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].

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| **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 |

This document summarizes contributions [10] – [38] submitted to agenda item 9.6.1 and the following email discussion:

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| [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)** |
| NTT DOCOMO | Mayuko Okano | mayuko.okano.ca@nttdocomo.com |
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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. |
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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** |
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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 (1-6)** | **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. |
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**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.)**

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| **Company** | **Comments** |
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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]:

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

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| **Company** | **Y/N** | **Comments** |
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**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.**

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| **Company** | **Comments** |
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2.4 Separate initial BWP

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

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| 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.**

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| **Company** | **Comments** |
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**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.**

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| **Company** | **Comments** |
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2.5 Simultaneous reception

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

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| 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:

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| 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:

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| 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.**

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| **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. |
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2.6 SI PDSCH bandwidth

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

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| **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.**

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| **Company** | **Y/N** | **Comments** |
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2.7 Msg4 PDSCH bandwidth

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

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| 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.**

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| --- | --- | --- |
| **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. |
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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.**

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| **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. |
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2.8 MsgA PUSCH bandwidth

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

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| 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).**

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| **Company** | **Option (1/2/other)** | **Comments** |
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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.**

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| **Company** | **Option (0/2/4)** | **Comments** |
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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?**

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| **Company** | **Y/N** | **Comments** |
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**FL6 Medium Priority Question 2.10-2a: Should multicast MBS PDSCH bandwidth be restricted? How?**

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| **Company** | **Y/N** | **Comments** |
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# 3 UE peak data rate reduction

3.0 Earlier agreements

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

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| 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**

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| **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. |
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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**

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| **Company** | **Y/N** | **Comments** |
| DOCOMO | Y | While our first preference is 3, we can live with 3.2. |
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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**

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| **Company** | **Y/N** | **Comments** |
| DOCOMO | Y |  |
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# 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?**

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| **Company** | **Y/N** | **Comments** |
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# References

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| --- | --- | --- | --- |
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| [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) |