3GPP TSG-RAN WG1 Meeting #112bis-e Draft R1-2303934

e-Meeting, 17th – 26th April 2023

**Agenda Item: 9.6.1**

**Title: FL summary #2 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 FLS for the initial discussion round can be found in [40]. The issues that are in the focus of this discussion round are tagged FL3.

Follow the naming convention in this example:

* *eRedCapFLS2-v000.docx*
* *eRedCapFLS2-v001-CompanyA.docx*
* *eRedCapFLS2-v002-CompanyA-CompanyB.docx*
* *eRedCapFLS2-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 *eRedCapFLS2-v002-CompanyA-CompanyB.docx*.
* CompanyC uploads an empty file named *eRedCapFLS2-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 *eRedCapFLS2-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.

**FL3 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]:

|  |
| --- |
| **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 helps with FDM multiplexing with legacy UEs |
| CMCC |  | Fine to keep current agreement. |
| Samsung |  | Needn’t revise the agreement. |
| LG | N | 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. |
| Qualcomm | N | No strong motivation to change it |
| FL2 | There does not seem to be much support for changing the maximum number of PRBs. | |

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. |
| Qualcomm |  | We are open for 60KHz SCS but this is not an urgent issue in this meeting. We may come back next meeting after further checking. |
| Samsung | N | 60kHz is not in the scope of WID. |
| OPPO | N | We think 60kHz is optional feature and not well implemented from Rel-15. This late stage is even harder to catch up. |

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 | 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 | 1 | Change/enhance default TDRA table is not preferred, so smaller values can have less limitations on the usable TDRA table entries. |
| Nordic | 4 |  |
| CMCC | 1 | 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 | 8 |  |
| LG | 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 | 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 | 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 | 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 | 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 | 4 |  |
| Qualcomm | 1 | Based on our analysis in [R1-2303898](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303898.zip), half-slot length is sufficient for Msg2-Msg3 timeline relaxation. This Tdoc shows that channel estimation and demodulation block is only affected by the larger number of PRBs and LDPC decoding block does not need any additional processing time. Assuming that channel estimation and demodulation block takes much smaller portion (about 20%) of total processing time compared to LDPC block, we calculated the required timeline relaxation as 7 symbols (X = 0.5/0.25) for both 15 and 30 KHz SCS.  Moreover, if other candidate (X = 1/0.5 or X=2/1) is chosen for X, there would be larger restrictions on Msg3 scheduling flexibility because there would be fewer valid entries in default TDRA table as mentioned by multiple companies. |

Among the responses received so far to Question 2.2-1a,

* 43% express that they prefer X=0.5/0.25 ms
  + 64% express that they are ok with X=0.5/0.25 ms
* 29% express that they prefer X=1/0.5 ms
  + 43% express that they are ok with X=1/0.5 ms
* 7% express that they prefer X=2/1 ms
  + 21% express that they are ok with X=2/1 ms

Based on the responses received so far, the following proposal can be considered.

**FL2 High Priority Proposal 2.2-1b:**

* **For the “FFS: value(s) of X”**
  + **X = [0.5/0.25 or 1/0.5] ms for 15/30kHz SCS**
  + **X = 2/1 ms for 15/30kHz SCS is no longer considered**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Lenovo | Y |  |
| FL3 | Based on discussion in the online (GTW) session on Monday 17th April, the following question can be considered.  **High Priority Question 2.2-1c: Please indicate your preferred option.**   * **Option 1:**   + **X = 0.5/0.25 ms for 15/30 kHz SCS**   + **A network-configurable additional early indication in Msg1 is not supported.** * **Option 2:**   + **X = 1/0.5 ms for 15/30 kHz SCS**   + **A network-configurable additional early indication in Msg1 is supported.** * **Option 3:**   + **X = 2/1 ms for 15/30 kHz SCS**   + **A network-configurable additional early indication in Msg1 is supported.** * **Option 4:**   + **Other (please elaborate in the comment field).** | |
| **Company** | **Option (1-4)** | **Comments** |
| Sharp | 4 | We cannot see the need of binding the selection for X with the msg1 early indication. And for Question 2.2-1a, we prefer option2. |
| CATT2 | Option 1, or 4 | Thanks FL for the update. Larger X may require new TDRA table/manner which become essential demand for additional early indication in Msg1, we admit. The key point is that different TDRA tables/manners must be applied to Rel-18 and Rel-17 RedCap UE, which gNB cannot handle without separate Msg1.  But after further checking, for the default legacy TDRA table, if RAR>5 MHz:   * X=0.5/0.25 ms, at least *j+1,* *j+2*, *j+3* entries are usable; * X=1/0.5 ms, at least *j+2*, *j+3* entries are usable; * X=2/1 ms, at least *j+3* entries are usable.   So regardless early indication in Msg1 is supported or not, all X values can be supported by legacy TDRA table. But current proposal seems implying that X=1/0.5 ms or X=2/1 ms will always have to introduce new default TDRA table/manner (?), which is not valid we doubt.  Our suggestion is proceed step by step: (S1) determine value of X; (S2) determine whether to introduce new default TDRA table/manner based on S1; (3) determine whether to support Msg1 early indication based on S2. |
| vivo | Option 1 or 4 | Our view is if large X values like X=2/1 ms for 15/30 kHz SCS request to enhance the default TDRA table or enhance the Δ values, so that the legacy/R17 RedCap UE and Rel-18 RedCap UE use different default TDRA table or Δ values, then the additional early indication in Msg1 is needed;  If no enhancement on the default TDRA table or the Δ values, no additional early indication in Msg1 is needed. Because NW still has the flexibility to use any entry in the current default TDRA table, if the scheduling timing K2 of the selected entry cannot meet the timeline for R18 “BW3/PR3+PR1” UE, the R18 “BW3/PR3+PR1” UE behavior is up to implementation. Alternatively, NW can decide either not to allocate MSG2 with the BW larger than 5MHz or use the limited entry in the current TDRA table for MSG2 with the BW larger than 5MHz, so that all UE types can meet the timeline requirement. |
| Spreadtrum | Option 3 | Sorry for missing the feedback in the last round  For X, our preference is 2/1 ms. Considering the worst case (20MHz PRB), at least the option [0.5/0.25 ms] is too short and cannot accept for us. As mentioned by some companies online, allowing the R18 5MHz RedCap to process 20Mhz broadcast is actually increased the complexity. If such a short time is also introduced, the complexity reduction for R18 RedCap is smaller.  For early indication, we are fine with FL proposal that a network-configurable additional early indication in Msg1 is supported. But for this sub-bullet, it reads like the Msg1 early indication only apply to BW3/PR3+PR1 UEs. To avoid ambiguity, we propose to combine this proposal and Question 2.3-3a, like:   * **Option 2:**   + **X = 1/0.5 ms for 15/30 kHz SCS**   + **A network-configurable additional early indication in Msg1 is supported.**     - **FFS: whether the 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** * **Option 3:**   + **X = 2/1 ms for 15/30 kHz SCS**   + **A network-configurable additional early indication in Msg1 is supported.**     - **FFS: whether the 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** |
| Ericsson | 2 | We are fine to accept Option 2 as a compromise.  The rationale behind the necessity of specifying smaller values of X has been clarified in our response to Question 2.2-1a and the necessity of specifying configurable Msg1 indication has been clarified in Question 2.3-1a.  @CATT Although all X values can be supported by the default TDRA table, higher values of X would significantly impact the NW scheduling flexibility. For example, for X = 2 ms (for 15 kHz SCS), only j+3 entries, i.e., only 2 out 16 entries, in the table are valid. However, with smaller values of X, most of the entries in the table would be valid, and so, there is no strong motivation to introduce a new default TDRA table. This would also be our preference. |
| Panasonic | Option 2 | Although we can accept any value among the candidates at the end, following is our analysis. The PDSCH processing time is mainly composed by the channel estimation, demodulation, rate-matching, LDPC decoding and higher layer processing:   * Channel estimation and demodulation: No additional complexity because since these are also required for PDCCH up to 20 MHz. * Rate-matching: Because of larger number of PRBs, the number of bits after demodulation is increased compared with the unicast PDSCH capability. * LDPC decoding and higher layer processing: Using RAR-specific scaling factor, the lower coding rate is used. UE peak rate of [10] Mbps does not take account of 20 MHz of PRB allocation but only 5MHz corresponding capability (as section 2.2). Therefore, the number of bits after rate matching is no difference compared with the unicast PDSCH capability.   Based on above analysis, which only increased part is rate matching, our thinking is option 1 would be feasible. On the other hand, with the consideration of the view to see the need of option 3, we think the most reasonable choice would be option 2. |
| ZTE, Sanechips |  | New default TDRA table or other approaches to introduce larger Msg3 scheduling delay are not needed based on the following agreement:   * 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.   Additionally, as we commented online, without msg1 early indication, it is meaningless to discuss value X, since the gNB would not care what’s UE implementation and what’s the processing time of RAR. Therefore, for all the options, msg1 indication is needed. Also, without msg1 early indication, even we do not have further agreement on value X, it would be fine to leave it to UE implementation. |
| Samsung | Option 2 or 3 |  |
| MediaTek2 | Option 3 or 2 | Our preference remains Option 3 but we can compromise to Option 2. |
| Intel | Option 3 or 2 | The issue of X is related to ‘FL1 High Priority Question 2.5-1a on simultaneous reception’. The relaxed decoding of RAR may overlap with reception of unicast PDSCH. With a larger X, UE has more room to arrange decoding of the RAR and unicast PDSCH. Hopefully, the UE may satisfy both PDSCHs within the respective timeline. |
| FUTUREWEI | Option 2 | This option is a compromise that still allows substantial use of the default TDRA tables while allowing the network to use Msg1 EI as needed. |
| Sierra Wireless | Option 2 |  |
| Qualcomm | Option 1 | We have a strong concern if we need to modify default TDRA table for eRedCap UEs. X=0.5/0.25 ms option gives smallest impact to NW scheduling and specification compared to other options given the current TDRA table. |
| Nokia, NSB | Option 2 | We think 1/0.5ms is a good compromise between complexity reduction and network scheduling flexibility. In this case, we can still use the default TDRA table with sufficient PUSCH time domain resource allocation options. In addition, since we don’t expect Msg2 to be significantly larger than 5MHz based on our analysis, we think this is a good compromise. Furthermore, if Msg1 early indication is support, there will not be an impact to legacy UE.  We are also OK with Option 1. |
| NEC | Option 2 | Prefer as a compromise. |
| CMCC | Option1 | We prefer smaller X to remain more scheduling flexibility of PUSCH for R18 RedCap UEs and reduce the impact of random access timeline NT,1 + NT,2 + 0.5 + X ms on access latency of R17 RedCap UEs.  Option 2 does not mean new PUSCH TDRA table must be needed. With existing table, if scheduled K2 cannot satisfy timeline requirement, UE behavior is up to the UE implementation and R18 Redcap UEs may retry random access, the access latency may increase but it is acceptable to R18 Redcap UEs. If scheduled K2 can satisfy timeline requirement, Msg3 is sent normally.  Network configuration of early indication provides sufficient flexibility, but flexibility should depend on whether it is useful. From the perspective of RAR reception and Msg3 size (4 or 6 RB in practical network), there is no need to distinguish R17 RedCap and R18 RedCap UEs. From the perspective of random access timeline, if scheduled K2 is smaller than NT,1 + NT,2 + 0.5 + X ms, access latency of R18 RedCap UEs may increase, if NW aim to reduce access latency of R18 RedCap UEs, NW can schedule K2 larger than NT,1 + NT,2 + 0.5 + X, there is still no strong need to distinguish R17 RedCap and R18 RedCap UEs. Thus, additional early indication in Msg1 is not needed for R18 RedCap UEs. |
| LG | Option 3 | Since each company has one’s own BB solution which can be different. it may be safer to set the UE processing time with accommodating various BB’s cases based on the views from companies potentially.  Early indication for eRedCap in Msg1 is needed and can be configured by NW on whether it is shared with Rel-17 RedCap or not. It can be considered to take into account limited usage under a special case due to reduce complication of RO/Preamble partitioning. |
| OPPO | Option 1 | This X is smaller than we preferred. This is considering the too much restriction by large value, e.g. potentially less useful default TDRA entries. |
| DENSO | Option 2 | We prefer Option 2, which balances scheduling flexibility and complexity reduction. |

**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). |
| Qualcomm | Same value of X is also applied to the following cases:   * Between reception of fallbackRAR and transmission of Msg3 (2-step RACH) * Between reception of successRAR and transmission of corresponding HARQ-ACK (2-step RACH) * Between reception of RAR PDSCH in which UE does not correctly receive the transport block and upcoming transmission of PRACH (4-step RACH) * Between reception of RAR with RAPID which is not associated with the corresponding PRACH transmission and upcoming transmission of PRACH (4-step RACH) |
| CATT2 | Open to consider the cases when broadcasting channel can be larger than 5 MHz but requires any kinds of feedback (e.g. Msg3 scheduled by fallbackRAR>5MHz) |
| vivo | At least the case of random access procedure for 2-step RACH needs a similar timing relaxation. We are open to discuss the other cases as QC mentioned. |
| LG | 2-step RACH also needs the time relaxation; Message B can be multiplexed with different UEs with successRAR or fallbackRAR. The X value can be the same with the time relaxation for decoding Messageb2 to be scheduled over 5MHz BW PRBs  The time relaxation can be also adapted in Message 1 retransmission after decoding RAR, when Message 2 is scheduled more than the number of the 5MHz BW PRBs for unicast. |

2.3 Separate early indication

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

|  |
| --- |
| * 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. |
| Qualcomm | Y | Introduction of Msg1 based early indication gives configuration flexibility to the NW. The configuration of Msg1 based separate early indication is up to NW so if not configured, Rel-18 eRedCap UE should follow configuration for Rel-17 RedCap UE |

Among the responses received so far to Question 2.3-1a, 71% say yes and 21% say no. Based on the responses, the following proposal can be considered.

**FL2 High Priority Proposal 2.3-1b:**

* **For Rel-18 eRedCap UEs, a network-configurable additional early indication in Msg1 is supported.**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Lenovo | Y |  |
| FL3 | See new Question 2.2-1c above, which was added based on discussion in the online (GTW) session on Monday 17th April. | |

**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** |
| Nordic | N | Use LCID in PUSCH part is enough |
| Ericsson | Y |  |
| CATT2 | N | As long as MsgA PUSCH will always carry dedicated LCID for Rel-18 LCID, the network does not need other information to do proper scheduling of MsgB and so on. |
| vivo | N | Same views as Nordic and CATT |
| MediaTek | N | Similar views with Nordic and CATT |
| LG | Y | We think that 2-setp RACH is should be treated in the same way as for 4-setp RACH and if Msg1 early indication is introduced in 4-step RACH, MsgA early indication is also supported obviously in 2-step RACH. |

**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. |
| Qualcomm | We are open for discussion on whether UE early indication is only applicable to UE BB BW reduction or both UE options. As Ericsson mentions, the objective on additional separate early indication(s) is only listed under UE BB bandwidth reduction in the WID. We may also need to discuss benefits and drawbacks from both NW and UE perspectives. |
| CATT2 | From RANP conclusion, they should share the same RACH procedure:   |  | | --- | | 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 |   Although all restrictions designed for BW3/PR3 seem redundant to ‘20 MHz + PR1’, it should be easy for ‘20 MHz + PR1’ to support restricted behavior of BW3/PR3. |
| vivo | Same views as Nordic and CATT. The guidance in the later RAN plenary should override the objective in the previous WID description. |
| Samsung | In the latest WID, separate initial early indication is supported only for BW3/PR3 UE or BW3/PR3+PR1 UE. |
| MediaTek | Per RAN agreements, PR1 UE should follow the same initial access as BW3/PR3 UEs. Hence, we don’t agree that a potential separate early indication only applies to BW3/PR3+PR1 UEs. Note: WID objectives should be modified accordingly to align with RAN#99 agreements.  *[RP-230778]*  *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* |
| Sierra Wireless | Agree with Ericsson that for phased network deployments it would be desirable for the network to identify or allow eRedCap BW3/PR3+PR1 vs PR1-only devices.  Our preference would be to have separate access control/barring for eRedCap BW/PR3+PR1 devices vs PR1-only devices. The same initial access procedure can still be used for eRedCap BW/PR3+PR1 devices vs PR1-only devices. |
| LG | PR1-only eRedCap UEs are different from BW3/PR3+PR1 eRedCap UEs in terms of UE supported PDSCH/PUSCH bandwidth. We can discuss whether the same early indication can be used for both PR1-only UEs and the BW3/PR3+PR1 UEs. |

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.**

|  |  |
| --- | --- |
| **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. |
| vivo | Same view as CATT, if Rel-17 separate initial BWP is not configured, then Rel-18 RedCap UE use legacy initial BWP.  About whether/how Rel-18 eRedCap read the IEs related to Rel-17 RedCap UE bar, it should be up to RAN2 to discuss and decide. |
| Panasonic | For a cell supporting both Rel-17 RedCap and Rel-18 eRedCap UEs, separate initial DL/UL BWP specific to Rel-18 eRedCap UEs can be configured only when the separate initial DL/UL BWP specific to Rel-17 RedCap UEs is NOT configured. Allowing the case is beneficial for scheduling flexibility while the NW complexity or test effort would not increase so much. The detail of the configuration is up to RAN2. |
| Samsung | Separate initial BWP is not needed. However, separate barring indication is needed. If Rel-18 eRedCap UE is not barred, it can use legacy initial BWP. |
| LG | It is OK up to one separate initial BWP regardless of Rel-17 RedCap or Rel-18 eRedCap. For example, the scenario is open that the initial BWP is for non-RedCap and Rel-17 RedCap and the separate initial BWP is for Rel-18 eRedCap. Without the configuration for the separate initial BWP, RedCap and eRedCap will be similarly operated in the initial BWP with non-RedCap. This case can give more flexibility to NW for scheduling and help load-balancing. How one separate initial BWP is configured to only Rel-18 eRedCap except to Rel-17 RedCap is up to RAN2 decision on signaling or configuration. |

**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. |
| CATT2 | As RANP guidance, they should share the same RACH procedure. So same initial BWP, as mentioned by Nordic. |
| vivo | Same views as Nordic and CATT |
| LG | PR1-only eRedCap UEs are different from BW3/PR3+PR1 eRedCap UEs in terms of UE supported PDSCH/PUSCH bandwidth. We can discuss whether the same initial BWP can be applied to both PR1-only UEs and the BW3/PR3+PR1 UEs. It is thought that considering various possibilities openly will help the discussion. |

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] expresses 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 order  RAR (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. |
| Qualcomm | N | The case is only when UE receives unicast PDSCH with SIB1/OSI PDSCH (for SI acquisition) simultaneously. In this case, an eRedCap UE can still receive both PDSCHs given that there is sufficient processing time budget for SIB1/OSI so any additional relaxation or any prioritization is not needed. This is more aligned with what we have agreed on for broadcast PDSCH (except RAR PDSCH).  Note that this scenario does not include the case that RAR PDSCH and unicast PDSCH are received at the same time. The broadcast PDSCH is only for SI acquisition (SIB1/OSI) as clearly described in the spec. |
| FL2/FL3 | Different views are expressed in the responses received so far. Companies are encouraged to check and comment on the responses from other companies. | |
| Sharp | N | the processing priority can be up to UE implementation, and does not need to be specificized. |
| CATT2 | N | Regarding the case (simultaneous RAR and unicast PDSCH) raised by Intel and Qualcomm, we think it is a corner case (if not totally impossible):   * NW can allocate unicase PDSCH only after RACH procedure is finished, i.e. UE ID is provided by Msg3, and C-RNTI is allocated by Msg4. * Therefore, it seems impossible for NW to transmit another unicast PDSCH to the UE before its Msg3 is received. So simultaneous reception between RAR and a unicast PDSCH is unlikely to happen, at least for initial access. |
| vivo | Y | Based on companies’ comments, it seems the common preference is UE should prioritize the unicast PDSCH; About the broadcast PDSCH, still there are different views, like broadcast PDSCH can be decoded afterwards (if there is no subsequent unicast PDSCH scheduling?), or up to UE implementation. |
| Spreadtrum | N | Same understanding as DOCOMO, i.e., up to UE implementation. |
| Ericsson |  | Same view as in the previous round.  It seems that many companies have the understanding that a reasonable UE implementation would prioritize unicast PDSCH, if no prioritization rule is specified. But we have similar concern as expressed by Vivo above — if there is continuous scheduling of unicast PDSCH in subsequent slots, would the UE skip decoding of SIB?  Also, to our understanding, the broadcast PDSCH referred to in the question concerns only those scheduled with SI-RNTI (and not those scheduled with RA-RNTI or P-RNTI, as commented by some companies above). |
| Panasonic | Y for SI,  N for RAR | **Unicast vs. P-RNTI triggered SI**  The current spec (w/o change) for FR1 is interpreted as:   * When unicast decoding is based on the capability 2 processing time, the SI shall be able to be decoded while unicast may be skipped. Otherwise, the simultaneous reception of both unicast and SI is required. (It is not up to the UE implementation which channel(s) are decoded)   Our view is, similar to capability 2 processing is applied. i.e. the P-RNTI triggered SI is decoded while unicast may be skipped. As the network is able to manage the case of capability 2 processing, precluding such simultaneous reception should be possible and it is beneficial for complexity reduction.  **Unicast vs. SI other than P-RNTI triggered SI (=autonomous SI acquisition)**  The current spec (38.214 clause 5.1):   |  | | --- | | 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. |   “During a process of autonomous SI acquisition” is intentionally vague without describing exact SI reception slot while unicast is expected to be decoded. The reason of such description is that the autonomous SI acquisition is lower priority than unicast because the urgency to receive SI is relaxed compared with P-RNTI triggered SI. P-RNTI triggered SI need to be received priority as the system operation will be changed after SI are received.  So, our interpretation of the spec (w/o change) is:   * At the time of the autonomous SI acquisition, unicast is decoded while it is not described whether the SI should simultaneously be decoded or not (It may be up to the UE implementation whether to decode the SI).   We propose to clarify precluding the potential simultaneous reception. But unlike the P-RNTI triggered SI case, the unicast should only be decoded while the autonomous SI acquisition, whose urgency is lower, is not expected. So the current wording can be acceptable but clarification of not mandating the simultaneous SI reception would be useful. Note that the autonomous SI acquisition by delaying the reception or HARQ combining and so on are still required.  **Unicast vs. RAR**  The current spec (38.214 clause 5.1):   |  | | --- | | The UE is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, G-RNTI for multicast or broadcast, MCCH-RNTI, G-CS-RNTI or CS-RNTI if another PDSCH in the same cell scheduled with RA-RNTI or MSGB-RNTI partially or fully overlap in time. |   We think no enhancement is needed on the current spec i.e., RAR is only decoded while the unicast decoding is not expected. The required processing time for RAR can be same as the case of no simultaneous reception of unicast.  **Summary of our proposal**:   |  |  |  | | --- | --- | --- | | unicast vs. P-RNTI triggered SI | unicast vs. autonomous SI acquisition | unicast vs. RAR | | The SI is only decoded while unicast decoding is not expected.  (Need spec change) | Unicast is only decoded while the SI acquisition is not expected or not described.  (Clarification is useful but keeping the current wording is also possible) | RAR is only decoded while the unicast decoding is not expected.  (No spec change) | |
| ZTE, Sanechips | Y | In connected mode, broadcast channel and unicast PDSCH may be received at the same time. If it is up to UE implementation, in order to avoid invalid scheduling, gNB can not schedule any PDSCH before PUCCH of the unicast PDSCH, which would be quite limited for the gNB.  If the gNB keep scheduling before PUCCH of the unicast PDSCH, the UE actually is unable to process. Consequently, the resource would be wasted, and the chain reactions by accumulated invalid scheduling can have serious performance impacts.  Therefore, to avoid the invalid scheduling and negative impacts, the gNB actually should schedule after the PUCCH feedback, which actually require the timeline relaxing for the gNB. |
| MediaTek | Y for RAR vs unicast | 1. **Unicast vs RAR**: from the clause 5.1 from 38.214 (cited by Panasonic in the above), our understanding is that Msg2/MsgB is prioritized over unicast PDSCH. Both RAR PDSCH and unicast PDSCH have process timeline requirements. Hence, we should specify which to be prioritized for processing. Per legacy operation, RAR should be prioritized. 2. **Unicast vs broadcast with SI-RNTI**, we are open for discussion. |
| Intel2 | Y | For the case that broadcast PDSCH (other than RAR) is overlapped in time with unicast PDSCH, we share the views from vivo and E//, the behavior should be defined, otherwise, it is not clear what is the expected behavior on broadcast PDSCH if there are unicast PDSCH in consecutive slots.  For the case of RAR, thanks for the comments from CATT. However, the comments are for initial access. On the other hand, we are considering connected mode operation. It is possible a unicast PDSCH is scheduled in the next slot of RAR. A simple way is to define the priority order to decode the different PDSCHs |
| Qualcomm | N | There are two different cases for unicast + broadcast PDSCHs in the spec so need to differentiate the discussions like below:  1: Unicast PDSCH and broadcast PDSCH with SI-RNTI:   |  | | --- | | 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. |   2. Unicast PDSCH and broadcast PDSCH with RA-RNTI/MSGB-RNTI   |  | | --- | | The UE is not expected to decode a PDSCH scheduled with C-RNTI, MCS-C-RNTI, G-RNTI for multicast or broadcast, MCCH-RNTI, G-CS-RNTI or CS-RNTI if another PDSCH in the same cell scheduled with RA-RNTI or MSGB-RNTI partially or fully overlap in time. |   For the case 1 (SI-RNTI), as commented above, an eRedCap UE can still receive both PDSCHs given that there is sufficient processing time budget for SIB1/OSI so any additional relaxation or any prioritization is not needed.  For the case 2 (RA-RNTI/MSGB-RNTI), current spec already defines prioritization between two PDSCHs. We believe that same behavior is sufficient for eRedCap UEs. |
| Nokia, NSB | N | In case of unicast + broadcast with SI-RNTI, we believe that no specification change is needed. This case should be supported and UE needs to process unicast transmission to meet the timeline. However, if companies would like to specify priority, we are open.  In case of unicast + RAR, it already states in 38.214 that UE should prioritize RAR. We don’t think modification is needed.  Also, since Rel-18 RedCap is only in FR1, the specification text related to FR2 does not apply. |
| CMCC | N | If broadcast here means PDSCH scheduled with SI-RNTI, it can be up to UE implementation, unicast can be prioritized over PDSCH scheduled with SI-RNTI. Meanwhile NW can avoid schedule continuous unicast PDSCH overlapping with SI in connected mode. |
| LG | N | Even if unicast PDSCH is processed first and then the other channel is done, there seems to be no major operational issue. Even considering the case that RAR and Unicast PDSCH are processed simultaneously, it seems good to choose the longest X ms for relaxation time due to give enough processing time to a UE. |
| OPPO | N | From the above comments, we see no issue have to be addressed for RedCap UE to receiving unicast and broadcast simultaneously. The case for processing capability 2 would be different, as it is mainly due to the stringent processing time requirement of low latency traffic. |

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 |  |
| Qualcomm | OK |  |
| Lenovo | Y |  |
| Sharp | Y |  |
| vivo | Y |  |
| Panasonic | Y |  |
| Samsung | Y |  |
| Sierra Wireless | 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 |  |
| Qualcomm | Y |  |
| Lenovo | Y |  |
| FL3 | RAN1 made the following agreement in the online (GTW) session on Monday 17th April:  Agreement:  Confirm the following working assumption by assuming that Msg3 indication is available:   * 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. | |

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 |  |
| Qualcomm | N | We don’t think any further UE behavior is needed for this case. |
| FL2/FL3 | Different views are expressed in the responses received so far. Companies are encouraged to check and comment on the responses from other companies. | |
| CATT2 | N | In current NR, a UE may also detect a Msg4 for another UE, using the same RNTI. The only difference is that legacy UE can only judge based on the UE ID in Msg4 PDSCH, while Rel-18 RedCap UE may judge a little faster, i.e. based on FDRA in DCI.  Many other cases can lead to similar result, e.g. fail to detect PDCCH, fail to decode PDSCH… But all should be as contention resolution failure. No difference as ‘fail to receive Msg4 successfully’. |
| vivo |  | We are fine with the UE behavior is interpreted as Option 1 the UE considers the contention resolution as not successful. We are open for discussing whether there is any specification impact. |
| Spreadtrum | N | But maybe we can have a conclusion for this case, e.g.,  Conclusion: It is up to UE implementation 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 |
| Ericsson |  | We think RAN1 can down-select between one of the options in the following proposal in the next meeting:  **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).** |
| Panasonic | Y | We think using the potential UE behavior options in this case raised by Ericsson is a good starting point.  We are not sure no spec change means the Option 3. To avoid any unexpected behavior by the UE in this case, the UE behavior should be specified. The UE should take either of the Option 1 or 2 since neither Option 1 nor 2 has a severe problem. |
| MediaTek | Y | We support Option 1 in Ericsson’s proposal. An LS should be sent to RAN2 for implementing to 38.321 so that R18 eRedCap has a clear understanding that in this case contention resolution has failed. |
| Intel | Y, issue of msg3 is more severe | As we commented in last round, the issue is not limited to msg4. It is even more severe for msg3 scheduled with >25 or 12 PRBs. The contention resolution timer is only started after UE’s transmission of msg3, so RACH retransmission cannot be triggered by the expire of contention resolution timer. There is no specified behavior for this situation in any specification. |
| FUTUREWEI |  | The conclusion proposed by Spreadtrum seems reasonable. |
| Qualcomm | N | We share the view from Spreadtrum that it can be up to UE implementation. |
| Nokia, NSB | N | We don’t think there is a need to specify UE behavior in this case as this would be similar to e.g. when UE detects the DCI but cannot decode the PDSCH. So we think existing specification can already handle this.  If any behavior is to be specified, then we are fine with Option 1 in the Ericsson’s response. |
| NEC | N | Ericsson’s option 2 would be in line with the existing specification “If a UE detects a DCI format with inconsistent information, the UE discards all the information in the DCI format.” |
| CMCC | N | In our understanding, UE behavior is option 1: The UE considers the contention resolution as not successful. |
| LG | N | Rel-18 eRedCap UEs should be treated in the same as for the legacy UEs in the case. |
| OPPO | N | Usually this should not be defined as error cases results in no standardized behavior.  Even it may have benefit for RAR, we don’t see this strong enough to have some special cases. |
| DENSO | N | We think that UE behavior is the same as Option 1. |

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).**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option (1/2/other)** | **Comments** |
| Nordic | Option 2 | which can achieve Option 1 in our opinion |
| CATT2 |  | Open to both options. Although we do not introduce separate PO in 2-step RACH for Rel-17 RedCap in R17.  Another possible way is purely by implementation, i.e. NW configure legacy PO <= 5 MHz if it allows Rel-18 RedCap UE to perform 2-step RACH. |
|  |  |  |

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. |
| Qualcomm | Option 2 | MsgB can multiplex messages to more than one UEs so MsgB needs to be considered as broadcast PDSCH. Then we have to handle MsgB PDSCH in the same way as the other broadcast PDSCH, i.e., Msg2 PDSCH. |
| Sharp | Option4 |  |
| CATT2 | Option 4 | gNB should be able to identify Rel-18 RedCap UE by MsgA PUSCH anyway. If so, it should be able to restrict the PRB number of MsgB within 5 MHz for Rel-18 RedCap UEs.  If multiple messages for multiple UE are to transmit, there are some ways to address this issue by implementation. For example, the gNB can send multiple *fallbackRAR* in multiple MsgBs (within 5 MHz) within the *msgB-ResponseWindow*. |
| vivo |  | Option 4 is first preference, but we can accept option 2 given Msg.B actually is kind of broadcast message and NW may want to prioritize 20MHz+PR1 R18 eRedCap UE. |
| Samsung | Option 4 |  |
| LG | Option 2 | MsgB-RNTI is different from C-RNTI or TC-RNTI (CS-RNTI, MCS-C-RNTI) which is scheduled for one UE of unicast PDSCH and is almost same with P-RNTI or RA-RNIT which can be scheduled for multiple UEs. Multiple UE’s MAC Control PDU contents can be multiplexed into a Message B according to TS 38.321. |

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. |
| CATT2 | N | Same as other broadcasting channel. |
| Panasonic | N | Whether MBS PDSCH is capable or not is able to be known to the network for IDLE mode as which UE support broadcast MBS PDSCH is not informed. Therefore, if the RedCap UE support MBS PDSCH, it should be same as non-RedCap UE. . |
| LG | N | It should be regarded as SIB broadcasting channel. |

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

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Nordic | Y |  |
| CATT2 |  | Open to further consider putting restriction to the allocable PRBs<5 MHz. |
| Panasonic | Y | Should be restricted as the unicast. The multicast retransmission is UE-specific and it should be limited to the capability. |
| LG |  | Open to discuss whether it is restricted or not. |

# 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 | 1 | Depending on the UE capabilities which are supported by the eRedCap UE, *vLayers*·*Qm*·*f* can be larger than X or Y. |
| vivo | 2 | For UE complexity reduction, the 10Mbps target data rate is the peak data rate. |
| Nordic | 1 | WID is clear on this  Relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for peak data rate reduction |
| CMCC | 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 | 1 | Follow WID description. |
| LG | 1 | WID is descripted as below.  Relaxation of the constraint (*vLayers*·*Qm*·*f* ≥ 4) for peak data rate reduction |
| CATT | 1 |  |
| FUTUREWEI | 1 |  |
| Intel | 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 | 1 | 10Mbps target data rate is the **minimum** peak data rate. |
| Nokia, NSB | 1 |  |
| Qualcomm | 1 |  |
| FL2 | Based on the responses received so far, the dominant view seems to be according to Option 1. | |
| FL3 | In the online (GTW) session on Monday 17th April, it became clear that different interpretations are possible regarding the RAN#99 agreement on the 10-Mbps peak rate target.  **High Priority Question 3.1-1b: What is your interpretation of the RAN#99 agreement?**   * **Interpretation 1: All Rel-18 eRedCap UEs should have the same 10-Mbps peak rate target regardless of what optional capabilities (e.g., MIMO) it might support.** * **Interpretation 2: “BW3/PR3+PR1 UEs” and “PR1-only UEs” should have the same 10-Mbps peak rate target, but Rel-18 eRedCap UEs that support optional capabilities (e.g., MIMO) might support higher peak rates.** * **Interpretation 3: Other (please elaborate in the comment field).** | |
| **Company** | **Interpretation (1/2/3)** | **Comments** |
| MediaTek | 1 | 1. The agreement at RP#99 is the following:    * 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.** [RP-230778] 2. The whole point of the WI was to define a device type of lower complexity than RedCap. Enabling the peak data rate to be higher than 10Mbps and approaching R17 RedCap data rates is completely unnecessary when we note that there is no further segment in between LTE Cat1/1bis (10Mbps) and LTE Cat2 (50Mbps). How many different peak data rates do we need to introduce in between 10Mbps and 50Mbps (already supported by R17 RedCap)? 3. If we allow Interpretation 2, **where is the boundary between R18 eRedCap and R17 RedCap**, especially considering the fact that “standalone PR1” has been agreed? 4. Interpretation 2 leads to the market fragmentation that is required to be avoided to really achieve reduction in device “complexity”, so we object to Interpretation 2. |
| CATT2 | 2 | We think RANP agreement provides a lower bound (or say minimum requirement) defined by 10 Mbps, which allows UE vendors to reduce complexity/cost as much as possible, but not infinitely low.  But this does not prohibit UE vendors implementing MIMO and/or 256QAM if they are interested in. This is the same as Rel-17 RedCap UE (only CA/DC is precluded). |
| vivo | 1 | We share the concern expressed by MediaTek. About the companies’ interpretation about the peak data rate is minimum peak data rate, isn’t the ‘minimum’ and ‘peak’ contradicts each other?  If companies have concern on the fixed modulation order and scaling factor, we are open to introduce the new scaling factor. |
| Spreadtrum | 1 | We prefer interpretation 1, we think MTK’s comments make sense.  If majority prefer interpretation 2, we think we should at least define an upper bound for R18 RedCap, especially for SA PR1 RedCap.  The supported peak data rate for BW3/PR3+PR1 UEs can be [~10Mbps, ~20Mbps] by reporting different SF and modulation orders. There is a data rate gap between R17 and R18 RedCap. Also as a R18 RedCap, PR1-only Ues should also follow the same peak data rate range [~10Mbps, ~20Mbps], otherwise, PR1-only Ues is meaningless as the complexity reduction will no longer exist if the achieved peak data rate close to or even same to R17 RedCap. |
| Ericsson |  | We have some sympathy for MediaTek’s concerns, although our understanding/ preference would be Interpretation 2. In order to avoid gridlock, we think that the following could be a possible way forward in RAN1:   * **Interpretation 3: At least baseline “BW3/PR3+PR1 UEs” and “PR1-only UEs” should have the same 10-Mbps peak rate target. Whether or not Rel-18 eRedCap UEs would support optional capabilities, such as MIMO, can be further discussed during UE capabilities discussion.**   The above interpretation might, however, necessitate a WID update as the current WID states that “By default, all UE capabilities applicable to a Rel-17 RedCap UE are applicable unless otherwise specified”.  Alternatively, the interpretation of the RAN#99 agreement can be clarified in RAN#100. |
| Panasonic | 1 | To avoid the market fragmentation and confliction with Rel-17 RedCap, peak rate much higher than 10 Mbps is not needed for any Rel-18 eRedCap UEs. Peak rate higher than 10 Mbps should be managed by Rel-17 RedCap UEs.  For the question 3.1-1a, we preferOption 2: *vLayers*·*Qm*·*f* = X and *vLayers*·*Qm*·*f* = Y, respectively. Option 2 reduces the number of allowed combination of *vLayers* and *Qm*, which would avoid the complexity increase at the network side. |
| ZTE, Sanechips | 2 | The RANP conclusion is talking about the peak data rate, which does not indicate the optional capabilities, 2Rx or 256QAM can not be supported. Moreover, we have agreement in RAN1 as following:   |  | | --- | | Agreement:  Revise the earlier agreement by removing the square brackets like this:   * 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 |   Further, in RAN1 111 meeting, if we check the FL summary R1-2212536, it is found that the original proposal for this issue is :   |  | | --- | | **FL1/FL2/FL3 High Priority Proposal 3-1a: The peak rate target is 10 Mbps based on peak data rate calculation according to 38.306 assuming FD-FDD with 1Rx without 256QAM.** |   After discussion and decision, we agree that using the minimum peak data rate is more correct. Therefore, there is no doubt that Interpretation 2 is true. If we go with Interpretation 1, some serveal RAN1 agreement would be reverted. For example, the ‘>=’ should be changed as ‘’=   |  |  | | --- | --- | | Agreement:  For the relaxed constraint X in the following earlier RAN1 agreement, down-select between X = 3 and X = 3.2.   |  | | --- | | * 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 | | |
| Samsung | 1 | Share the same view as MTK. |
| Intel | 2 | We share view of other companies that 10Mbps is the minimum peak data rate which allows maximum UE complexity reduction. Then, it is not precluded if a UE vendor wants to implement a powerful UE capability. |
| FUTUREWEI | 2 | 256QAM and other data rate increasing optional capabilities are available by default as noted in the WID  “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.” |
| Sierra Wireless | 1 | We prefer to have the same peak data rate for all Rel-18 eRedCap devices, regardless of which features the device supports, similar to LTE Cat1/1bis. This will reduce market fragmentation and confusion as to what is eRedCap. Customers identify devices based on peak data rate, so having a single value for eRedCap (regardless optional feature support), would be clear similar to the way LTE categories have done. |
| Qualcomm | 2 | Our interpretation and preference is to set the minimum peak data rate as 10Mbps for both BW3/PR3+PR1 UEs and PR1-only UEs. This may mean that some eRedCap UEs may support data rate higher than 10Mbps depending on the implementation. Interpretation 1 brings too much restriction to UE implementation because with this restriction, some UE may need to unnecessarily disable some high capability functions even though they are supported, e.g., 2Rx or 256QAM.  I also share the same view with Futurewei that eRedCap UE needs to follow the NR UE capability framework not the LTE UE capability method. |
| Nokia, NSB | 2 | We agree with other companies that 10Mbps is the minimum peak data rate. It is also our understanding that Rel-18 RedCap UE can support optional MIMO and 256QAM capabilities as specified in the WID. Rel-18 RedCap UE supporting optional MIMO and 256QAM capabilities should have higher data rates (same as for Rel-17 RedCap) as anyway these UEs are considered higher capability. |
| NEC | 2 | 10Mbps should be the minimum requirement. It is up to UE vendor whether peak data rate of a device corresponds to =X or >X, but not <X. |
| CMCC | 2 | R18 RedCap UEs with basic feature like “BW3/PR3+PR1 UEs” and “PR1-only UEs” have the same 10-Mbps peak rate, but Rel-18 eRedCap UEs that support optional capabilities (e.g., MIMO) might support higher peak rates.  Similarly, R17 RedCap UEs with basic feature have the same 20Mbps peak rate, but Rel-17 eRedCap UEs that support optional capabilities might support higher peak rates. |
| OPPO | 2 | The data rate is clear for low bond.  We think the UE vLayers·Qm·f ≥ X should not be used to restrict RedCap UE further. Instead, we can further consider to restrict the Rel-18 5MHz RedCap UE’s MIMO layers and scaling factors. |

* 1. 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. |
| Qualcomm | Y |  |

Based on responses received so far to Question 3.1-1a and Proposal 3.2-1a, the following proposal can be considered.

**FL2 High Priority Proposal 3.2-1b:**

* **For the relaxed constraint *vLayers*·*Qm*·*f* ≥ X,**
  + **X=3.2**

Based on discussion in the online (GTW) session on Monday 17th April, the following updated proposal can be considered.

**FL3 High Priority Proposal 3.2-1c:**

* **For UE peak data rate reduction with UE BB bandwidth reduction, for the relaxed constraint,**
  + **X=3.2**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| MediaTek |  | As we commented, we don’t have a strong concern with the exact value. In fact, we are totally fine with Nordic’s proposal for X=3.1. In our view, only 10Mbps peak data rate is supported by all R18 eRedCap and therefore NO reporting on scaling factor/max mod order/max mimo layer is needed at all. Gnb can immediately figure out the peak data rate supported by the UE once it receives its early indication during RACH. |
| CATT2 | Y | The difference on complexity/cost should be marginal for 3.0~3.2. That’s why we can compromise to 3.2. And anyway we need to capture this in TS 38.306. |
| vivo | Y |  |
| Spreadtrum | Y |  |
| Ericsson | Y |  |
| Panasonic | Y |  |
| ZTE, Sanechips |  | The BWP size and the SCS are the two factors to calculate the peak data rate. The gNB would not always configure the maximum BWP size and 30KHz for a Rel-18 RedCap UE. That means when we calculate the peak data rate, we can not assume that all the cases satisfy the 10Mbps under different gNB configuration.  The peak data rate is based on the UE capability. The UE supports 30KHz and 11PRBs PDSCH, and the peak data rate can be achieved. That is enough. A larger X only can bring more complexity and is more far away the peak data rate target. Therefore, we still prefer X=3.0.  Compared with 3.0, if proponents can provide the benefits of X=3.2, we also would consider to compromise. |
| Samsung | Y |  |
| Intel | Y |  |
| FUTUREWEI |  | Can accept |
| Sierra Wireless | Y |  |
| Qualcomm | Y |  |
| Nokia, NSB | Y |  |
| NEC | Y |  |
| CMCC | Y |  |
| LG | Y |  |
| OPPO |  | 3 vs. 3.2 does not change much data rate. 3 only have less than 10Mbps in a case of 30kHz SCS. We still prefer 3 but can live with other values. |

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 |  |
| Qualcomm | Y |  |

Based on responses received so far to Question 3.1-1a and Proposal 3.3-1a, the following proposal can be considered.

**FL2 High Priority Proposal 3.3-1b:**

* **For the relaxed constraint *vLayers*·*Qm*·*f* ≥ Y,**
  + **Y=0.75 assuming 20 MHz bandwidth in the 38.306 peak rate expression**

Based on discussion in the online (GTW) session on Monday 17th April, the following updated proposal can be considered.

**FL3 High Priority Proposal 3.3-1c:**

* **For UE peak data rate reduction as a standalone feature, for the relaxed constraint,**
  + **Y=0.75 assuming 20 MHz bandwidth in the 38.306 peak rate expression**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| MediaTek |  | We are fine with the value of 0.75. However, we do have a strong concern with the greater sign > being specified, especially for this standalone PR1 case where UE is capable of receiving and processing 20MHz as legacy R17 RedCap. If “>=” instead of “=” is agreed, then where is the boundary between R18 and R17 RedCap?  As for reporting maximum peak data in 38.306, we think there is no need to Rel-18 RedCap to do the reporting. Once gNB realizes it is an R18 eRedCap UE from early indication in RACH, gNB will realize 10Mbps is the peak rate of the UE. |
| CATT2 | Y | Similar comment as the one for X. |
| vivo | Y |  |
| Spreadtrum | Y |  |
| Ericsson | Y |  |
| Panasonic | Y |  |
| ZTE, Sanechips | Y |  |
| Samsung | Y |  |
| Intel | Y |  |
| FUTUREWEI | Y |  |
| Sierra Wireless | Y |  |
| Qualcomm | Y |  |
| Nokia, NSB | Y |  |
| NEC | Y |  |
| CMCC | Y |  |
| LG | Y |  |
| OPPO | 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 |  |
| Samsung | N |  |
| LG | Y | For FDRA optimization, RBG size 16 can be difficult to constrain FDRA assignment up to 25 PRBs for 15KHs SCS in RA Type 0. So UEs which are allocated only 16 PRBs with RBG size 16 cannot reach peak date rate. Some large RBG sizes may be discussed on Configuration 1 dependent on BWP size. |

# References

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| --- | --- | --- | --- |
| [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 |
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| [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] | [R1-2303](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303898.zip)898 | UE complexity reduction for eRedCap  (revision of [R1-2303602](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112b-e/Docs/R1-2303602.zip)) | Qualcomm Incorporated |
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| [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 |
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