3GPP TSG-RAN WG1 Meeting #114 Draft R1-2308224

Toulouse, France, 21st – 25th August 2023

**Agenda Item: 9.6.1**

**Title: FL summary #1 on Rel-18 RedCap UE complexity reduction**

**Source: Moderator (Ericsson)**

**Document for: Discussion, Decision**

# 1 Introduction

This feature lead (FL) summary (FLS) concerns the Rel-18 work item (WI) on enhanced support of reduced capability (RedCap) NR devices [1, 2]. The final FLS from the previous RAN1 meeting can be found in [3], and a RAN1 agreement summary is available in [4].

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

|  |
| --- |
| **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
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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 [5], where the different nicknames for the UE complexity reduction features (“PR1” and “BW3/PR3”) originate from TR 38.865 [6].

|  |
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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., 10 Mbps**Note 1: Peak data rate of “Rel-18 eRedCap: UE capable of 20MHz + PR1” and “Rel-18 eRedCap: UE capable of BW3/PR3 + PR1” is same including unicast and broadcast respectively.Note 2: PRB processing capability of “Rel-18 eRedCap: UE capable of 20MHz + PR1” is not limited to “25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS” and it corresponds to PRB size corresponding to 20 MHz.Note 3: The only difference between “Rel-18 eRedCap: UE capable of 20MHz + PR1” and “Rel-18 eRedCap: UE capable of BW3/PR3 + PR1” is Note 2 and *vLayers·Qm·f* in order to have the same peak rate.Note 4: The initial access procedure of Rel-18 eRedCap UE capable of 20MHz + PR1 is realized by following:* Same as Rel-18 eRedCap UE capable of BW3/PR3 + PR1
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RAN#100 endorsed this working assumption regarding the peak data rate. The moderator summary can be found in [7].

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| Conclusion: Working assumption: The peak rate target is 10 Mbps regardless of what optional features the UE may support. (i.e., WGs can progress on this topic based on this assumption).No consensus about Proposal 3-3b. Revised WID will be handled in RAN #101. |

This document summarizes contributions [8] – [34] submitted to agenda items 9.6.1, and the following email discussion:

|  |
| --- |
| [114-R18-RedCap] Email discussion on eRedCap – Johan (Ericsson)* To be used for sharing updates on online/offline schedule, details on what is to be discussed in online/offline sessions, tdoc number of the moderator summary for online session, etc.
 |

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

Follow the naming convention in this example:

* *eRedCapFLS1-v000.docx*
* *eRedCapFLS1-v001-CompanyA.docx*
* *eRedCapFLS1-v002-CompanyA-CompanyB.docx*
* *eRedCapFLS1-v003-CompanyB-CompanyC.docx*

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

* Assume CompanyC wants to update *eRedCapFLS1-v002-CompanyA-CompanyB.docx*.
* CompanyC uploads an empty file named *eRedCapFLS1-v003-CompanyB-CompanyC.checkout.*
* CompanyC checks that no one else has created a checkout file simultaneously, and if there is a collision, CompanyC tries to coordinate with the company who made the other checkout (see, e.g., contact list below).
* CompanyC then has 30 minutes to upload *eRedCapFLS1-v003-CompanyB-CompanyC.docx.*
* If no update is uploaded in 30 minutes, other companies can ignore the checkout file.
* Note that the file timestamps on the server are in UTC time.

In file names, please use the hyphen character (not the underline character) and include ‘v’ in front of the version number, as in the examples above and in line with the general recommendation (see slide 11 in [R1-2306353](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_114/Docs/R1-2306353.zip)), otherwise the sorting of the files will be messed up (which can only be fixed by the RAN1 secretary).

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

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

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

2.0 Earlier agreements

RAN1 has made the following agreements for UE BB bandwidth reduction [4]:

|  |
| --- |
| **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**Conclusion:For UE BB complexity reduction, broadcast of separate SIB1/OSI (PDSCH) to Rel-18 RedCap UEs is not supported.Agreement:* 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.

**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.**Msg2 bandwidth, Msg2-Msg3 timeline, and Msg1 indication**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

Agreement:* For the “FFS: value(s) of X”,
	+ X = 1/0.5 ms for 15/30 kHz SCS
* Legacy default TDRA table and Δ are reused.
* A network-configurable additional separate early indication in Msg1 for Rel-18 eRedCap UEs is supported.
	+ When Msg1 indication for Rel-18 eRedCap UEs is configured, it is used by Rel-18 eRedCap UEs (with or without UE BB bandwidth reduction).
* When Msg1 indication for Rel-18 eRedCap UEs is not configured while Msg1 indication for Rel-17 RedCap UEs is configured, Rel-18 eRedCap UEs shall share the PRACH that is configured for Rel-17 RedCap UEs.
	+ Note: Rel-18 eRedCap UEs will be differentiated from Rel-17 RedCap UEs based on Msg3 of Rel-18 eRedCap UEs.
* Additional early indication in MsgA PRACH is not supported.

Agreement:* For UE BB bandwidth reduction, the same timeline relaxation as for the Msg2-Msg3 timeline applies at least for the following cases:
	+ Case 4a: Between reception of RAR PDSCH in which UE does not correctly receive the transport block and upcoming transmission of PRACH
	+ Case 4b: Between reception of RAR with RAPID which is not associated with the corresponding PRACH transmission and upcoming transmission of PRACH

**Msg4 bandwidth**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.

Agreement:Final LS [R1-2304262](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_112b-e/Docs/R1-2304262.zip) is endorsed.**MsgB bandwidth and timeline**Agreement:For UE BB bandwidth reduction, for 2-step RACH, assuming that MsgA PUSCH indication is transmitted:* The bandwidth of a MsgB scheduled with MSGB-RNTI should be limited in a similar way as Msg2.
	+ The same timeline relaxation as for the Msg2-Msg3 timeline (i.e., 1 slot for Msg2 PDSCH larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS) applies at least for the following cases:
		- Case 2a: Between reception of fallbackRAR and transmission of Msg3
		- Case 2b: Between reception of successRAR and transmission of corresponding HARQ-ACK
* The bandwidth of a MsgB scheduled with C-RNTI should be limited in a similar way as Msg4.

**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.Conclusion:For UE BB bandwidth reduction, for autonomous SI acquisition, the following paragraph in TS 38.214 clause 5.1 still applies:* “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.”
* FFS: Msg4 PDSCH scheduled by TC-RNTI case

Agreement:* For UE BB complexity reduction, for RRC\_IDLE and RRC\_INACTIVE, there is no need to relax the requirements on simultaneous reception of two PDSCH transmissions for SIB1 / OSI / paging / RAR / Msg4 scheduled by TC-RNTI for the case when Msg4 PDSCH is not larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.
* Note: This means that the following paragraph in TS 38.214 clause 5.1 still applies for the case when Msg4 PDSCH is not larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS:
	+ “The UE in RRC\_IDLE and RRC\_INACTIVE 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.”

Agreement:Down-select between these options for handling of simultaneous reception during P-RNTI triggered SI acquisition when the total number of PRBs for the PDSCH scheduled with SI-RNTI and the PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI is larger than the maximum number of PRBs that the UE can process per slot.* Option 2: The UE may skip decoding of PDSCH [in slot n or n+1] scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI but decodes SI PDSCH triggered by P-RNTI in slot n.
* Option 3: The prioritization between reception of PDSCH scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI and SI PDSCH triggered by P-RNTI is up to the UE implementation.
* Option 4: During a process of P-RNTI triggered SI acquisition, the UE is not expected to [be scheduled PDSCH/to decode PDSCH scheduled] with C-RNTI/MCS-C-RNTI/CS-RNTI if in the same cell, another PDSCH scheduled with SI-RNTI partially or fully overlap in time.
* Option 7: No specification change
 |

2.1 Random access timeline

RAN1 has made several agreements related to random access timeline relaxation. For details, see agreements listed under headings *‘Msg2 bandwidth, Msg2-Msg3 timeline, and Msg1 indication’* and *‘MsgB bandwidth and timeline’* in the above Section 2.0. The discussion is captured in Section 2.1 in the RAN1#113 FLS [3].

It has been agreed that the following cases should have similar timeline relaxation as the Msg2-Msg3 timeline:

* Case 2a: Between reception of fallbackRAR and transmission of Msg3
* Case 2b: Between reception of successRAR and transmission of corresponding HARQ-ACK
* Case 4a: Between reception of RAR PDSCH in which UE does not correctly receive the transport block and upcoming transmission of PRACH
* Case 4b: Between reception of RAR with RAPID which is not associated with the corresponding PRACH transmission and upcoming transmission of PRACH

Contributions [13, 20, 29, 32, 34] propose similar timeline relaxation for a few additional cases. The following proposed additional cases come from contribution [13]:

* Case 2c: Between reception of MsgB PDSCH scheduled by MSGB-RNTI in which UE does not correctly receive the transport block in the corresponding PDSCH within the window and transmission of only PRACH according to Type-1 random access procedure or to transmit both PRACH and PUSCH according to Type-2 random access procedure.
* Case 2d: Between reception of MsgB PDSCH scheduled by MSGB-RNTI with RAPID which is not associated with the corresponding PRACH transmission from the UE and transmission of only PRACH according to Type-1 random access procedure or to transmit both PRACH and PUSCH according to Type-2 random access procedure.

Companies are invited to comment on the following questions.

**FL1 High Priority Question 2.1-1a: Should the same timeline relaxation as for the Msg2-Msg3 timeline be used for Case 2c/2d above? If the answer is no, please elaborate in the comment field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y |  |
| ZTE, Sanechips | Y |  |
| Nordic  | Y |  |
| QC | YES |  |
| CATT | Y |  |
| Panasonic | Y |  |
| MTK | Y |  |
| Spreadtrum | Y |  |
| DOCOMO | Y |  |
| Nokia, NSB | Y |  |
| Ericsson | Y |  |
| LG  | Y | The previous agreements of 4-step RACH should be applied for the same cases of 2-step RACH. |
| Xiaomi1 | Y |  |

**FL1 Medium Priority Question 2.1-2a: Are there additional cases (other than Case 2c/2d) that should use the same timeline relaxation as the Msg2-Msg3 timeline? Please elaborate in the comment field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| LG  | N | In our view, there are no additional cases other than Case 2c/2d.  |
|  |  |  |
|  |  |  |

2.2 Simultaneous reception

RAN1 has made several agreements related to simultaneous reception of more than one PDSCH. For details, see agreements listed under heading *‘Simultaneous reception’* in the above Section 2.0. The discussion is captured in Section 2.2 in the RAN1#113 FLS [3].

### Autonomous SI acquisition

There is an FFS regarding Msg4 in the following conclusion for simultaneous reception during autonomous SI acquisition:

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| --- |
| Conclusion:For UE BB bandwidth reduction, for autonomous SI acquisition, the following paragraph in TS 38.214 clause 5.1 still applies:* “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.”
* FFS: Msg4 PDSCH scheduled by TC-RNTI case
 |

Contributions [13, 17] argue that there is no remaining issue and that the FFS can be considered resolved.

**FL1 Medium Priority Question 2.2.1-1a: Can the FFS be considered resolved? If the answer is no, please elaborate in the comment field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y | For RRC\_CONNECTED UE performing contention-based RACH, in Msg3 transmission, the C-RNTI MAC CE will be included in Msg3, and based on following TS 38.321, the Msg4 becomes a PDCCH carrying a UL grant which is scheduled by the C-RNTI. There is no Msg4 PDSCH for such case.**TS 38.321 5.1.5 Contention Resolution**Once Msg3 is transmitted the MAC entity shall:1> if notification of a reception of a PDCCH transmission of the SpCell is received from lower layers: -------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------2> if the C-RNTI MAC CE was included in Msg3: 3> if the Random Access procedure was initiated for SpCell beam failure recovery or for beam failure recovery of both BFD-RS sets of SpCell (as specified in clause 5.17) and the PDCCH transmission is addressed to the C-RNTI; or3> if the Random Access procedure was initiated by a PDCCH order and the PDCCH transmission is addressed to the C-RNTI; or 3> if the Random Access procedure was initiated by the MAC sublayer itself or by the RRC sublayer and the **PDCCH transmission is addressed to the C-RNTI and contains a UL grant for a new transmission**: 4> consider this Contention Resolution successful; 4> stop ra-ContentionResolutionTimer; 4> discard the TEMPORARY\_C-RNTI; 4> consider this Random Access procedure successfully completed |
| ZTE, Sanechips |  | In our initial understanding, the C-RNTI is not always carried via msg3 for contention-based RACH even in connected mode.Additionally, if FFS is removed, does it mean we do not need to consider this case? Or do we need another conclusion for SI colliding with msg3 scheduled by TC-RNTI. |
| Nordic  |  | Maybe would be worth to clarify how this works in legacy. Is legacy UE allowed to drop PDSCH with TC-RNTI while autonomously acquiring SI? I believe no reasonable UE would do such thing, if being in process of initial access waiting for MSG4. -> maybe no need to specify, if legacy NR managed without this case. |
| CATT | Y | In addition to vivo, we think the most important point of the original statement is that the autonomous SI acquisition does not impact unicast PDSCH reception in RRC\_CONNECTED mode. Even if TC-RNTI may be used in RRC\_CONNECTED mode (though we still do not spot this case), this seems not a new issue for normal UE, i.e. no spec handling for normal UE. Then we don’t need one for eRedCap, either. |
| Spreadtrum | Y |  |
| DOCOMO | Y |  |
| Nokia, NSB | Y |  |
| Ericsson | Y |  |
| LG | Y | In our view, there are no remaining issue on Autonomous SI acquisition. |
| Xiaomi1 | Y | In our view, the following conclusion aims to describe the overlapping between two PDSCHs. During RRC\_CONNECTED states, the Msg4 is only scheduled by DCI with CRC scrambled by C-RNTI, and there is no Msg4 scheduled by TC-RNTI.

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| Conclusion:For UE BB bandwidth reduction, for autonomous SI acquisition, the following paragraph in TS 38.214 clause 5.1 still applies:* “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.”
* FFS: Msg4 PDSCH scheduled by TC-RNTI case
 |

For overlapping reception between Msg4 and SI PDSCHs during RRC\_IDLE or RRC\_INACTIVE states, we already have the following agreement:

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| --- |
| Agreement:* For UE BB complexity reduction, for RRC\_IDLE and RRC\_INACTIVE, there is no need to relax the requirements on simultaneous reception of two PDSCH transmissions for SIB1 / OSI / paging / RAR / Msg4 scheduled by TC-RNTI for the case when Msg4 PDSCH is not larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.
* Note: This means that the following paragraph in TS 38.214 clause 5.1 still applies for the case when Msg4 PDSCH is not larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS:
	+ “The UE in RRC\_IDLE and RRC\_INACTIVE 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.”
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Therefore, there is no need to discuss TC-RNTI case anymore.  |

### P-RNTI triggered SI acquisition

RAN1#113 agreed to down-select between the following options for handling of simultaneous reception during P-RNTI triggered SI acquisition [3].

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| --- |
| Agreement:Down-select between these options for handling of simultaneous reception during P-RNTI triggered SI acquisition when the total number of PRBs for the PDSCH scheduled with SI-RNTI and the PDSCH scheduled with C-RNTI, MCS-C-RNTI, or CS-RNTI is larger than the maximum number of PRBs that the UE can process per slot.* Option 2: The UE may skip decoding of PDSCH [in slot n or n+1] scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI but decodes SI PDSCH triggered by P-RNTI in slot n.
* Option 3: The prioritization between reception of PDSCH scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI and SI PDSCH triggered by P-RNTI is up to the UE implementation.
* Option 4: During a process of P-RNTI triggered SI acquisition, the UE is not expected to [be scheduled PDSCH/to decode PDSCH scheduled] with C-RNTI/MCS-C-RNTI/CS-RNTI if in the same cell, another PDSCH scheduled with SI-RNTI partially or fully overlap in time.
* Option 7: No specification change
 |

The contributions submitted to this meeting express the following preferences:

* **Option 2:**
	+ 1st choice: [9, 12, 13, 18, 19, 20, 25, 27, 28, 33, 34]
	+ 2nd choice: [15, 23]
* **Option 3:**
	+ 1st choice: –
	+ 2nd choice: [13, 15, 23, 24]
* **Option 4:**
	+ 1st choice: [14, 15, 27]
	+ 2nd choice: [13, 17]
* **Option 7:**
	+ 1st choice: [10, 11, 17, 21, 22, 23, 24, 26, 29, 31, 32]
	+ 2nd choice: [9]

The following should be noted:

* For Options 2 and 4, different views are expressed regarding how to resolve the square brackets.
* For Options 2 and 3, [23] proposes to clarify that UE transmits NACK when it cannot decode unicast.
* For Option 3, [13] proposes to clarify whether the UE can drop both unicast PDSCH and SI PDSCH.

In the following question, the options have been updated in an attempt to address the above comments.

**FL1 High Priority Question 2.2.2-1a: Companies are invited to give each one of the following options a grade:**

* **Option 2a:**
	+ **The UE may skip decoding of PDSCH in slot n scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI but decodes SI PDSCH triggered by P-RNTI in slot n. In this case, the UE transmits NACK.**
* **Option 2b:**
	+ **The UE may skip decoding of PDSCH in slot n or n+1 scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI but decodes SI PDSCH triggered by P-RNTI in slot n. In this case, the UE transmits NACK.**
* **Option 2c:**
	+ **The UE may skip decoding of PDSCH in slot n+1 scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI but decodes SI PDSCH triggered by P-RNTI in slot n. In this case, the UE transmits NACK.**
* **Option 3:**
	+ **The prioritization between reception of PDSCH scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI and SI PDSCH triggered by P-RNTI is up to the UE implementation. In this case, the UE receives at least one of them. If the UE does not receive the PDSCH scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI, it transmits NACK.**
* **Option 4a:**
	+ **During a process of P-RNTI triggered SI acquisition, the UE is not expected to be scheduled PDSCH with C-RNTI/MCS-C-RNTI/CS-RNTI if in the same cell, another PDSCH scheduled with SI-RNTI partially or fully overlap in time.**
* **Option 4b:**
	+ **During a process of P-RNTI triggered SI acquisition, the UE is not expected to decode PDSCH scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI if in the same cell, another PDSCH scheduled with SI-RNTI partially or fully overlap in time.**
* **Option 7: No specification change**

**Please use the following grade scale (where there is no restriction on the number of times a grade can be used).**

* **+1 = preferred**
* **0 = neutral/ok**
* **-1 = not preferred**

|  |  |  |
| --- | --- | --- |
| **Company** | **Grade (+1/0/-1) for each one ofOptions 2a/2b/2c/3/4a/4b/7** | **Comments** |
| **2a** | **2b** | **2c** | **3** | **4a** | **4b** | **7** |
| Example | +1 | 0 | -1 | 0 | +1 | 0 | -1 |  |
| vivo | +1 | 0 | 0 | +1 | +1 | +1 | -1 | Option 7 is not preferred. It requests the eRedCap with BB BW reduction to decode both which beyond its capability.  |
| ZTE, Sanechips | +1 | +1 | +1 | -1 | 0 with update | 0 with update | -1 | We suggest to focus on option2 and option 7 firstly. It is quite diverge to select from all the detail options. If option2 is selected, then we can further discuss how to capture the details. Additionally, for option2, option2d can be considered:* **Option 2c:**
	+ **The UE may skip decoding of PDSCH in slot n and n+1 scheduled with C-RNTI/MCS-C-RNTI/CS-RNTI but decodes SI PDSCH triggered by P-RNTI in slot n. In this case, the UE transmits NACK.**

For option4a and 4b, we suggest to also make a update if option4 is further considered “**be scheduled PDSCH in slot n and slot n+1” or “decode PDSCH in slot n and n+1”** |
| Nordic | 1 | 1 | 1 | -1 | 0 | 0 | -1 |  |
| QC | -1 | -1 | -1 | -1 | -1 | -1 | +1 | Option 2b: the intention seems excluding unicast in both slot n and n+1. If so, the wording should be “**in slot n and n+1**”.Option 4b: what is the difference between 4b and 2a? Can FL please clarify? |
| CATT | -1 | -1 | -1 | -1 | -1 | 0 | 1 | In any case it is always possible that a UE does not correctly receive unicast PDSCH and provide NACK. The R18 RedCap UE can do so without spec change.Reusing FR2 rule may be acceptable. |
| Panasonic | 0 | 0 | 0 | 0 | 1 | 1 | -1 | Options 2a/2b/2c are OK. But we would not support to skip both unicast in slot n and n+1. The UE would be able to decode one of them since the SI does not require the immediate decoding. |
| MediaTek | +1 | +1 | +1 | +1 | 0 | 0 | -1 | It seems 2b should slot n *and* (instead of *or*) slot n+1  |
| Spreadtrum | -1 | -1 | -1 | 0 | -1 | -1 | +1 |  |
| FUTUREWEI | +1 | 0 | 0 | -1 | -1 | -1 | 0 |  |
| DOCOMO | 0 | -1 | -1 | 0 | -1 | -1 | +1 | In our understanding, for option 2a/2b/2c/3, there is a possibility that unicast PDSCH is scheduled in the same time domain resource with SI PDSCH and a UE may be able to decode both unicast PDSCH and SI PDSCH depending on the UE implementation. For this case, if the UE skip decode/reception of the unicast PDSCH, NACK should be transmitted to avoid misalignment of HARQ codebook. On the other hand, for option 4a and possibly for option 4b, it is not allowed that unicast PDSCH is scheduled in FDMed resource with SI PDSCH. |
| Sharp | -1 | -1 | -1 | -1 | 0 | -1 | 1 |  |
| Nokia, NSB | -1 | -1 | -1 | -1 | -1 | -1 | +1 |  |
| Ericsson | 0, but see comment | +1, but see comment | -1 | -1 | -1 | -1 | 0 | In general, we prefer Option 2. However, we think it’s important to first have consensus on what the legacy Capability 2 behavior (~ Option 2) is, and in particular, whether the UE is expected to NACK. If the legacy UE is not expected to send NACK, an eRedCap UE should not be expected to send NACK.Our understanding of the legacy behavior is that the UE is expected to send NACK only for Type-1 HARQ codebook.  |
| DENSO | +1 | +1 | +1 | -1 | 0 | +1 | 0 | We prefer Option 2a or 2b/2c with “**in slot n and n+1**”. For Option 4, we prefer 4b which reuse FR2 rules. Option 7 is also acceptable. |
| LG  | -1 | -1 | -1 | -1 | -1 | 0 | +1 | Option 7 is firstly preferred; we can also consider Option 4b.  |
| Xiaomi1 | -1 | -1 | -1 | -1 | -1 | -1 | +1 | We can’t see any difference between option 4b and 2a. Besides, we have one question on “**The UE may skip decoding of PDSCH in slot n**”. Does it mean that “The UE also may not skip decoding of PDSCH in slot n”? If so, the UE can also indicate ACK to the gNB. |

### Msg2/MsgB reception

Contributions [13, 15, 17, 18, 20, 23, 32, 34] discuss prioritization of Msg2/MsgB PDSCH over another PDSCH. The following proposal from contribution [34] can be considered.

**FL1 Medium Priority Proposal 2.2.3-1a: If a PDSCH is scheduled with RA-RNTI or MSGB-RNTI in slot n, UE is not expected to decode another PDSCH scheduled with C-RNTI, SI-RNTI, MCS-C-RNTI, G-RNTI for multicast or broadcast, MCCH-RNTI, G-CS-RNTI or CS-RNTI,**

* in the same slot (i.e., slot n) if the PDSCH scheduled with RA-RNTI or MSGB-RNTI is not greater than 25/12 PRBs with 15/30kHz SCS,
* in slots n and n+1 if the PDSCH scheduled with RA-RANTI or MSGB-RNTI is greater than 25/12 PRBs with 15/30kHz SCS.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y with update | Suggest following change for the 1st sub-bullet* **in the same slot (i.e., slot n) if the PDSCH scheduled with RA-RNTI or MSGB-RNTI is partially or fully overlap in time ~~not greater than 25/12 PRBs with 15/30kHz SCS~~,**
 |
| ZTE, Sanechips | Y | The original version is better, since overlapping does not mean UE can not process especially when the PRB number does not exceed the limitation. |
| Nordic | Y |  |
| QC |  | We support the spirit of this proposal. But we don’t support the proposal in its current formulation. We think in a same slot n, UE is not expected to decode unicast PDSCH, if NW schedule Msg2/MsgB. But we don’t see the need to exclude unicast in next slot n+1. Therefore, we support the following updated proposal.**Updated Medium Priority Proposal 2.2.3-1a: If a PDSCH is scheduled with RA-RNTI or MSGB-RNTI in slot n, UE is not expected to decode another PDSCH scheduled with C-RNTI, SI-RNTI, MCS-C-RNTI, G-RNTI for multicast or broadcast, MCCH-RNTI, G-CS-RNTI or CS-RNTI,*** ~~in the same slot (i.e., slot n) if the PDSCH scheduled with RA-RNTI or MSGB-RNTI is not greater than 25/12 PRBs with 15/30kHz SCS,~~
* ~~in slots n and n+1 if the PDSCH scheduled with RA-RANTI or MSGB-RNTI is greater than 25/12 PRBs with 15/30kHz SCS.~~
 |
| CATT | N | For the 1st bullet, if the PDSCH scheduled with RA-RNTI or MSGB-RNTI is not greater than 25/12 PRBs with 15/30kHz SCS, what is the difference between R18 RedCap UE case and Rel-17 RedCap UE? Why we put restriction only for R18 RedCap UE but not R17?For the 2nd bullet, the Msg3 scheduling timeline is already relaxed. |
| MediaTek | Y |  |
| FUTUREWEI |  | Can the proposal be rephrased (it seems both bullets are applicable for the same slot)**If a PDSCH is scheduled with RA-RNTI or MSGB-RNTI in slot n, UE is not expected to decode another PDSCH scheduled with C-RNTI, SI-RNTI, MCS-C-RNTI, G-RNTI for multicast or broadcast, MCCH-RNTI, G-CS-RNTI or CS-RNTI,*** in the same slot (i.e., slot n) ~~if the PDSCH scheduled with RA-RNTI or MSGB-RNTI is not greater than 25/12 PRBs with 15/30kHz SCS~~,

in slot~~s n and~~ n+1 if the PDSCH scheduled with RA-RANTI or MSGB-RNTI is greater than 25/12 PRBs with 15/30kHz SCS. |
| DOCOMO | N | The current spec as below is sufficient.

|  |
| --- |
| 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. |

The processing time of RAR PDSCH would be extended when the number of PRBs for the PDSCH exceed 5MHz and not tight. Thus, we don’t see the need to restrict the scheduling in n+1 slot. |
| Ericsson | Y | Also fine with Qualcomm’s revision |
| LG | N | We don’t think there is a need for spec update for this. So far, we have not considered n+1 slot for decoding in simultaneous reception. |
| Xiaomi1 |  | In the current spec in TS 38.214 Clause 5.1, it only states the case of simultaneous reception between RAR/MsgB PDSCH and unicast/MBS PDSCH.

|  |
| --- |
| 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.  |

So, just as legacy UE behavior, we can’t see any problem to schedule both PDSCH scheduled by RA-RNTI and PDSCH scheduled by C-RNTI in the same slot without any overlapping if the RAR or MsgB PDSCH is not lager than 25/12 PRBs. So, for the first sub-bullet, we suggest to modify as follows:* partially or fully overlap in time ~~in the same slot (i.e., slot n)~~ if the PDSCH scheduled with RA-RNTI or MSGB-RNTI is not greater than 25/12 PRBs with 15/30kHz SCS,

That is to say, the same rule can be used between eRedCap supporting 48-1 and non-eRedCap for the case of RAR/MsgB PDSCH not larger than 25/12 PRBs.For the second sub-bullet, except for the overlapping between RAR/MsgB PDSCH and unicast/MBS PDSCH, other broadcast channels with larger than 25/12 PRBs, such as SIB1, OSI, paging and so on, should also be revisited whether there is a need to further define the UE behavior in the “slot n+1”. |

### 2.2.4 MBS reception

Contributions [29, 32] discuss simultaneous reception or prioritization of MBS PDSCH and another PDSCH.

**FL1 Low Priority Question 2.2.4-1a: Should the UE receive MBS PDSCH and another PDSCH simultaneously under some circumstances? If the answer is yes, please comment on those circumstances in the comment field? If the answer is no, please comment on how the UE should prioritize between the two PDSCHs.**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| QC | Yes | On high level, we think reception of MBS PDSCH + unicast PDSCH is similar to reception of SIB/Paging + unicast PDSCH. Therefore, this functionality should be supported. There could be some minor differences such as multicast could be with >1 MIMO and higher than 64QAM, where SIB/Paging could not. Those secondary points can be discussed.  |
| DOCOMO |  | Need clarification whether/how to support but can be discussed after the progress in section 2.4. |
| LG | Yes | We think that if UE supports fdm-BroadcastUnicast-r17 or fdm-MulticastUnicast-r17 in RRC CONNECTED in a slot are partially or fully overlapping in time domain and non-overlapping in frequency domain, this issue need to be discussed at some point of time within Rel-18.Suggestion from DOCOMO is fine. |

2.3 Msg3/MsgA PUSCH bandwidth

Contributions [17, 21, 22, 23, 28, 29, 32, 31] discuss what the UE behaviour should be if Msg3/MsgA PUSCH is scheduled with more than 25 PRBs for 15 kHz SCS or more than 12 PRBs for 30 kHz SCS.

**FL1 Medium Priority Question 2.3-1a: Companies are invited to express their preference regarding the UE behavior for the potential case that MsgA PUSCH is scheduled with more than 25 PRBs for 15 kHz SCS or more than 12 PRBs for 30 kHz SCS.**

* **Option 1: The UE occupies a portion of PRBs within one legacy MsgA PUSCH occasion.**
* **Option 2: The UE has a separate MsgA PUSCH frequency domain resource configuration.**
* **Option 3: The UE falls back to 4-step RACH procedure.**
* **Option 4: No need to specify UE behavior (please elaborate in the comment field on what this means).**

**This question focuses on MsgA PUSCH, but if your answer is relevant also for Msg3 PUSCH, please indicate it in the comment field.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option(s)** | **Comments** |
| vivo | Opt.4 | Early indication in Msg.A PUSCH for Rel-18 eRedCap is supported. gNB will not configure the PRBs Msg.A PUSCH for Rel-18 eRedCap lager than 25/12 PRBs for 15/30 kHz SCS. |
| Nordic  | Op. 4 | to us this seems an error case which should not happen |
| QC | Option 4 | It was agreed PR3 UE’s UL PUSCH cannot exceed 5Mhz. It is NW’s responsibility to make sure the scheduled/configured Msg3/MsgA transmission is within 5Mhz.  |
| CATT | 4 | Option4, R18 RedCap UE does not expect this case. |
| MediaTek | 4 |  |
| DOCOMO | Opt.4 | Similar view with vivo. eRedCap UE does not expect that MsgA is scheduled with larger BW than 5MHz. But we are open to discuss other options. |
| Sharp |  | For a eRedcap UE mac entity , if no separate eRedCap feature indication, it may check if a 2-step resource for redcap is available by considering its bandwidth. RAN1 should define a clear behavior for further RAN2 discussion. So option4 should be prcluded and option 1/2/3 can be considered furtherly.  |
| Nokia, NSB | 4 | We agree with other companies that this is not expected by the UE |
| Ericsson | Option 4 (in RAN1) | Can be up to RAN2 to specify UE behavior, if needed.  |
| LG | Option 3 | When it comes to Msg3 PUSCH bandwidth, some exceptional cases can be considered without early indication. Especially, because the early indication is not supported in 2-step RACH, gNodeB does not have the way how to check whether UEs is Rel-18 eRedCap or not, when Msg A PUSCH is not decoded successfully. |
| Xiaomi1 | 4 | For the MsgA PUSCH channel bandwidth, we have the following agreements.

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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. |

In our view, the above agreement just mean that 2-step RACH will not be performed for the case of MsgA PUSCH with larger than 25/12 PRBs. Actually, there is no spec impact in RAN1 but it may have some MAC spec impact in RAN2. So, we suggest to send the related LS to RAN2 to take above agreement into consideration when performing RACH procedure. |

2.4 MBS PDSCH bandwidth

Contributions [9, 12, 13, 14, 15, 17, 18, 20, 21, 22, 23, 27, 29, 31, 32] discuss the maximum bandwidth for various MBS PDSCH cases.

**FL1 Medium Priority Question 2.4-1a: Companies are invited to comment on whether the UE should support that the following cases are scheduled in DCI with a number of PRBs larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.**

* **Case 1: Broadcast MBS PDSCH**
	+ **Case 1a: Without PDSCH in consecutive slots and without PDSCH repetition**
	+ **Case 1b: With PDSCH in consecutive slots and/or with PDSCH repetition**
* **Case 2: Multicast MBS PDSCH**
	+ **Case 2a: Without HARQ feedback**
	+ **Case 2b: With HARQ feedback**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Case 1a and Case 1b: YesCase 2a and Case 2b: No, given Multicast MBS PDSCH targets for connected UEs |
| ZTE, Sanechips | We are OK to discuss the MBS. However, since we actually have not the clear support for MBS in Rel-17 RedCap, if Rel-18 RedCap UE support MBS, does it mean Rel-17 RedCap UE also support it and the specification change also should be considered if needed? |
| Nordic  | Case 1a we can consider, but the rest of cases answer is NO, because this case would result in increase of UE’s complexity.  |
| QC | Case 1a: # PRBs can be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCSCase 1b: # PRBs cannot be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCSCase 2a: We think the formulation of this case is not good enough. We should differentiate two sub-cases under 2a, one is with PDSCH repetition, and one is without PDSCH repetition. * Case 2a1: without HARQ feedback and without PDSCH repetition: # PRBs can be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS
* Case 2a2: without HARQ feedback but with PDSCH repetition: # PRBs cannot be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS

Basically, case 2a1 is similar to case 1a. Case 2a2 is similar to case 1b. Case 2b: # PRBs cannot be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS |
| CATT | Case 1a: YCase 1b: YCase 2a: N, (this would lead to obvious performance and poor QoS)Case 2b: N, (eRedCap UE is not able to feedback with legacy PUCCH timeline, but we cannot extend timeline in this case).  |
| FUTUREWEI | R17 redcap UE can indicate support of MBS, by default R18 redcap can also do soThe RedCap UE can receive broadcast MBS in the CONNECTED state. There may have to be restrictions. To avoid all these complications/exception cases, a simple rule should apply: # PRBs cannot be larger than 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS |
| DOCOMO | Case 1: Yes. RNTI which schedules broadcast MBS PDSCH would be shared with legacy UEs and thereis no corresponding UL transmission for the PDSCH. Therefore, the same principle as SI PDSCH or paging PDSCH can be applied.Case 2: No. G-RNTI and G-CS-RNTI can be configured separately between legacy UEs and eRedCap UEs. Therefore, even if the number of PRB is restricted for eRedCap, multicast MBS PDSCH can be scheduled without any restriction on BW. In addition, even when the HARQ feedback is disabled, HPN field is included in DCI, and hence NW needs to know when the HPN can be reused. In the current specification for NTN, when the HARQ feedback is disabled, the HPN can be reused after Tproc,1, i.e., there is processing time requirement even when the HARQ feedback is disabled. Therefore, if larger number of PRB allocation than 5MHz is allowed, this processing time requirement needs to be extended similar to RAR PDSCH processing. |
| Sharp | for broadcast MCCH , it is ok for case1a/1b.for broadcast MTCH, case 1a is ok. |
| Nokia, NSB | Case 1a and 1b: YesCase 2a: Yes. However, we don’t have strong view on this one and would be fine to go with No if that is the majority view.Case 2b: No |
| Ericsson | Larger than 25/12 PRBs: Cases 1aNot larger than 25/12 PRBs: Case 2bNo strong preference for 1b and 2a |
| DENSO | Case 1a and Case 1b: YesCase 2a and Case 2b: NoAs QC pointed out, if there is concern about repetition case, we prefer to focus on the repetition case of broadcast and multicast in RRC\_INACTIVE (Case 1b and 2a2) firstly, and then clear the HARQ case of multicast in RRC\_CONNECTED. |
| LG | Broadcast MBS PDSCH can be scheduled lager than 5MHz BW regardless of Case1a or Case 1b. Multicast MBS PDSCH without HARQ feedback (Case 2a) can be scheduled lager than 5Mhz BW similar to the Broadcast MBS PDSCH, but the multicast MBS PDSCH with HARQ feedback (Case 2b) should not be scheduled lager than 5Mhz BW, i.e., should be regarded the same as unicast PSCH. |
| Xiaomi1 | Case 1a: YCase 1b: YCase 2a: Y. We can’t observe the performance degradation with lager than 25/12 PRBs for multi-cast PDSCH since the soft combination can be performed just like other broadcast channels. Case 2b: No.  |

# 3 UE peak data rate reduction

3.0 Earlier agreements

RAN1 has made the following agreements for UE peak data rate reduction [4]:

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| Agreement:* UE peak data rate reduction is supported at least as an add-on to UE BB bandwidth reduction,
	+ The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ X.
	+ FFS: the value of X
* If UE peak data rate reduction is supported as a standalone feature,
	+ The constraint *vLayers*·*Qm*·*f* ≥ 4 is relaxed to *vLayers*·*Qm*·*f* ≥ Y.
	+ FFS: the value of Y
	+ Note: Whether this option is supported will be decided in RAN plenary.

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

Agreement:* For UE peak data rate reduction with UE BB bandwidth reduction,
	+ The 10-Mbps peak rate target corresponds to a *vLayers*·*Qm*·*f* of 3.2
* For UE peak data rate reduction without UE BB bandwidth reduction,
	+ The 10-Mbps peak rate target corresponds to a *vLayers*·*Qm*·*f* of 0.75
	+ This is assuming 20 MHz bandwidth in the 38.306 peak rate expression.
* Note: This does not imply that downlink MIMO and 256 QAM are not supported
 |

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 [5], where the different nicknames for the UE complexity reduction features (“PR1” and “BW3/PR3”) originate from TR 38.865 [6].

|  |
| --- |
| **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., 10 Mbps**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
 |

RAN#100 endorsed this working assumption regarding the peak data rate. The moderator summary can be found in [7].

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| Conclusion: Working assumption: The peak rate target is 10 Mbps regardless of what optional features the UE may support. (i.e., WGs can progress on this topic based on this assumption).No consensus about Proposal 3-3b. Revised WID will be handled in RAN #101. |

3.1 Relaxed constraints

Contributions [9, 11, 12, 14, 15, 16, 17, 18, 19, 21, 22, 24, 25, 27, 28, 30, 32, 33, 34] discuss the relaxed constraints for peak data rate reduction.

* For UE peak data rate reduction without UE BB bandwidth reduction, several contributions, e.g., [9, 11, 17, 19, 22, 32, 34], note that the agreed *vLayers*·*Qm*·*f* value of 0.75 is feasible and achieves 10 Mbps for the non-MIMO case but less suitable in the MIMO case. In the MIMO case, existing (*vLayers, Qm, f*) values can achieve a *vLayers*·*Qm*·*f* value of 0.8 (which corresponds to a peak data rate slightly higher than 10 Mbps) but not 0.75 (without introducing a new *scalingFactor (f)* value).
* Several contributions [11, 12, 16, 18, 21, 30] express that since the peak data rate is fixed, some or all of the existing peak data rate related parameters (*vLayers, Qm, f*) may not be needed.
* Some contributions [19, 24, 25, 34] note that this topic is related to whether optional features (MIMO, 256QAM, *scalingFactor (f)* values lower than 1) are supported. This question is discussed in Section 3.2.

Companies are invited to comment on the following question. Note that combinations with optional features is treated separately in Section 3.2 in this document.

**FL1 High Priority Question 3.1-1a: Assuming a fixed peak data rate (10 Mbps), do you agree that the UE does not need to signal some or all existing peak data rate related parameters (*vLayers, Qm, f*)? Please elaborate.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y |  |
| ZTE, Sanechips |  | If the UE does not report this, it seems to change the legacy behavior and also has impacts on RAN2. alternatively, supporting a peak data rate larger than 10Mpbs or not supporting 2DL MIMO layers could be the candidates options. |
| Nordic | Y | if peak rate is THE peak rate, RAN2 can easily hard-code values for ***vLayers, Qm, f*** foreRedCap. Alternatively, RAN2 can restrict values that are allowed to be reported by eRedcap.  |
| QC | No | We still prefer UE follow the unified reporting framework to report all parameters ***vLayers, Qm, f.*** A new f=0.375 can be introduced for vLayers =2 |
| CATT |  | We slightly prefer not to change legacy bebavior. RedCap UE shall report v, Q, f as legacy UE. |
| Panasonic | Y | The reporting parameters of ***Qm, f*** are both optional since Rel-15, thus omitting the reporting would not impact RAN2. |
| MediaTek |  | We would like to clarify a question first. Question: For a band with a (maximum) CBW of 5MHz (with 25 PRBs with 15kHz), what is the v\*Q\*f value that a PR1 UE should indicate in order to support 10Mbps? Is it still 0.75? Or it should be around 0.75\*(106/25) ~= 1.0 instead?  |
| Spreadtrum | No | We also still prefer UE to report all parameters ***vLayers, Qm, f.***  |
| FUTUREWEI |  | We understand the spirit of the proposal but we would like to avoid changing legacy signaling from the RAN1 perspective. |
| DOCOMO |  | It should be clarified how the NW can know the exact peak rate of an eRedCap UE without reporting *Qm* and *f*. is the peak rate would be the value when *vLayers, Qm, f* is 0.75 for UE without BB BW reduction and the value when *vLayers, Qm, f* is 3.2 for UE with BB BW reduction? |
| Nokia, NSB |  | We think that it not be necessary for UE to signal Qm and f. However, we don’t have a strong view and would be fine with keeping legacy procedure. |
| Ericsson | Y |  |
| LG | Y |  |
| Xiaomi1 | Y in general  | Considering that *a* fixed peak data rate is specified, there is no need to use the formula to calculate anymore. So, *Qm and f* shouldn’t to be report. But, *vLayer****s*** needs to be reported to indicate the maximum supported MIMO layers. The first two parameters are only used for peak data rate calculation. |

3.2 Combinations with optional features

Several contributions [12, 13, 18, 24, 27, 34] discuss combinations with optional features, especially MIMO and 256QAM. Contribution [12] also suggests allowing a 2-Rx UE without MIMO, since the MIMO support may not provide much benefit for the UE due to the cap on the peak data rate (10 Mbps).

**FL1 High Priority Question 3.2-1a: Which ones (if any) of the following features should Rel-18 eRedCap UEs be able to support as optional features?**

* **Potential optional feature 1: 2 Rx branches with DL MIMO**
* **Potential optional feature 2: 2 Rx branches without DL MIMO**
* **Potential optional feature 3: DL 256QAM**

|  |  |  |
| --- | --- | --- |
| **Company** | **Potential optional feature(s)** | **Comments** |
| vivo | 1, 2 | We did not much see the need of supporting 256QAM. But we are fine with optionally supporting it.  |
| ZTE, Sanechips | 1, 2 |  |
| Nordic |  | We do not see a need to preclude those optional features. But baseline should remain as 1Rx and 64QAM.  |
| QC | Feature 1 and 3 | It seems not a correct statement that “MIMO support may not provide much benefit for the UE due to the cap on the peak data rate (10 Mbps)” In our view, 2Rx/2L MIMO have at least the following clear benefits. * 2Rx can support same data rate with lower SNR (3dB Rx combining gain), so there is clear benefit of 2 Rx.
* In terms of peak rate (or any data rate), 2L MIMO can support it with half bandwidth (by doubling spectrum efficiency). Hence there is clear benefit of 2L as well.

By the way, a regular UE can report DL MIMO layers 1,2,4,8. Not sure why we need restrict eRedcap UE’s MIMO capability reporting, if a UE can support 2L MIMO. Similar view on high mod order 256 QAM. Optional feature 1 and 3 should be supported with UE capability of course. We think the way to phrase question maybe should be flipped: what is the justification to restrict to only 1L given a 2Rx UE already implemented 2 Rx? |
| CATT | 1, 3 | In general we think it is up to UE to implement optional features. However, we have similar concern with QC for feature 2, but in a different angle: In R17, the max DL MIMO layer is aligned with Rx (so as the SIB1 cell bar indication for 2Rx UE). But now feature 2 is creating the case that UE’s max DL MIMO layer# is not aligned with SIB1 cell barring Rx#.  |
| Panasonic | None | Considering peak rate target 10 Mbps, the strong need is not seen to support the 2-Rx or 256QAM transmission. Also, allowing fewer types of UE (i.e., less variation of the capability) would help the cost reduction of the UE thanks to the economics of the scale. |
| Spreadtrum | 1, 3 |  |
| FUTUREWEI |  | The entire proposal is ill phrased. We do not need a positive agreement for Opts. 1 and 3 to continue to be optionally supported, that is already there by default. Opt. 2 on the other hand is a different behavior from rel-17 and we do not support it. |
| DOCOMO | 1,2,3 |  |
| Nokia, NSB | 1, 3 | We agree that 1 and 3 are already optionally supported per WID. We do not support 2. |
| Ericsson | 1, 2, 3 |  |
| DENSO | 1,3 |  |
| LG | 1, 3 | By default, we think that all features on Rel-18 eRedCap UEs can be supported optionally. We are open for further discussion on Option 2. |
| Xiaomi1 | 1,2,3 | Except for the BB bandwidth reduction and peak data rate reduction, there is no objective to relax other features on basis of RedCap in the Rel-18 eRedCap WID, so both option 1,2,3 can be optionally supported by the eRedCap.  |

# 4 Detailed spec text proposals

The submitted contributions bring up some specification text aspects not covered elsewhere in this document.

**FL1 Low Priority Question 4-1a: Should the following proposal be treated in this meeting?**

* **Contribution [**[**9**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306435.zip)**] proposes to revert clause 17.1 title in the 38.213 draft specification to “RedCap procedures” to reflect that the clause applies to both Rel-17 and Rel-18 RedCap UEs.**

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

**FL1 Low Priority Question 4-2a: Should the following proposal be treated in this meeting?**

* **Contribution [**[**24**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307554.zip)**] proposes to specify in 38.214 that the maximum 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS for PUSCH and PDSCH allocated to the 5MHz eRedCap UE should not be exceeded.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FUTUREWEI |  | We would like to avoid duplicating specifications  |
|  |  |  |
|  |  |  |

**FL1 Low Priority Question 4-3a: Should the following proposal be treated in this meeting?**

* **Contribution [**[**31**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307855.zip)**] provides a 38.213 TP for clarification of the random access timeline relaxation’s (i.e., X’s) dependency on the SCS.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| QC | Yes | This is a simple clarification which follow the legacy of existing specification.  |
| Sharp | Yes |  |
| LG | Yes | We share similar view with QC. |

# 5 Other aspects

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

**Common PUCCH**

* Consider enhancements of user multiplexing capacity for common PUCCH [23, 29].
* Do not think PUCCH will become the bottleneck during random access [22].
* Impacts would need to be carefully considered before deciding to do this [32].

**CSI reporting**

* Consider making PUCCH resources not necessary for CSI reports [8].
* Consider making CSI reporting optional in TDD systems [8].

**FDRA optimization**

* Discuss whether/how to use potential spare bits in FDRA field in RAR UL grant [10].
* For unicast, the FDRA indications and RBG sizes can be based on 5-MHz sub-bands [26].

**Frequency hopping**

* Support frequency hopping at least for unicast PUSCH [26].
* Study how to improve Msg3 frequency hopping range [28].

**HD-FDD scheduling**

* HD-FDD UE is capable of processing one additional unicast DCI scheduling PUSCH, as in TDD [33].

**Msg2-Msg3 timeline**

* Consider PUSCH TDRA in *pusch-ConfigCommon* specific to Rel-18 eRedCap UEs [12, 23].
* Consider additional timing extension for Msg3 to meet the minimal gap requirement [31].

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

**FL1 Medium Priority Question 5-1a: Is there a need to treat any of the issues listed above in this meeting?**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | N | This is last RAN1 meeting for the WI finalization, focus should be given for more essential issues.  |
| Nordic  | Y | HD-FDD aspect has close to zero spec impact and in our opinion is essential for having spectral efficient HD-FDD |
| CATT | N | We have more than 10 FL proposals to address in this meeting. |
| DOCOMO | Y | We prefer to consider common PUCCH capacity enhancement. The easiest way to ensure the common PUCCH capacity for non-RedCap, Rel-17 RedCap and Rel-18 eRedCap is to introduce additional PRB offset specific to Rel-18 eRedCap. However, it would cause PUSCH peak rate degradation for legacy UEs. Therefore, we prefer to consider two sequence generation without FH which can enables multiplexing with CS with non-RedCap UEs. |
| Nokia, NSB | N | We should prioritize FL proposals first before looking at these issues. |
| Ericsson | Y | **Msg2-Msg3 timeline**As analysed in [12], due to RAN1#113 decision to relax the Msg2-Msg3 timeline, scheduling flexibility of eRedCap UEs is significantly reduced. The scheduled flexibility can be improved by enabling the network to configure the relaxed timeline specifically for eRedcap UEs, i.e., by having a eRedCap-specific *PUSCH-TimeDomainResourceAllocationList* in *pusch-ConfigCommon* in SIB1. This allows for better scheduling flexibility for eRedcap UEs without impacting regular NR UEs or Rel-17 RedCap UEs. |
| Xiaomi1 | N | Share similar view with CATT that we may not have enough time to discuss it in this meeting. |

# References

|  |  |  |  |
| --- | --- | --- | --- |
| [1] | [RP-223544](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_98e/Docs/RP-223544.zip) | Revised WID on Enhanced support of reduced capability NR devices | Ericsson |
| [2] | [R1-2300177](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_112/Docs/R1-2300177.zip) | WI work plan for Rel-18 RedCap | Rapporteur (Ericsson) |
| [3] | [R1-2305959](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_113/Docs/R1-2305959.zip) | FL summary #4 on Rel-18 RedCap UE complexity reduction | Moderator (Ericsson) |
| [4] | [R1-2306261](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_113/Docs/R1-2306261.zip) | RAN1 agreements for Rel-18 NR RedCap | Rapporteur (Ericsson) |
| [5] | [RP-230778](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_99/Docs/RP-230778.zip) | Proposal for PR1 in eRedCap | Moderator (CMCC) |
| [6] | [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 |
| [7] | [RP-231488](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_100/Docs/RP-231488.zip) | Moderator summary #2 on Rel-18 eRedCap WID revisions | Moderator (Ericsson) |
| [8] | [R1-2306390](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306390.zip) | CSI report of Reduced Capability Devices | GDCNI |
| [9] | [R1-2306435](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306435.zip) | Discussion on R18 RedCap complexity | FUTUREWEI |
| [10] | [R1-2306529](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306529.zip) | Discussion on potential solutions to further reduce UE complexity | Huawei, HiSilicon |
| [11] | [R1-2306656](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306656.zip) | Discussion on enhanced support of RedCap devices | Spreadtrum Communications |
| [12] | [R1-2306683](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306683.zip) | Further RedCap UE complexity reduction | Ericsson |
| [13] | [R1-2306761](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306761.zip) | Discussion on further UE complexity reduction | Vivo |
| [14] | [R1-2306917](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306917.zip) | Redcap complexity reduction | Sony |
| [15] | [R1-2306996](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2306996.zip) | UE complexity reduction for eRedCap | Panasonic |
| [16] | [R1-2307002](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307002.zip) | Discussion on Rel-18 RedCap UE | NEC |
| [17] | [R1-2307098](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307098.zip) | Discussion on further complexity reduction for Rel-18 RedCap UE | CATT |
| [18] | [R1-2307138](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307138.zip) | Discussion on further UE complexity reduction | ZTE, Sanechips |
| [19] | [R1-2307206](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307206.zip) | Discussion on further reduced UE complexity | CMCC |
| [20] | [R1-2307289](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307289.zip) | Further RedCap UE complexity reduction | Apple |
| [21] | [R1-2307395](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307395.zip) | Discussion on further complexity reduction for eRedCap UEs | Xiaomi |
| [22] | [R1-2307417](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307417.zip) | RedCap UE Complexity Reduction | Nokia, Nokia Shanghai Bell |
| [23] | [R1-2307482](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307482.zip) | Discussion on further UE complexity reduction for eRedCap | NTT DOCOMO, INC. |
| [24] | [R1-2307554](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307554.zip) | Further consideration on reduced UE complexity | OPPO |
| [25] | [R1-2307622](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307622.zip) | Discussion on further complexity reduction for eRedCap UEs | China Telecom |
| [26] | [R1-2307689](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307689.zip) | Further UE complexity reduction for eRedCap | Samsung |
| [27] | [R1-2307757](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307757.zip) | Discussion on UE complexity reduction | DENSO CORPORATION |
| [28] | [R1-2307764](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307764.zip) | Discussion on UE complexity reduction | Transsion Holdings |
| [29] | [R1-2307791](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307791.zip) | Discussion on further UE complexity reduction for eRedCap | LG Electronics |
| [30] | [R1-2307841](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307841.zip) | Considerations for further UE complexity reduction | Semtech Neuchatel SA |
| [31] | [R1-2307855](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307855.zip) | Discussion on complexity reduction for eRedCap UE | Sharp |
| [32] | [R1-2307937](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2307937.zip) | UE complexity reduction for eRedCap | Qualcomm Incorporated |
| [33] | [R1-2308021](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2308021.zip) | On further complexity reduction of NR UE | Nordic Semiconductor ASA |
| [34] | [R1-2308039](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_114/Docs/R1-2308039.zip) | On eRedCap UE complexity reduction | MediaTek Inc. |