
| CMCC | Y |  |
| SONY | Y |  |
| Samsung | Y |  |
| LG | Y  | We prefer to confirm the working assumption on Message 4 bandwidth  |
| CATT | Y | We also think ‘not expected to’ is a better wording than ‘not required to’. But the current form is also acceptable, since it is not wrong anyway. |
| FUTUREWEI | Y | Unless an issue is identified |
| Intel | Y | We are fine to confirm the WA. Since msg4 with >25 or 12PRBs are not for the UE, UE could know the failure of its RACH procedure. Therefore, RACH retransmission can be triggered.  |
| Ericsson | Y | We can also be fine with the proposed modifications (replacing “required to process” with “required to receive” or “expected to process”). |
| ZTE, Sanechips | Y |  |
| Nokia, NSB | Y |  |

Contributions [10, 17, 37] discuss the UE behavior for the potential case when a UE detects a DCI scheduling a Msg4 PDSCH transmission with a larger bandwidth than it can receive or process.

**FL1 High Priority Question 2.7-2a: Is there a need to specify some UE behavior for the potential case when a UE detects a DCI scheduling a Msg4 PDSCH transmission with a larger bandwidth than it can receive or process? Please elaborate in the comment field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| DOCOMO | N | In our view, if a UE cannot receive the DCI scheduling Msg4 PDSCH which indicates no larger PRBs than 25/12 for 15/30 kHz SCS before the contention resolution timer expires, the same procedure as legacy UE for the case where the timer expired should be applied. |
| vivo | FFS | Even if early indication for Rel-18 eRedCap UE is always included in MSG3, gNB cannot distinguish the Rel-18 eRedCap UE capable of 20MHz+PR1 and Rel-18 eRedCap UE capable of BW3/PR3+PR1. Considering the Rel-18 eRedCap UE capable of 20MHz+PR1, NW may schedule bandwidth larger than 5MHz for MSG4. Then for Rel-18 eRedCap UE capable of 20MHz+PR1, it can process; But for Rel-18 eRedCap UE capable of BW3/PR3+PR1, we think UE is not required to process a Msg4 PDSCH with a larger number of PRBs than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.  |
| Nordic  |  | We would be fine with having agreed conclusion on behavior, e.g. that UE is not providing ACK/NACK.  |
| CMCC | N | The UE does not process Msg4 PDSCH with a larger bandwidth than it can receive, and following behaviour is the same as legacy UE. |
| Samsung | N | It can be up to UE implementation. |
| LG | N  | We don’t think that further clarification on UE behavior is needed for the potential case. |
| CATT | N | This is equivalent to ‘contention resolution failed’, no matter it is due to failure of PDCCH detection, or failure PDSCH reception, or incorrect FDRA indication. |
| FUTUREWEI |  | Ok with a conclusion on behavior |
| Intel | Y | If UE decoding a PDCCH scheduling msg4 with >25 or 12 PRBs, UE could know the failure of its RACH procedure. UE can restart RACH procedure and doesn’t need to wait for the expire of contention resolution timer. It helps to reduce latency of random access. Further, we see a more problematic case for msg3 scheduling if the RAR schedules a msg3 with >25 or 12 PRBs. Note: The contention resolution timer is not started yet since the UE will not transmit the msg3 with >25 or 12 PRBs. The existing spec for RACH procedure does not specify any UE behaviour for such case. To avoid uncontrollable RACH procedure, e.g., up to UE implementation, UE behavior for such case should be defined.  |
| Ericsson |  | In one of the RAN1#112 sessions, contention resolution was discussed. As we discuss in our contribution [R1-2302298](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302298.zip), in case of contention between random access attempts from different UEs, the Msg4 PDSCH transmission that a UE tries to receive may in fact be intended for another UE. So, if the network makes a Msg4 PDSCH transmission to a Rel-17 RedCap UE or a non-RedCap UE, there is a risk that a Rel-18 eRedCap UE tries to receive it. If the scheduled Msg4 PDSCH bandwidth is too wide for the Rel-18 eRedCap UE to receive or process, it will detect this already when it receives the DCI scheduling the Msg4 PDSCH, but it may not be obvious how the Rel-18 eRedCap UE ought to react in this situation, assuming that this situation is allowed to happen. A few different approaches were discussed in the RAN1#112 session, and RAN1 could select one of these approaches.The following proposal (similar as in our contribution but with some minor tweaks) can be considered:**Proposal: For UE BB complexity reduction, for the case when the UE detects a DCI scheduling a Msg4 PDSCH transmission with a larger bandwidth than it can receive or process, RAN1 selects one of the following options:*** **Option 1: The UE considers the contention resolution as not successful.**
* **Option 2: The UE discards the DCI (as if the DCI was never received) and continues monitoring the DCI until *ra-ContentionResolutionTimer* expires.**
* **Option 3: The UE behaviour is undefined (as if the event is not expected).**

Our preference is Option 1 or Option 2. We may also be fine with other (simple, robust) approaches. |
| ZTE, Sanechips | N | If a UE is not required to process a Msg4 PDSCH with a larger number of PRBs than 25 PRBs, why we still need to define the UE behavior? |
| Nokia, NSB | N |  |

2.8 MsgA PUSCH bandwidth

RAN1 has made the following agreement regarding the MsgA PUSCH bandwidth [7]:

|  |
| --- |
| Agreement:For UE BB complexity reduction, a UE is not expected to perform 2-step RACH with a MsgA PUSCH resource spanning a bandwidth of more than ~5 MHz per slot or per hop, if applicable. |

Contribution [36] proposes to consider the following options for the support of the 5-MHz MsgA PUSCH bandwidth:

* Option 1: Occupy a portion of PRBs within one legacy PO (larger than 5MHz) by Rel-18 eRedCap UEs
* Option 2: Separate MsgA PUSCH frequency domain resources configuration for Rel-18 eRedCap UEs.

Companies are invited to reply to the following question.

**FL1 Medium Priority Question 2.8-1a: Companies are invited to express a preference (if any) between the two options listed above or propose some other option (if needed).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option (1/2/other)** | **Comments** |
| Nordic  | Option 2 | which can achieve Option 1 in our opinion |
|  |  |  |
|  |  |  |

2.9 MsgB PDSCH bandwidth

The contributions express the following views regarding how to restrict the MsgB PDSCH bandwidth:

* Contributions [10, 13, 15, 16, 20, 21, 25, 32] propose to restrict the MsgB PDSCH bandwidth in a similar way as for Msg4 PDSCH.
* Contributions [18, 26, 30, 37] propose to restrict the MsgB PDSCH bandwidth in a similar way as for Msg2 PDSCH, since MsgB has a similar multiplexing of messages to different UEs as Msg2.

Companies are invited to reply to the following question.

**FL1 Medium Priority Question 2.9-1a: Should the MsgB PDSCH bandwidth be limited in the same way as for Msg2 or Msg4?**

* **Option 0: No.**
* **Option 2: Yes, limit the MsgB PDSCH bandwidth in the same way as for Msg2 PDSCH.**
* **Option 4: Yes, limit the MsgB PDSCH bandwidth in the same way as for Msg4 PDSCH.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option (0/2/4)** | **Comments** |
| Nordic  | MSG4 Option 4 | This, because HARQ-ACK is provided for MSG-B. In case MSG-A -> Fallback RAR. MSG2 BW rule would apply on relaxation of timeline. |
|  |  |  |
|  |  |  |

2.10 MBS PDSCH bandwidth

Contribution [36] proposes that broadcast MBS PDSCH transmissions can be wider than 5 MHz whereas multicast MBS PDSCH transmissions should not be larger than the maximum number of PRBs for unicast.

Companies are invited to reply to the following questions.

**FL1 Medium Priority Question 2.10-1a: Should broadcast MBS PDSCH bandwidth be restricted? How?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | Y | Even if HARQ-ACK not provided, MBS PDSCH can be scheduled continuously over continuous slots.  |
|  |  |  |
|  |  |  |

**FL6 Medium Priority Question 2.10-2a: Should multicast MBS PDSCH bandwidth be restricted? How?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic  | Y |  |
|  |  |  |
|  |  |  |

# 3 UE peak data rate reduction

3.0 Earlier agreements

RAN1 has made the following agreements for UE peak data rate reduction [7]:

|  |
| --- |
| 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.

Agreement:* The minimum DL peak rate target (for FD-FDD) is 10 Mbps based on peak data rate calculation according to 38.306.
* The same value for X is used for DL and UL

Agreement:For the relaxed constraint X in the following earlier RAN1 agreement, down-select between X = 3 and X = 3.2. |

RAN#99 discussed whether UE peak data rate reduction (“PR1”) should be supported as a standalone feature or only in combination with UE BB bandwidth reduction (“BW3/PR3”) and endorsed the following proposal [8], where the different nicknames for the UE complexity reduction features (“PR1” and “BW3/PR3”) originate from TR 38.865 [9].

|  |
| --- |
| **Rel-18 eRedCap UE capable of 20MHz + PR1 and Rel-18 eRedCap UE capable of BW3/PR3 + PR1 are designed/targeted to same peak data rate, i.e., 10Mbps**Note 1: Peak data rate of “Rel-18 eRedCap: UE capable of 20MHz + PR1” and “Rel-18 eRedCap: UE capable of BW3/PR3 + PR1” is same including unicast and broadcast respectively.Note 2: PRB processing capability of “Rel-18 eRedCap: UE capable of 20MHz + PR1” is not limited to “25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS” and it corresponds to PRB size corresponding to 20 MHz.Note 3: The only difference between “Rel-18 eRedCap: UE capable of 20MHz + PR1” and “Rel-18 eRedCap: UE capable of BW3/PR3 + PR1” is Note 2 and *vLayers·Qm·f* in order to have the same peak rate.Note 4: The initial access procedure of Rel-18 eRedCap UE capable of 20MHz + PR1 is realized by following:* Same as Rel-18 eRedCap UE capable of BW3/PR3 + PR1
 |

3.1 Target data rate

The contributions express the following views regarding clarifications of the target data rate (10 Mbps):

* Contribution [37] proposes to confirm that 10 Mbps is a minimum requirement.
* Contribution [35] proposes to constrain PR1-only UE to similar peak rate as BW3/PR3+PR1 UE.
* Contributions [13, 38] propose to clarify that BW3/PR3 is not supported as a standalone feature.
* Contributions [15, 36] propose to clarify whether ‘≥’ or ‘=’ applies to the relaxed constraint.

Companies are invited to reply to the following question.

**FL1 High Priority Question 3.1-1a: Which option should apply for the relaxed constraints (X and Y)?**

* **Option 1: *vLayers*·*Qm*·*f* ≥ X and *vLayers*·*Qm*·*f* ≥ Y, respectively**
* **Option 2: *vLayers*·*Qm*·*f* = X and *vLayers*·*Qm*·*f* = Y, respectively**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option (1/2)** | **Comments** |
| DOCOMO | Option 1 | Depending on the UE capabilities which are supported by the eRedCap UE, *vLayers*·*Qm*·*f* can be larger than X or Y. |
| vivo | Option 2 | For UE complexity reduction, the 10Mbps target data rate is the peak data rate.  |
| Nordic  | **Option 1** | WID is clear on this Relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for peak data rate reduction |
| CMCC | Option 1 |  |
| SONY | 2 | The thing that defines an R18 RedCap UE seems to be the data rate of 10Mbps. We hence think that there shouldn’t be multiple options for the constraint.  |
| Samsung | Option 1 | Follow WID description. |
| LG | Option 1 | WID is descripted as below.Relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for peak data rate reduction |
| CATT | Option 1 |  |
| FUTUREWEI | Option 1 |  |
| Intel | Option 1 | It is up to UE capability report the values of *vLayers*, *Qm*, *f* . X/Y is the minimum value of *vLayers*·*Qm*·*f* |
| Ericsson | 1 | The WID states that “By default, all UE capabilities applicable to a Rel-17 RedCap UE are applicable unless otherwise specified”. If the UE indicates support for MIMO and/or 256QAM and/or high scaling factors, then it seems reasonable that the peak rate is correspondingly higher, i.e., the 10-Mbps peak rate target is a target for the least capable Rel-18 eRedCap UE. |
| ZTE, Sanechips | Option1 | 10Mbps target data rate is the **minimum** peak data rate. |
| Nokia, NSB | Option 1 |  |

3.2 Add-on feature

The contributions express the following views regarding the relaxed peak rate constraint X:

* Contributions [10, 12, 13, 15, 17, 18, 24, 25, 26, 27, 28, 30, 35, 37, 38] propose X=3.2.
* Contributions [11, 16, 31, 33] propose X=3 or X=3.2.
* Contributions [14, 16, 19, 34, 36] propose X=3.
* Contribution [29] proposes X=3.1.
* Contribution [11] proposes X=4Y.
* Contribution [33] proposes new scaling factors (*f*).

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

**FL1 High Priority Proposal 3.2-1a: X=3.2**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| DOCOMO | Y | While our first preference is 3, we can live with 3.2. |
| vivo | Y |  |
| Nordic  | N | We proposed to apply 3.1 as default compromise value, when parameter Scaling factor is not configured.This means that no new scaling factors are needed.In fact, if Option 2 in **Question 3.1-1a** would be agreed, then scaling factors are not applicable at all. 😉 |
| CMCC | Y |  |
| SONY | Y | We are OK with this for the sake of progress. Our preference would have been X = 3, as noted by FL. |
| Samsung | Y |  |
| LG | Y | We support X= 3.2 as it can satisfy the 10 Mbps peak rate target for both 15 kHz and 30 kHz SCS. |
| CATT | Y | Our first preference is 3, we can live with 3.2. |
| FUTUREWEI |  | Can accept |
| Intel | Y |  |
| Ericsson | Y |  |
| ZTE, Sanechips |  | 15KHz or 30KHz is up to gNB configuration, which is not related to the UE’s peak data rate. Therefore, X=3 is enough to satisfy the peak data rate requirement.If the 10Mbps should be always provided for both 15KHz and 30KHz, based on this logic, the BWP size configuration also should be provided to meet the peak data requirement. What we discuss here is a UE capability, and is not related to gNB configuration. Therefore, we do not need to keep peak data rate satisfying 10Mbps at any gNB configuration. |
| Nokia, NSB | Y | In our analysis, there is marginal complexity difference between 3.2 to 3, therefore we prefer 3.2. |

3.3 Standalone feature

The contributions express the following views regarding the relaxed peak rate constraint Y:

* Contributions [10, 13, 14, 15, 17, 18, 19, 24, 26, 27, 28, 30, 31, 35, 36, 38] propose Y=0.75.
* Contributions [11, 16] propose Y=0.75 or Y=0.8.
* Contribution [33] proposes Y=0.7 or Y=0.75.
* Contribution [34] proposes Y=0.7.
* Contribution [29] proposes Y=0.725.
* Contribution [25] proposes Y=0.8.
* Contribution [11] proposes Y=X/4.
* Contributions [16, 33] propose new scaling factors (*f*).
* Contribution [10] proposes to always assume 20 MHz bandwidth in the peak rate calculation to avoid that the resulting peak rate and TBS become too small.

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

**FL1 High Priority Proposal 3.3-1a: Y=0.75 assuming 20 MHz bandwidth in the 38.306 peak rate expression**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| DOCOMO | Y |  |
| vivo | Y |  |
| Nordic | N | 0.75 cannot be configured when RedCap UE supports two layers. Therefore, 0.75 is not technically feasible solution. |
| CMCC | Y |  |
| SONY | Y | We are OK with Y = 0.75 for the sake of progress. |
| Samsung | Y |  |
| LG | Y | We support Y=0.75 as it can satisfy the 10 Mbps peak rate target for both 15 kHz and 30 kHz SCS. The same reason that we support X=3.2. |
| CATT | Y | OK. A new scaling factor should also be introduced. |
| FUTUREWEI | Y |  |
| Intel | Y |  |
| Ericsson | Y | As we discuss in our contribution [R1-2302298](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302298.zip), it is imperative that the UE-supported maximum bandwidth of 20 MHz is always applied when calculating the maximum peak rate, even when the channel/carrier bandwidth is less than 20 MHz. Otherwise, if Y=0.75 is applied when the channel/carrier bandwidth is less than 20 MHz, this may be problematic due to the following reasons:Firstly, the data rate supported by the PR1-only UEs would become too low. For example, a bandwidth of 10 MHz would correspond to 5.2/5.6 Mbps and 4.8/5.2 Mbps in DL/UL with 15 and 30 kHz SCSs, respectively. And a bandwidth of 5 MHz would correspond to 2.5/2.7 Mbps and 2.2/2.4 Mbps in DL/UL with 15 and 30 kHz SCSs, respectively.Secondly, the maximum TBS values corresponding to the above peak rate values would be too small to receive initial access messages. For example, based on TS 38.213/38.331, the maximum TBS for SIB is 2976 bits. That is, a peak rate of at least 3 Mbps with 15 kHz SCS and 6 Mbps with 30 kHz are needed to properly receive the SIB. |
| ZTE, Sanechips | Y |  |
| Nokia, NSB | Y |  |

# 4 Other aspects

The submitted contributions bring up the following other aspects which are not covered in any other section in this FLS.

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

* Proposals on UE capabilities and UE type definitions are brought up in some contributions [13, 18, 36]. These aspects are expected to be discussed in the next RAN1 meeting.

**FDRA optimization**

* There is no need to consider potential optimization of FDRA indications [18, 21].
* Consider potential optimizations of FDRA indication for PUSCH but not for PDSCH [19].
* Consider potential optimizations of FDRA indications in case of large RBG size [26].
* Discuss whether/how to use potential spare bits in FDRA field in RAR UL grant [12, 26].
* For unicast, the FDRA indications and RBG sizes can be based on 5-MHz sub-bands [23].

**Other functionality**

* Consider enhancements of user multiplexing capacity for common PUCCH [26, 33].
* Restrict the SRS bandwidth to 5 MHz, like the other UL bandwidths [29, 31].
* Do not restrict the SRS bandwidth to 5 MHz [13, 18, 20].
* A half-duplex UE should be capable of processing one additional UL DCI per slot [29].
* Introduce a new cell barring indication and an IFRI field in SIB1 [36].

To be able to focus on more pressing issues, the above aspects could be down-prioritized in this meeting.

**FL1 Medium Priority Question 4-1a: Is there a need to treat any of the issues listed above in this meeting?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| SONY |  | **SRS bandwidth**We think that restricting the SRS bandwidth to 5MHz could have a beneficial impact on UE complexity (a greater impact than reported in the TR). While we do not expect progress on this issue at this meeting, we think that this issue should still be on the table for the upcoming RAN1#113 F2F meeting. This will allow companies to further check the implications of supporting 20MHz bandwidth for SRS. |
| CATT | N |  |
|  |  |  |

# References

|  |  |  |  |
| --- | --- | --- | --- |
| [1] | [RP-223544](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_98e/Docs/RP-223544.zip) | Revised WID on Enhanced support of reduced capability NR devices | Ericsson |
| [2] | [R1-2300177](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112/Docs/R1-2300177.zip) | WI work plan for Rel-18 RedCap | Rapporteur (Ericsson) |
| [3] | [R1-2301886](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112/Docs/R1-2301886.zip) | FL summary #1 on Rel-18 RedCap UE complexity reduction | Moderator (Ericsson) |
| [4] | [R1-2301887](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112/Docs/R1-2301887.zip) | FL summary #2 on Rel-18 RedCap UE complexity reduction | Moderator (Ericsson) |
| [5] | [R1-2301888](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112/Docs/R1-2301888.zip) | FL summary #3 on Rel-18 RedCap UE complexity reduction | Moderator (Ericsson) |
| [6] | [R1-2301889](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112/Docs/R1-2301889.zip) | FL summary #4 on Rel-18 RedCap UE complexity reduction | Moderator (Ericsson) |
| [7] | [R1-2301885](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112/Docs/R1-2301885.zip) | RAN1 agreements for Rel-18 NR RedCap | Rapporteur (Ericsson) |
| [8] | [RP-230778](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_99/Docs/RP-230778.zip) | Proposal for PR1 in eRedCap | Moderator (CMCC) |
| [9] | [TR 38.865 V18.0.0](https://ftp.3gpp.org/Specs/archive/38_series/38.865/38865-i00.zip) | Study on further NR RedCap UE complexity reduction (Release 18) | RAN1 |
| [10] | [R1-2302298](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302298.zip) | Further RedCap UE complexity reduction | Ericsson |
| [11] | [R1-2302323](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302323.zip) | Discussion on R18 RedCap complexity | FUTUREWEI |
| [12] | [R1-2302342](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302342.zip) | Discussion on potential solutions to further reduce UE complexity | Huawei, HiSilicon |
| [13] | [R1-2302497](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302497.zip) | Discussion on further UE complexity reduction | Vivo |
| [14] | [R1-2302560](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302560.zip) | Further consideration on reduced UE complexity | OPPO |
| [15] | [R1-2302612](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302612.zip) | Discussion on enhanced support of RedCap devices | Spreadtrum Communications |
| [16] | [R1-2302715](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302715.zip) | Discussion on further complexity reduction for Rel-18 RedCap UE | CATT |
| [17] | [R1-2302808](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302808.zip) | Complexity reduction for eRedCap UE | Intel Corporation |
| [18] | [R1-2302887](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302887.zip) | RedCap UE Complexity Reduction | Nokia, Nokia Shanghai Bell |
| [19] | [R1-2302943](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302943.zip) | Discussion on further UE complexity reduction | ZTE, Sanechips |
| [20] | [R1-2303029](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303029.zip) | Discussion on further complexity reduction for eRedCap UEs | China Telecom |
| [21] | [R1-2303062](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303062.zip) | Discussion on UE complexity reduction | Sharp |
| [22] | [R1-2303089](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303089.zip) | UE complexity reduction | Lenovo |
| [23] | [R1-2303140](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303140.zip) | Further UE complexity reduction for eRedCap | Samsung |
| [24] | [R1-2303246](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303246.zip) | Discussion on further reduced UE complexity | CMCC |
| [25] | [R1-2303378](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303378.zip) | Discussion on UE complexity reduction | Transsion Holdings |
| [26] | [R1-2303425](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303425.zip) | Discussion on further UE complexity reduction for eRedCap | LG Electronics |
| [27] | [R1-2303452](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303452.zip) | Considerations for further UE complexity reduction | Sierra Wireless. S.A. |
| [28] | [R1-2303495](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303495.zip) | Further RedCap UE complexity reduction | Apple |
| [29] | [R1-2303536](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303536.zip) | On further complexity reduction of NR UE | Nordic Semiconductor ASA |
| [30] | [R1-2303602](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303602.zip) | UE complexity reduction for eRedCap | Qualcomm Incorporated |
| [31] | [R1-2303638](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303638.zip) | UE complexity reduction for eRedCap | Panasonic |
| [32] | [R1-2303656](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303656.zip) | Discussion on UE complexity reduction | DENSO CORPORATION |
| [33] | [R1-2303721](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303721.zip) | Discussion on further UE complexity reduction for eRedCap | NTT DOCOMO, INC. |
| [34] | [R1-2303836](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303836.zip) | UE complexity reduction for eRedCap | Sony |
| [35] | [R1-2303847](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303847.zip) | Considerations for Rel-18 eRedCap UE complexity reduction | Sequans Communications |
| [36] | [R1-2303883](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303883.zip) | Discussion on further complexity reduction for eRedCap UEs (revision of [R1-2302994](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2302994.zip)) | Xiaomi |
| [37] | [R1-2303899](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303899.zip) | Discussion on Rel-18 RedCap UE(revision of [R1-2303173](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303173.zip)) | NEC |
| [38] | [R1-2303909](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303909.zip) | On eRedCap complexity reduction(revision of [R1-2303349](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303349.zip)) | MediaTek Inc. |
| [39] | [R2-2301910](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121/Docs/R2-2301910.zip) | Report from eRedCap breakout session | Session chair (Ericsson) |