

3GPP TSG RAN WG1 Meeting #106bis-E

e-Meeting, October 11th – 19th, 2021

Source: Moderator (Intel Corporation)

Title: FL summary #4 on other aspects of UE complexity reduction for RedCap

Agenda item: 8.6.1.3

Document for: Discussion and Decision

1 Introduction

This document presents a summary of submitted contributions to AI 8.6.1.3 (Other aspects of RedCap complexity reduction).

/This one is to use NWM – please use ***RAN1-106bis-e-NWM-NR-R17-RedCap-03*** as the document name

[106bis-e-NR-R17-RedCap-03] Email discussion regarding other aspects of UE complexity reduction – Debdeep (Intel)

- 1st check point: October 14
- Final check point: October 19

Based on the submitted contributions to RAN1 #106b-E meeting, the discussion points are categorized into the following topics:

- L2 buffer size reduction and scaling factor for peak data rates for RedCap
- Supported DCI formats for RedCap
- Miscellaneous including UE features

A summary of the third round discussions with a new FL4 Proposal 1 is provided in Section 2.5.

For Sections 3 and 4, the corresponding discussions can be closed for now.

2 L2 buffer size and peak rate scaling factor for RedCap

RAN1 received an LS from RAN2 [19], informing that RAN2 discussed several options during RAN2 #114-e meeting but could not arrive at a conclusion on whether and how to reduce L2 buffer size for Rel-17 RedCap UEs, and asking RAN1 to discuss the issue and provide feedback to RAN2.

Table 1:

1. Overall Description:

RAN2 discussed several options for L2 buffer size reduction for Rel-17 RedCap in RAN2#114 and RAN2#115 but did not reach any conclusion on whether and how the possible reduction should be made.

As this is related to RAN1, RAN2 respectfully ask RAN1 to discuss L2 buffer size reduction and provide feedback to RAN2.

2. Actions:

To RAN1 group

ACTION: RAN2 respectfully ask RAN1 to discuss L2 buffer size reduction and provide feedback to RAN2.

As one of the means to realize L2 buffer size reduction, adaptations to Rel-15 specifications on scaling factors for DL/UL peak rates have been considered by RAN2 and RAN1.

The primary motivation is to allow RedCap UEs to support peak data rates that are much lower than the corresponding achievable peak rates considering the agreed complexity reduction features (on BW, # of Rx branches, max modulation order, etc.) for RedCap. It is noted by the proponents that some of the RedCap use-cases (e.g., IWSN) may require much lower data rates than the min. peak rates achievable for currently-agreed capabilities for RedCap UEs.

As specified in TS 38.306, the peak rate scaling factor was introduced in Rel-15 based on the following motivations [21].

- *Scaling factor is used to reflect the association of capability mismatch between the baseband capability and RF capability for both SA UE and NSA UE.*
- *Scaling factor is used to scale down maximum throughput of NSA UEs operating in EN-DC scenario that share hardware resources between LTE and NR.*

Clearly, neither of the above motivations directly apply to RedCap use-cases.

Further, to ensure that the scaling factor is utilized by UEs primarily for the originally intended use-cases, it is currently specified that for single carrier NR SA operation, a UE would need to ensure that any indicated value of scaling factor (default value = 1) is such that the product of max number of layers, max modulation order, and scaling factor is no less than 4.

Considering that RedCap UEs are limited to single carrier operations, allowing RedCap UEs to indicate scaling factors < 1 is effectively limiting one or more of: (i) max PDSCH TBS; and (ii) max # of HARQ processes, without relaxing them for PHY layer operations.

During RAN1 #106-E meeting, the issue was discussed within RAN1, again without the group arriving at a consensus on whether and how to facilitate L2 buffer size reduction and the applicability of peak rate scaling

factors for Rel-17 RedCap. However, as part of the RAN1 #106-E discussions, the following options were identified [22]:

- **Opt. 1:** *Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} are available to RedCap UEs, with the same constraint on the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation.*
 - *No change to current specs for RedCap.*
- **Opt. 2:** *Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} are available to RedCap UEs, with the relaxation/removal of the constraint on the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation.*
- **Opt. 3:** *Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} and new smaller values from one or more of: {0.1, 0.2} are available to RedCap UEs, with the relaxation/removal of the constraint on the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation.*
- **Opt. 4:** *Scaling factors for peak DL/UL rates are NOT available to RedCap UEs.*
- *Other options are not precluded.*

In contributions [1], [4], [6], [7], [8], [9], [10], [12], [15], [16], [17], [18], submitted to RAN1 #106bis-E, companies shared their views on applicability of peak rate scaling factor for RedCap UEs.

A summary of indicated preferences based on submitted contributions:

- **Optimize applicability and/or introduce smaller values of scaling factors for Rel-17 RedCap to enable lower L2 buffer sizes**
 - **Yes:** [1], [4], [7], [12], [15], [17]
 - **No (not optimized or not applicable at all for Rel-17 RedCap):** [6], [7], [8], [9], [10], [16]

Primary reasons for supporting optimization of peak rate scaling factors for Rel-17 RedCap, as cited by proponents:

1. Better match of supported peak rates to low-end data rate requirements of IWSN.
2. Potential UE cost/complexity reduction via L2 buffer size reduction (without any quantitative estimates on the expected cost/complexity benefits).

Primary reasons for either not supporting scaling factor for Rel-17 Redcap UEs or not optimizing from that for non-RedCap UEs, as cited in company contributions:

1. The original reasons for application of peak rate scaling factor do not apply to RedCap UEs.

2. For single-carrier operation, UE cost/complexity reduction via L2 buffer size reduction is upper bounded by cost/complexity reduction features like limiting max TBS or reducing max number of HARQ-ACK processes. Both methods were studied during the SI phase and was decided to be not considered as part of the Rel-17 WI on RedCap.

Further inputs from companies are solicited below to determine whether and how to enable reduced L2 buffer size for Rel-17 RedCap UEs and optimize the support of scaling factor for RedCap in Rel-17 NR.

Please share your views on the following for potential reduction in L2 buffer size requirements via peak rate scaling factors for Rel-17 RedCap.

- ***Opt. 1: Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} are available to RedCap UEs, with the same constraint on the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation, i.e., equal to 4.***
 - ***No change to current specs for RedCap.***
- ***Opt. 2: Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} are available to RedCap UEs, with the relaxation/removal of the constraint on the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation.***
- ***Opt. 3: Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} and new smaller values from one or more of: {0.1, 0.2} are available to RedCap UEs, with the relaxation/removal of the constraint on the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation.***
- ***Opt. 4: Scaling factors for peak DL/UL rates are NOT available to RedCap UEs.***
- ***Other options are not precluded.***

Feedback Form 1: FL1 Question 1: Whether and how to reduce L2 buffer size via peak rate scaling factor

1 – QUALCOMM JAPAN LLC.

Qualcomm

We support Option 1 (No change to current spec is needed for R17 RedCap UE) for the following reasons:

1) to ensure the co-existence with non-RedCap UE, especially for sharing SIB transmitted within the BW of MIB-configured CORESET#0

2) reducing L2 buffer size via peak rate scaling factor reduction is out of the scope of R17 RedCap WI objectives

2 – Spreadtrum Communications

From our perspective, technical discussion especially focused on feasibility evaluation on RAN1 related solutions will help to reach consensus and feedback to RAN2 with useful information.

Based on SI conclusion in TR38.875 copied below, similar with DRB number and SN in PDCP and RLC, reduction of L2 buffer size is in the scope of RedCap WI, which is also the reason why RAN2 send an LS to RAN1 for technical support.

The following UE complexity reduction techniques for higher layers have been discussed in RAN2:

- *Reduction of the maximum number of DRBs which UE needs to mandatorily support.*
- *Reduction of L2 buffer size. According to the calculation in TS 38.306, with peak data rate reductions, L2 buffer requirements for RedCap UEs are implicitly reduced accordingly. Benefits and feasibility of further reduction requires evaluation in normative phase if it is to be considered.*
- *SN in PDCP and RLC is 18-bits, and the size could be reduced depending on which features RedCap UEs support, if a clear benefit in such reduction is identified.*
- *The gain of relaxing RRC processing delay requirements was not studied and requires further evaluation in normative phase if it is to be considered.*

These UE complexity reduction techniques for higher layers have not been explicit objectives during the study and would require further evaluation during the normative phase if they are to be considered.

In addition, based on working assumption in RAN2#114, “by default, all non-RedCap UE capabilities are applicable for RedCap UE”, naturally, peak rate scaling factor is applicable to RedCap UEs.

Regarding SI schemes of the limiting max TBS or reducing max number of HARQ-ACK processes, these schemes are quite different with peak rate scaling factor scheme. First of all, all the cost evaluations for TBS restriction and HARQ relaxation in SI phase are focus on RF and BB, while the L2 buffer size reduction is related to the memory (this component is completely different from RF and BB). Secondly, the spec impacts and standardization works are quite different between TBS restriction (and/or HARQ relaxation) and the L2 buffer size reduction (via SF), the former brings great spec impacts and standardization efforts (such as for TBS restriction, new TBS definition is required), while the latter can be easily realized by reusing the current scheme and procedures. Therefore, the discussion on the L2 buffer size reduction is not equivalent to TBS restriction or HARQ relaxation.

Regarding the solutions listed by FL, we support option 2. As we evaluated in our contribution (R1-2109837), there is no impacts to the initial access when the constraint is relaxed from 4 to 1.5.

3 – vivo Communication Technology

We prefer option 2 or 3.

4 – HUAWEI Technologies Japan K.K.

Although the LS from RAN2 inquires about this issue, the relevant discussion about TBS restriction was indeed carried out during SI however was not adopted. Thus, it appears that the effect resulted from any modification on scaling factor is already out of scope, unless if there is clear difference between L2 buffer size reduction and TBS restriction. However, the former is purely RAN2 issue and it is not clear what RAN1 can evaluate except from TBS restriction point of view.

5 – MediaTek Inc.

We support Option 1. We agree with the views from Huawei.

6 – Ericsson LM

We support Option 2.

We expect that the LS response will be treated in [106bis-e-NR-R17-RedCap-05].

7 – NTT DOCOMO INC.

We support Option 1 and share the view with Qualcomm.

8 – Nokia

We support Option 1 and 4.

For L2 buffer size reduction, we feel scaling factor reduction would introduce additional complexity in the network while the complexity reduction is not clear as similar techniques such as TBS restriction and HARQ process reduction were considered in SI but not adopted.

9 – Futurewei Technologies

During the study phase, there were proposals for such things that were not agreed, and in the RAN WI setup, these RAN2-related ones were not included. So Opt 4 is the status quo and our preference. If there is a strong desire to keep the spec the same, we can discuss Opt 1 further. Do not support opt 2 or 3.

10 – u-blox AG

We support Option 2 and 3.

11 – Sierra Wireless

We support Option 1, (Option 4 is also Ok)

This is not an essential feature and is not within the scope of the WID. As commented by others, similar techniques such as TBS size reduction were studied in the SI phase but were not adopted.

12 – CATT

We support Option 2 and Option 3.

13 – CAICT

We support Option 2 to reduce L2 buffer size for R17 RedCap and share the view with Spreadtrum

14 – Samsung Research America

We support Option 1 for no spec change.

We are also open to further discuss on relax the constraint on the minimum value for L2 buffer for RedCap UE, e.g., from 4 to 1 or some other value.

15 – Xiaomi Communications

We share similar view with Spreadtrum and we are fine with option 2 and option 3.

16 – GUANGDONG GENIUS TECHNOLOGY CO

We support option 2 and 3 and we share the view with Spreadtrum.

17 – Potevio Company Limited

We prefer option 2 or 3.

<p>18 – China Mobile Com. Corporation</p> <p>Option 1 and option 2. As summarized by the FL, the two motivations may not hold any more for RedCap UEs, then the motivation of option 2 is to reduce UE cost/complexity by reducing L2 buffer size. The final decision is up to RAN2 considering whether UE cost/complexity reduction can be justified, if so, option 2 can be considered since it only involves minor spec change.</p>
<p>19 – Nordic Semiconductor ASA</p> <p>Option 2 relax to 2</p>
<p>20 – ZTE Corporation</p> <p>We are fine with option 2 or option 3. A simple method used to reduce cost is quite appropriate for RedCap UE.</p>
<p>21 – Transsion Holdings</p> <p>We support Option 2 or option 3</p>
<p>22 – LG Electronics Inc.</p> <p>We prefer option 1 and can accept option 4.</p> <p>We don't think there will be a serious problem with the current constraint. Also, as other companies stated, L2 buffer size reduction is out of scope of Rel-17 RedCap WI.</p>
<p>23 – China Unicom</p> <p>We prefer Option 2 and Option 1.</p>
<p>24 – Sequans Communications</p> <p>We support Option 4 since introduction and intended use of scaling factor parameters in spec have nothing to do with current proposed intention for RedCap..</p> <p>But we are also fine with Option 1 if it means to save a lot burden from spec change and it ensures coexistence with legacy NR UEs.</p> <p>L2 buffer size reduction and optimizing applicability of scaling factors is out of Rel-17 WI scope.</p>
<p>25 – Intel Corporation (UK) Ltd</p> <p>We support either Option 4 or Option 1 (no special handling for RedCap).</p> <p>Potential cost/complexity reduction from L2 buffer size reduction remains unclear. RAN2 could not conclude on whether L2 buffer size reduction should be pursued, and RAN1 decided not to pursue more meaningful cost/complexity reduction techniques like limiting max TBS and/or limiting max number of HARQ processes. In view of this, we do not see a need to pursue L2 buffer size reduction for Rel-17 RedCap.</p>
<p>26 – Apple Poland Sp. z.o.o.</p> <p>Apple</p> <p>We prefer Opt.3 and can accept Opt.2.</p>

Our view is that Opt.2 at least is really minor and negligible specification impact and especially in the right direction to somehow optimize the cost of low-end Redcap device. This is in the same direction as potential Rel-18 optimization to introduce reduced BW that is favored by many companies.

2.1 Summary of first round on L2 buffer size reduction

The received feedback is summarized as below:

- **Option 1:** QC, MTK, DCM, Nokia/NSB, FTW, Sierra Wireless, SS, China Mobile, LGE, China Unicom, Sequans, Intel **(13)**
- **Option 2:** SPRD, vivo, Ericsson, u-Blox, CATT, CAICT, Samsung (2nd pref), Xiaomi, Guangdong, Potevio, China Mobile (2nd pref), Nordic, ZTE, Transsion Holdings, China Unicom, Apple **(16)**
- **Option 3:** vivo, u-Blox, CATT, Xiaomi, Guangdong, Potevio, ZTE, Transsion Holdings, Apple **(9)**
- **Option 4:** HW/HiSi, Nokia/NSB, FTW, Sierra Wireless, LGE, Sequans, Intel **(7)**

2.2 Second round discussion on L2 buffer size reduction

Based on the received inputs to the first round of discussion on L2 buffer size reduction, a possible way forward could be to consider a further step of down-selection and harmonization. Towards this, FL2 Proposal 1 is suggested as the next step.

FL2 Proposal 1

- *For reduction in L2 buffer size requirements via peak rate scaling factors for Rel-17 RedCap*
 - *Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} are available to Rel-17 RedCap UEs*
 - *The minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation is down-selected from the following:*
 - *4 (i.e., same as for non-RedCap; no spec change)*
 - *Less than 4 (e.g., 1, 1.5, 2) (i.e., reduced as a cost/complexity reduction feature for Rel-17 RedCap)*

Please share your preferences for the minimum value of the product of max # of layers, max modulation order, and scaling factor.

Feedback Form 2: FL2 Proposal 1: Whether and how to reduce L2 buffer size via peak rate scaling factor

1 – Spreadtrum Communications

Our preference for the minimum value of the product is “**less than 4**”.

According the evaluation in our contribution (R1-2109837) and justification explanation in the first round, the constraint can be relaxed to 1.5 for R17 RedCap.

2 – QUALCOMM JAPAN LLC.

Qualcomm

Thanks FL for the updated proposal, and the comments of all companies above.

Regarding the minimum value for the product of *(max number of MIMO layers)*(max modulation order)*(scaling factor configured by higher layer)*, we think R17 RedCap UE should re-use the number (4) applied to non-RedCap UE for the following reasons:

- 1) applying a product value less than 4 leads to reduced peak data rates and extra TBS restriction on DL/UL
- 2) TBS restriction for R17 RedCap UE was proposed and studied during the phase of R17 SI, but has been excluded from the RAN1 objectives of R17 WI
- 3) applying a product value less than 4 potentially impacts the co-existence of RedCap and non-RedCap UE and reduces the spectral efficiency of NW (e.g. imposing constraints on multiplexing RedCap and non-RedCap UEs in DL/UL MU-MIMO; limiting the payload size of broadcast/multicast messages targeting both RedCap and non-RedCap UEs)
- 3) it is unclear to us how much cost/complexity reduction can be achieved by reducing the product value from 4 to a smaller value (say x), how many intermediate values should be specified between x and 4, and how many more bits need to be allocated in UE capability signaling
- 4) "reducing the peak data rates of RedCap UE" was discussed at RAN#93 meeting for R18 eRedCap, and has been included in the moderator's recommendation for the scope of R18 eRedCap UE; therefore, further peak data rates reduction and TBS restriction can be studied/discussed in R18
- 5) in R17, we should focus on the essential complexity reduction features to enable a single RedCap UE type, instead of distracting the discussion with a risk of market fragmentation

3 – China Mobile Com. Corporation

CMCC

We think the minimum value '4' is ok. Whether reduce the value of product to be less than 4 needs further evaluation on the cost reduction by RAN2. If the cost reduction is justified, it is fine to reduce the value of product.

4 – Futurewei Technologies

4 (i.e., same as for non-RedCap; no spec change). In addition, only the scaling factor of 1 should be available for RedCap UEs as these reductions were not agreed in the RAN1 study or in the WI setup in RAN.

5 – Nokia

Our preference is 4 based on the reasons we stated in the first round of discussion

6 – Ericsson LM

We are fine with the FL's updated proposal. Our preference for the minimum value is **less than 4**.

7 – Intel Corporation (UK) Ltd

[Moderator]

It'd be great if you could please indicate on the reflector thread at your earliest convenience if you have concerns with FL2 Proposal 1.

<p>In the meantime we can continue collecting inputs here regarding views between Alt 1 and Alt 2. For companies preferring Alt. 2, kindly also indicate the value it should be in your view.</p>
<p>8 – Sierra Wireless</p> <p>Our preference is 4 (i.e., same as for non-RedCap; no spec change).</p>
<p>9 – CATT</p> <p>We support the proposal. For the downselection, we prefer less than 4.</p>
<p>10 – LG Electronics Inc.</p> <p>Our preference is 4, no spec change.</p>
<p>11 – GUANGDONG GENIUS TECHNOLOGY CO</p> <p>We support the proposal. Our preference is “less than 4”.</p>
<p>12 – Samsung Research America</p> <p>We prefer no spec change, and keep the minimum value of 4.</p>
<p>13 – NTT DOCOMO INC.</p> <p>We prefer “4” but open to further discuss “less than 4” if majority companies prefer it</p>
<p>14 – vivo Communication Technology</p> <p>RedCap WI is supposed to cover a wide range of use cases with large variety of target data rage. For industrial sensors and low-end video surveillance and wearables, the data rate is normally less than 10Mbps. Following the existing constraint (i.e. 4) will mean that all RedCap UEs has to support at least 55Mbps which is obviouly not cost effecient for these use cases.</p> <p>Therefore, we support the option “<i>Less than 4</i>” and are fine with the number 1.5 as proposed by Spread-trum.</p>
<p>15 – Shenzhen YZF Network Technolog</p> <p>OPPO we support the proposal. we prefer “less than 4” to support kinds of low end RedCap UEs</p>
<p>16 – CEPRI</p> <p>As an industrial company, we really concern about cost and use cases of IWSN (Industrial wireless sensors) and Video surveillance for R17 RedCap. With relaxing some certain constraints, the cost can be reduced, which is very important for the scale of applications in vertical industries.</p> <p>Our preference is “less than 4”, and as explained in our co-signed contribution R1-2109837, the value 1.5 is preferred.</p>
<p>17 – HUAWEI Technologies Japan K.K.</p> <p>Fine with FL proposal</p>

<p>18 – GDCNI</p> <p>Thanks FL for the updated proposal . Our preference is “less than 4”, 1.5 or 2 are acceptable.</p>
<p>19 – Transsion Holdings</p> <p>We support the proposal. For the downselection, we prefer 1.5.</p>
<p>20 – Xiaomi Communications</p> <p>We are fine with the proposal and our preference is ”less than 4”. The value of 1.5 is acceptable to us</p>
<p>21 – CAICT</p> <p>Our preference for the minimum value is less than 4, and can be relaxed to 1.5 as explained in R1-2109837.</p>
<p>22 – Sequans Communications</p> <p>Our preference is that scaling factor of 1 should only be available for RedCap UEs for the reasons explained before. But we are also flexible to move forward with the proposal and support no spec change, i.e. minimum value of 4.</p>
<p>23 – ZTE Corporation</p> <p>We are fine with the FL proposal and prefer ”Less than 4”</p>
<p>24 – u-blox AG</p> <p>We are fine with the updated proposal from FL.</p> <p>Our preference for the minimum value is less than 4.</p>
<p>25 – MediaTek Inc.</p> <p>We prefer to keep the current spec.</p> <p>In our view, it seems there is no consensus in RAN1 on the reduction in L2 buffer size requirements via peak rate scaling factors. Hence, the default assumption should be re-using the existing peak rate scaling factors and minimum value (i.e. no spec change). We can accept the current proposal if this understanding is added to the proposal (e.g. a note saying: If no consensus reached in RAN1 on the down-selection, the existing minimum value is used.).</p> <p>Also, I assume the down-selection meant to be done in RAN1, right? Given that RAN1 need to send reply LS to RAN2, shall we put a timeline for the down-selection (e.g. down-select in this RAN1 meeting)?</p>
<p>26 – Ericsson LM</p> <p>Our suggestion is [1.5], to be confirmed in the next RAN1 meeting. The two bullets–”4” or ”Less than 4”–need not be down selected in this meeting.</p>
<p>27 – Intel Corporation (UK) Ltd</p> <p>As discussed before, Alt 1 should be followed considering technical and procedural consistency. Otherwise, we should revisit some other cost/complexity reduction schemes as well for more meaningful impact.</p>

2.3 Summary of second round discussion

The received feedback to FL2 Proposal 1 is summarized below.

- All responding companies seem to find FL2 Proposal 1 agreeable.
- On the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation, the group is divided. The views are summarized below.
 - **Min. value of product = 4 (current specs)**
 - QC, CMCC, FTW, Nokia/NSB, Sierra Wireless, LGE, Samsung, DCM, Sequans, MTK, INTC (11)
 - **Min. value of product < 4 (1.5 or 2)**
 - SPRD, Ericsson, CATT, Guangdong, vivo, OPPO, CEPRI, GDCNI, Transsion Holdings, Xiaomi, CAICT, ZTE, u-Blox (13)
 - **No preference indicated**
 - HW/HiSi (1)

2.4 Third round discussion on L2 buffer size reduction

Based on Chairman's guidance and comments received during Friday GTW session, we can try once more towards possible convergence on whether to pursue further cost/complexity reduction or not for Rel-17 RedCap.

Given that it is now commonly understood that the baseline is current specs (i.e., scaling factors are applicable to RedCap with existing constraints) and the comments that the two options are not equivalent, we can try to see if companies can accept relaxation of the constraint for Rel-17 RedCap as a cost/complexity reduction feature.

FL3 Proposal 1

- *For reduction in L2 buffer size requirements via peak rate scaling factors for Rel-17 RedCap*
 - *Scaling factors for peak DL/UL rates with existing values {0.4, 0.75, 0.8, 1} are available to Rel-17 RedCap UEs*
 - *The minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation is **reduced from 4 to 1.5**.*

Please indicate below if you can accept this proposal or not.

Feedback Form 3: FL3 Proposal 1: Whether and how to reduce L2 buffer size via peak rate scaling factor

1 – QUALCOMM JAPAN LLC.

Qualcomm

- First of all, thanks for the efforts of FL as well as the discussion of all participating companies.

- We agree with the first bullet of this proposal on re-using the existing scaling factors for DL/UL peak data rates. However, we cannot accept the second bullet of this proposal, based on the reasons mentioned before (copied below).
- Considering the current status, it is not likely for companies to reach a consensus by the end of RAN1#106b.
- Therefore, we suggest to capture the conclusion that *”There is no consensus in RAN1 in reducing the minimum value of the product of max number of layers, max modulation order, and scaling factor as applicable for single carrier NR SA operation”* in the reply LS to RAN2.

Re-using the Peak Rate Scaling Factors and Configuration Constraints of non-RedCap UE

Regarding the minimum value for the product of (*max number of MIMO layers*)*(*max modulation order*)*(*scaling factor configured by higher layer*), we think R17 RedCap UE should re-use the number (4) applied to non-RedCap UE for the following reasons:

- 1) applying a product value less than 4 leads to reduced peak data rates and extra TBS restriction on DL/UL
- 2) TBS restriction for R17 RedCap UE was proposed and studied during the phase of R17 SI, but has been excluded from the RAN1 objectives of R17 WI
- 3) applying a product value less than 4 potentially impacts the co-existence of RedCap and non-RedCap UE and reduces the spectral efficiency of NW (e.g. imposing constraints on multiplexing RedCap and non-RedCap UEs in DL/UL MU-MIMO; limiting the payload size of broadcast/multicast messages targeting both RedCap and non-RedCap UEs)
- 3) it is unclear to us how much cost/complexity reduction can be achieved by reducing the product value from 4 to a smaller value (say x), how many intermediate values should be specified between x and 4, and how many more bits need to be allocated in UE capability signaling
- 4) ”reducing the peak data rates of RedCap UE” was discussed at RAN#93 meeting for R18 eRedCap, and has been included in the moderator’s recommendation for the scope of R18 eRedCap UE; therefore, further peak data rates reduction and TBS restriction can be studied/discussed in R18
- 5) in R17, we should focus on the essential complexity reduction features to enable a single RedCap UE type, instead of distracting the discussion with a risk of market fragmentation

2 – Spreadtrum Communications

We can accept this proposal. The related feasibility estimation can be found in our contribution (R1-2109837) and justification explanation in the first round.

If this proposal is not accepted by some companies, we would like to suggest those company could give technical and non-technical reasons, so that RAN1 can collect useful information to feedback some useful information to RAN2 to help them make decision on L2 buffer size reduction. Thanks.

3 – GDCNI

We support this proposal.

4 – Transsion Holdings

We support this proposal.

5 – GUANGDONG GENIUS TECHNOLOGY CO

We support this proposal.

<p>6 – CAICT</p> <p>We are fine with FL's proposal.</p>
<p>7 – MediaTek Inc.</p> <p>Thank you for the FL efforts.</p> <p>We don't support the proposal. Similar complexity reduction features were discussed in the SI phase and there was no consensus to support them for R17 RedCap.</p>
<p>8 – NTT DOCOMO INC.</p> <p>Qualcomm's proposal reflect current situation correctly and we support it</p>
<p>9 – Xiaomi Communications</p> <p>we are OK with FL's proposal</p>
<p>10 – CATT</p> <p>We are fine with the proposal.</p>
<p>11 – Futurewei Technologies</p> <p>For the reasons given before, we do not agree to the FL proposal. The conclusion from Qualcomm is the natural result.</p>
<p>12 – Ericsson LM</p> <p>We are fine with the proposal. It is also fine to have the value as WA or FFS until the next meeting.</p>
<p>13 – CEPRI</p> <p>We are fine with this proposal.</p>
<p>14 – ZTE Corporation</p> <p>We are fine with it. From RAN1 perspective, all the pros and cons can be provided for RAN2 even though there may be no consensus.</p>
<p>15 – China Mobile Com. Corporation</p> <p>We are fine with the proposal.</p>
<p>16 – Sierra Wireless</p> <p>We can NOT accept the FL proposal.</p> <p>Fully agree with Qualcomm that in RAN1 there is no consensus to change the specification and thus a conclusion should be agreed saying that no consensus could be reached.</p>
<p>17 – Nokia</p> <p>We do not support the FL proposal. Agree with Qualcomm and others that the conclusion should be there is no consensus in RAN1.</p>

18 – Apple Poland Sp. z.o.o.

We are fine with the proposal.

One of argument is standard efforts to enable it. It should be clear that the only spec impact is to add 'the restriction of 4 is not applied for reduced capability UE'. Is it truly negligible spec impact? Regarding the argument of market segmentation, I do see many companies proposed to reduce BW to 5MHz for Rel-18 Redcap enhancement WI and see a huge benefit to optimize the low-end Redcap device. It is difficult to understand why the market segmentation concern and co-existence issues are suddenly disappear in Rel-18? Why optimization for low-end Redcap device benefit become attractive just in next release? We really think this is the right thing to do in Rel-17 with no standard impact.

19 – Nordic Semiconductor ASA

As we noted in our contribution, Some Redcap UE's number of layers will reduce from 2->1. And thus UE must support twice a coding-rate/MO to match non-RedCap numbers. And finally, we do not agree with QC that there is coexistence issue with non-Redcap UEs, because broadcast signaling is QPSK only, so gNB cannot anyway schedule TBS with TBS greater than corresponding to scaling factor 2.

TS38.214: "The UE is not expected to decode a PDSCH scheduled with P-RNTI, RA-RNTI, SI-RNTI and $Q_m > 2$ "

Therefore, we think that factor minimum should be relaxed to 2 for RedCap UEs.

20 – Sequans Communications

We do not support the FL proposal and agree with Qualcomm view.

21 – Intel Corporation (UK) Ltd

As discussed before, we do not agree with pursuing cost/complexity reduction via peak rate scaling factor for reasons discussed before, well-summarized in the response from QC. For us, the most important reason is that it's currently out-of-scope and if we are to change that, we should revisit prior decisions on more effective means in this regard, e.g., TBS limitations, and/or reducing # of HARQ processes. The benefits from cost/complexity reduction from L2 buffer size reduction only for Rel-17 RedCap is yet to be established.

To Nordic, the same constraint also applies to non-RedCap UEs in bands where 2Rx is required. Thus, change from 4 to 2 Rx does not seem reason enough to change the constraint for RedCap.

22 – Spreadtrum Communications

Based on the discussion so far, we would like to give some observations from our perspective:

1. We do not agree L2 buffer size reduction is out of scope. If it is out of scope, RAN2 wouldn't discuss this issue for several meetings and will not send an LS to RAN1 for feedback.

2. From our observation, why RAN2 send an LS to RAN1, the main motivation is that some schemes (for L2 buffer size reduction) are related to RAN1. So, the natural feedback from RAN1 should be feasibility, spec. impact, the benefit, or system impact, etc. Thus, we adopted the suggestion from ZTE on the NWM, which by using con. Vs. pros to collect some information or observations for RAN2.

3. For L2 buffer size reduction, making "no consensus" conclusion is not suitable in RAN1. From our perspective, the final decision should be made in RAN2. As we explained before, this issue was initially

discussed in RAN2 in SI stage, and then based on SI conclusion, further L2 buffer size reduction was continuously discussed in RAN2 for several meetings until now.

23 – Futurewei Technologies

If we are to conclude anything other than "No consensus in Rel-17", it should be based on what we know so far.

- L2 buffer reduction was a potential complexity reduction feature from the SI that was NOT included in the WID initially or agreed to be in scope when brought up later at RAN.
- It is very late to be adding a new complexity reduction feature in this Rel-17 WI
- There is no consensus on the benefit of the feature. Some feel there is a benefit, others feel there is no significant benefit based on the past analysis of similar features in the SI.

The best use of our remaining time in the WI is to conclude as above. If somehow we decide to focus on this new feature and not on completing RedCap, it should be left open that only the scaling factor of 1 is needed for RedCap as the expected gains for smaller scaling factors using the agreed evaluation methodology on top of the other features are expected to be negligible.

2.5 Summary of third round discussion

Based on received responses to , company views are summarized as below:

Table 2:

FL3 Proposal 1 acceptable: Yes	SPRD, GDCNI, Transsion Holdings, Guangdong, CAICT, Xiaomi, CATT, E//, CEPRI, ZTE, CMCC, Apple, Nordic (13)
FL3 Proposal 1 acceptable: No	QC, MTK, DCM, FTW, Sierra Wireless, Nokia/NSB, Sequans, Intel (8)

Given the situation, it is clear that there is no consensus to pursue L2 buffer size reduction in Rel-17 for RedCap UEs.

Thus, it is recommended to share the status of discussions in RAN1 to RAN2 as proposed below.

FL4 Proposal 1

- *For reduction in L2 buffer size requirements via peak rate scaling factors for Rel-17 RedCap*
 - *There is no consensus in RAN1 on whether and how to support reduced L2 buffer size requirements.*
 - *Send a response LS to RAN2 with the following:*
 - *RAN1 discussed various options for use of peak rate scaling factor as potential means of L2 buffer size reduction for Rel-17 RedCap but could not arrive at a consensus on whether and how to pursue L2 buffer size reduction as a cost/complexity reduction feature.*

- RAN1 discussed the following options towards optimizing peak rate scaling factor for RedCap:
 - Relaxing the product of max number of layers, max modulation order, and scaling factor < 4, and/or
 - Reducing the scaling factor < 0.4
- While it was observed that Rel-15 specifications with the same scaling factors and constraints may still be available for RedCap UEs (in case of no spec changes), RAN1 could not converge on whether the cost/complexity benefits are sufficient to justify such changes in Rel-17.
- It was also noted by multiple companies in RAN1 that more effective UE cost/complexity reduction features with the same performance impact, but high cost/complexity reduction potential, were discussed and not pursued by RAN1 during the SI phase. Thus, such companies consider L2 buffer size reduction via peak rate scaling factor optimization as out-of-scope for the current WI.

Please indicate only if you have **strong objections** to the above.

Feedback Form 4: FL4 Proposal 1: On conclusion and response LS to RAN2

1 – Spreadtrum Communications

Thanks Debdeep for your great efforts.

As we had indicated on RAN1 email reflector, we can accept this **FL4 proposal 1** for progress with the following two points.

1. Removing the first bullet and part of the first sub-bullet: As L2 buffer size reduction is essentially a RAN2 issue, RAN1 is not properly to make such statement. Additionally, when talking about consensus, specific details should be provided, e.g, whether in the scope, whether is technical feasible, system impact or spec. impact, etc., which can give RAN2 valuable information.

~~o There is no consensus in RAN1 on whether and how to support reduced L2 buffer size requirements.~~

o Send a response LS to RAN2 with the following:

- RAN1 discussed various options for use of peak rate scaling factor as potential means of L2 buffer size reduction for Rel-17 RedCap ~~but could not arrive at a consensus on whether and how to pursue L2 buffer size reduction as a cost/complexity reduction feature.~~

2. Adding the following bullet: We think it is fair to inform RAN2 that the proponent companies in RAN1 have reached convergence, comparing with the last bullet which said multiple companies consider L2 buffer size reduction via peak rate scaling factor optimization as out-of-scope for the current WI.

- It was noted the proponent companies in RAN1 have converged to a single proposal, i.e. relaxing the product to be smaller value (4->[1.5]) while keeping the existing scaling factor unchanged for Rel-17 RedCap.

2 – Intel Corporation (UK) Ltd

[Moderator] Subsequent discussions were carried out in the email thread itself. The thread here is now closed.

3 DCI formats for RedCap

Contributions [2], [3], [4], [5], [13], [14] discuss applicability of various DCI formats for Rel-17 RedCap.

Contributions [2], [6], and [14] propose not to pursue optimizations to DCI formats for RedCap UEs, especially in view of reducing PDCCH blocking probability.

Most discussions on DCI formats for RedCap consider support of DCI formats 2_x and 3_x for Rel-17 RedCap.

For **DCI formats 3_x**, optional support for these formats can follow from conclusions on optional support of SL/V2X features by Rel-17 RedCap, while the latter is expected to be discussed further as part of discussions on UE features, as part of AI 8.6.2 and/or AI 8.17.6.

Companies generally seem to agree that **DCI format 2_5** is not supported by Rel-17 RedCap, and that **DCI formats 2_0, 2_1, 2_2, 2_3, and 2_6** can be supported by Rel-17 RedCap as optional feature(s).

Contributions [3], [4], and [13] propose that **DCI format 2_4** is supported for Rel-17 RedCap as an optional feature. Contributions [5] and [14] suggest that DCI format 2_4 may be supported by Rel-17 RedCap UE in TDD deployments or that support FD-FDD, but not supported by HD-FDD RedCap UEs. Given that the basic constraints between TDD and HD-FDD are the same when considering applicability of DCI 2_4 and the fact proper grouping of UEs can address differentiated handling between FD-FDD and HD-FDD UEs, the UL CI feature and DCI 2_4 can still be supported as optional feature by Rel-17 RedCap if it can be supported by TDD or FD-FDD RedCap UEs.

Considering the above, the following FL proposal is made.

- *Following DCI formats can be optionally supported by Rel-17 RedCap UEs:*
 - *DCI formats 2_0, 2_1, 2_2, 2_3, 2_4, 2_6*
- *DCI format 2_5 is NOT supported by Rel-17 RedCap UEs.*

Feedback Form 5: FL1 Proposal 1: DCI formats 2_x for Rel-17 RedCap

1 – QUALCOMM JAPAN LLC.

Qualcomm

We agree with the FL proposal in general. Some additional comments on our side:

- 1) DCI format corresponding to R17 PEI can also be optionally supported by RedCap UE.
- 2) Regarding DCI format 2_0 carrying SFI, it can be optionally supported by R17 RedCap UE in TDD. For R17 RedCap UE operating in FD-FDD or Type-A HD-FDD, DCI format 2_0 (SFI) is not supported.

2 – Spreadtrum Communications

We are generally fine with the FL proposal.

<p>3 – vivo Communication Technology</p> <p>We are generally fine with the FL proposal. One issue as raised in AI 8.6.1.2 is the interaction between SFI and HD-FDD collision needs to be discussed further.</p>
<p>4 – HUAWEI Technologies Japan K.K.</p> <p>Ok</p>
<p>5 – MediaTek Inc.</p> <p>Fine with the proposal.</p>
<p>6 – Ericsson LM</p> <p>We expect that these aspects will be treated in [106bis-e-R17-UE-features-REDCAP-02].</p>
<p>7 – Nokia</p> <p>We think that this should be part of UE capability discussion. However, we are fine in general with the proposal.</p>
<p>8 – NTT DOCOMO INC.</p> <p>We are generally fine with the proposal, but DCI 2_0 should be discussed in [106bis-e-R17-UE-features-REDCAP-02] for HD-FDD case.</p>
<p>9 – Futurewei Technologies</p> <p>The proposal should be modified to be a conclusion, based on feature discussions. We should add a bullet stating there is no additional specification impact.</p>
<p>10 – Intel Corporation (UK) Ltd</p> <p>[Moderator] Considering that multiple companies prefer to discuss this as part of UE features, we can expect this to be resolved in the relevant email threads. BTW, @Ericsson, @NTT DCM, it is assumed that the cited thread was intended to mean [106bis-e-R17-UE-features-REDCAP-01].</p> <p>With this, the discussion for FL1 Proposal 1 can be closed for now. In any case, thanks to those who shared their views so far.</p>

4 Miscellaneous including UE features

In contribution [16], it is proposed that SRS transmissions outside of active UL BWP and frequency selective scheduling outside of active DL BWP are not supported by RedCap UEs. It is also proposed that the max BW specified for R17 RedCap UE (20 MHz in FR1, 100 MHz in FR2) applies to both BB and RF. The latter is indeed interpretation for the cost/complexity reduction feature of reduced max BW for RedCap UEs. However, if necessary, these details can be further discussed and confirmed as part of AI 8.6.1.1.

Contribution [7] proposes to consider configuration of separate PDCCH SS set for RedCap UEs to reduce PDCCH blocking in case of shared initial DL BWP between RedCap and non-RedCap UEs. However, contributions [2], [6], and [14] propose that mechanisms for PDCCH blocking reduction are not pursued further in Rel-17.

Contribution [14] also suggests not to pursue enhancements for DL coverage recovery for RedCap UEs in Rel-17.

In contribution [20], updated evaluation results for cost/complexity reduction estimates, considering the possible combinations of cost/complexity reduction features finally being specified in Rel-17, have been presented.

Please indicate below if you think any of the above aspects or any other issue related to UE cost/complexity reduction needs to be discussed further during RAN1 #106bis-E meeting.

Feedback Form 6: FL1 Question 2: Miscellaneous issues on RedCap cost/complexity reduction

1 – QUALCOMM JAPAN LLC.

Qualcomm

We think RF retuning/BWP switching timeline faster than those of R15/16 non-RedCap UE should not be supported for R17 RedCap UE in FR1. Furthermore, for DCI or timer-based BWP switching, Type-2 swtiching delay specified for R15/16 non-RedCap UE (Table 8.6.2-1, TS 38.133) should be specified as a baseline capability of R17 RedCap UE.

We also think SRS transmissions outside of active UL BWP and frequency selective scheduling outside of active DL BWP are not supported by RedCap UEs.

Besides, R17 RedCap UE can optionally support NR positioning, NR SDT and DSS, subject to the UE complexity reduction features agreed in RAN1/2.

2 – Ericsson LM

We expect that some of these aspects will be treated in [106bis-e-R17-UE-features-REDCAP-02].

3 – Samsung Research America

When RedCap UEs share the initial DL BWP with legacy UEs, the connectivity can be large. So PDCCH blocking can be an issue in the shared initial DL BWP. In this case, dedicated SS sets can be considered with limited spec efforts for RedCap UEs.

5 References

1. R1-2108822, Other UE complexity reduction aspects for RedCap, Ericsson
2. R1-2109232, Discussion on other aspects related to complexity reduction, CATT
3. R1-2109289, Discussion on potential modification of existing DCI formats, CMCC
4. R1-2109334, Discussion on other issues for RedCap, ZTE, Sanechips
5. R1-2109419, Discussion on the DCI format for RedCap, Xiaomi
6. R1-2109432, Other UE Complexity Reduction Aspects, Nokia, Nokia Shanghai Bell
7. R1-2109498, Other aspects for complexity reduction for RedCap UEs, Samsung
8. R1-2109619, Other aspects on UE complexity reduction for RedCap, Intel Corporation

9. R1-2109728, Discussion on L2 buffer size reduction, Sierra Wireless. S.A.
10. R1-2109751, Other complexity reduction aspects for RedCap UEs, Huawei, HiSilicon
11. R1-2109760, Discussion on UE Capability of DL MIMO and Rx branches for RedCap, NEC
12. R1-2109837, Discussion on L2 buffer size reduction for RedCap, Spreadtrum Communications, CAICT, CATT, CEPRI, China Unicom
13. R1-2109853, Other aspects on UE complexity reduction for RedCap, Panasonic Corporation
14. R1-2109977, Other aspects related to UE complexity reduction of RedCap, LG Electronics
15. R1-2110042, Discussion on L2 buffer size reduction for Redcap, Apple
16. R1-2110195, Other Aspects of UE Complexity Reduction, Qualcomm Incorporated
17. R1-2110280, On other aspects related to RedCap UE, Nordic Semiconductor ASA
18. R1-2108893, Discussion on RAN2 LS on L2 buffer size reduction, Spreadtrum Communications
19. R1-2108713, LS to RAN1 on L2 buffer size reduction, RAN2 (Intel, Spreadtrum)
20. R1-2108824, Other aspects for RedCap, Ericsson
21. R1-1807651, Reply LS on formula or table for L1 data rate, RAN1
22. R1-2108524, FL summary #2 on other aspects of UE complexity reduction for RedCap, Moderator (Intel), RAN1 #106-E