3GPP TSG RAN WG2 Meeting #123bis R2-230xxxx

**Xiamen, China, October 09-13, 2023**

**Agenda item:** 7.x.x

**Source:** Intel Corporation

**Title:** Outcome of email discussion [POST123][753][eRedCap] on UE Capabilities for Rel-18 eRedCap

**Document for:** Discussion and decision

# Introduction

This document aims to review the running CRs on UE capabilities for Rel-18 eRedCap and to also discuss the open topics identified during RAN2#123 meeting.

* [Post123][753] Running eRedCap CRs for 38306 and 38331 for capabilities (Intel)

Scope: Implement agreements reached so far in the running CRs.

Intended outcome: Running CRs submitted to next meeting.

Please provide your inputs **before/by Tuesday September 19th EOD PST** to have few days afterwards to further review the report and updated CRs (as official email discussion deadline is Friday September 22nd, 2023).

The following are RAN2 agreements relevant to this discussion:

***Organizational***

***[RAN2#122]***

* *We will use the approach suggested by P1a above when implementing the running CRs and the rapporteurs will identify if there are issues with this approach and we can discuss further in later meetings.*

*Proposal 1a: In the R18 specification descriptions, the R17 legacy texts for RedCap UEs descriptions are NOT inherited/applied by default to the eRedCap UEs, i.e. we use following terminologies:*

*- “(e)RedCap UE” to describe the same behaviors for both RedCap and eRedCap UEs;*

*- “RedCap UE” to describe the RedCap UE only/specific behaviors;*

*- “eRedCap UE” to describe the eRedCap UE only/specific new behaviors.*

***RRC\_INACTIVE eDRX above 10.24 sec***

***[RAN2#121bis-e]***

* *Introduce an optional UE capability with signalling for Rel-18 enhanced eDRX in RRC\_INACTIVE.*
* *UE can support Rel-18 enhanced eDRX, only if it supports Rel-17 RRC\_IDLE eDRX. TBD if it must also support Rel-17 RRC\_INACTIVE eDRX.*

***[RAN2#122]***

* *UE can support Rel-18 INACTIVE eDRX (which comprises eDRX cycles and PTWs), even if it doesn’t support Rel-17 INACTIVE eDRX.*

***eRedCap UE***

***[RAN2#121bis-e]***

* *A Rel-18 eRedCap UE should be able to indicate its support via new UE capability signaling specific to Rel-18 eRedCap.*

***[RAN2#123]***

* *The support of Rel-18 eRedCap (FG 48-1 and 48-2) is defined as independently of Rel-17 RedCap (FG 28-1) understanding that RAN1 also agreed that UE supporting Rel-18 eRedCap feature(s) indicate support of this FG 48-1 instead of FG 28-1 (supportOfRedCap-r17).*
* *New UE capability (referred e.g., as supportOfEnhancedRedCap-r18) is defined to capture FG 48-1 (i.e., RedCap UE with reduced peak data rate and reduced baseband bandwidth in FR1) with the corresponding details explained in RAN1 feature list (R1-2306223).*
* *New UE capability (referred e.g., supportOfNotReducedBB-BW-r18) is defined to capture FG 48-2 (i.e., RedCap UE with reduced peak data rate without reduced baseband bandwidth in FR1) with the corresponding details explained in RAN1 feature list (R1-2306223).*
* *To remove from RAN2 running Capability CRs any reference to supportOfEnhancedRedCap-r18 as it is part of RAN1 feature list and its corresponding TP should be captured as part of Mega-Capability CRs. If so, to agree to the update done on UE capabilities running CR to 38.306 and 38.331 in R2-2307657 and R2-2307659.*
* *We will create a temporary CR for RAN1 eRedCap features*
* *To add in the list of functional components for the supportOfEnhancedRedCap-r18 the support of eRedCap early indication based on Msg3 and MsgA PUSCH.*
* *A Rel-18 eRedCap UE (both FG 48-1 and FG 48-2) can also support all RAN2-centric Rel-17 RedCap UE capabilities in the same manner.*
  + *Discuss during CR implementation how to capture this in TS 38.306: option 1) add in the field description of R18 eRedCap capability (i.e. supportOfEnhancedRedCap-r18) the following statement “all supportOfRedCap-r17 related capabilities specified in this specification remain applicable for Rel-18 RedCap UEs, unless indicated otherwise” or option 2) update the field description of the RAN2-centric Rel-17 RedCap UE capabilities to be applicable to (e)RedCap UEs.*
* *To include the following in “section 4.2.x.1 Definition of eRedCap UE” of TS 38.306:*

*eRedCap UE is the UE with reduced peak data rate and, with or without reduced baseband bandwidth in FR1:The maximum bandwidth is 20 MHz for FR1. UE features and corresponding capabilities related to UE bandwidths wider than 20 MHz in FR1 are not supported by eRedCap UEs. eRedCap UEs do not support operation in FR2. The specifications and capabilities of a RedCap UE are also applicable to eRedCap UEs unless stated otherwise.”*

* *Section 4 on “Supported max data rate for DL/UL” in TS 38.306 needs to be updated to include RAN1 agreement on the new value(s) of X for which the legacy constraint “vLayers·Qm·f ≥ 4” is relaxed by capturing the following TP: “For single carrier NR SA operation, the UE (except a UE indicating supportOfERedCap-r18) shall support a data rate for the carrier that is no smaller than the data rate computed using the above formula, with J=1 CC and component vLayers(j)⋅Qmj⋅fj is no smaller than 4. For UE indicating supportOfEnhancedRedCap-r18 in single carrier NR SA operation, the UE shall support a data rate for the carrier that is no smaller than the data rate computed using the above formula, with J=1 CC and component vLayers(j)⋅Qmj⋅fj is no smaller than 0.75 if UE does not indicate supportOfNotReducedBB-BW-r18 or 3.2 if UE also indicates supportOfNotReducedBB-BW-r18.”).*

The following are RAN1 agreements on feature list [1] relevant to this discussion (the latest inputs were provided in RAN1 LS [2]):

|  |  |  |
| --- | --- | --- |
| **Feature #** | **48-1** | **48-2** |
| **Group** | **RedCap UE with reduced peak data rate and reduced baseband bandwidth in FR1** | **RedCap UE with reduced peak data rate without reduced baseband bandwidth in FR1** |
| **Components** | The following components are the same as for *supportOfRedCap-r17* (28-1):  1. Maximum FR1 RedCap UE bandwidth is 20 MHz.  3. Early indication of RedCap UE in Msg.1 for 4-step RACH  4. Separate initial UL BWP for RedCap UEs  - It includes the configuration(s) needed for RedCap UE to perform random access  - Enabling/disabling of frequency hopping for common PUCCH resources  5. Separate initial DL BWP for RedCap UEs  - It includes CSS/CORESET for random access  - For separate initial DL BWP used for paging, CD-SSB is included  - For separate initial DL BWP only used for RACH, SSB may or may not be included  - For separate initial DL BWP used in connected mode as BWP#0 configuration option 1, CD-SSB is included  6. 1 UE-specific RRC configured DL BWP per carrier  7. 1 UE-specific RRC configured UL BWP per carrier  8. RRC reconfiguration of any parameters related to BWP  9. UE-specific RRC configured DL BWP with CD-SSB or NCD-SSB  10. NCD-SSB based measurements in RRC-configured DL BWP  The following components are new compared to *supportOfRedCap-r17* (28-1):  11. DL/UL peak data rate target of 10 Mbps corresponding to *vLayers*·*Qm*·*f* = 3.2  12. Maximum number of PDSCH/PUSCH PRBs that can be scheduled for unicast per slot of 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS  13. Relaxed processing timeline of 1/0.5 ms for 15/30 kHz SCS when the RAR PDSCH and MsgB PDSCH (if supported) is larger than 25/12 PRBs for 15/30 kHz SCS  14. Network-configurable additional separate early indication in Msg1 for Rel-18 eRedCap UEs  FFS whether to add additional components | Component 13 in FG 48-1 is supported by FG 48-2 during initial access.  The capabilities of FG 48-2 are the same as for FG 48-1 except that the following restriction does not apply:  12. Maximum number of PDSCH/PUSCH PRBs that can be scheduled for unicast per slot of 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS  Component 11 in FG 48-1 does not apply and DL/UL peak data rate target of 10 Mbps corresponding to *vLayers*·*Qm*·*f* = 0.75 when *vLayers* = 1 and *vLayers*·*Qm*·*f* = 0.8 when *vLayers* = 2 |
| **Pre-req.** |  | 48-1 |
| **Need for gNB to know if feature is supported** | Y | Y |
| **Consequence if the feature is not supported by the UE** | Network assumes the UE is not a RedCap UE with reduced peak data rate without reduced baseband bandwidth in FR1 | Network assumes the UE is not a RedCap UE with reduced peak data rate without reduced baseband bandwidth in FR1 |
| **Type** | Per UE | Per UE |
| **FDD/ TDD diff** | No | No |
| **FR1/ FR2 diff** | FR1 only | FR1 only |
| **Note** | A UE supporting this FG is not required to support FG 6-1.  A UE supporting this FG is not allowed to support FG 28-1.  The specifications for a UE supporting FG 28-1 (‘RedCap UE’) also apply for a UE supporting this FG (FG 48-1) unless stated otherwise.  It is up to RAN2 whether/how to capture the capabilities for early indication of RedCap UE in Msg 3 and Msg A.  It is up to RAN2 whether/how to capture the capabilities for additional separate early indication of Rel-18 eRedCap UE in Msg 3 and Msg A PUSCH. |  |
| **Mandatory/ Optional** | Optional with capability signaling  UEs supporting Rel-18 eRedCap UE complexity reduction feature(s) indicate support of this FG instead of FG 28-1 (supportOfRedCap-r17). | Optional with capability signaling |

In addition, RAN1 also provided inputs on their agreements on the reduced peak data rate for Rel-18 eRedCap UEs in LS [3] as it seems to have specification impacts at least on TS 36.306 clause 4.1.2 (‘Supported max data rate for DL/UL’):

* *The UE signals peak data rate related parameters vLayers, Qm and f corresponding to 10 Mbps.*
  + *No new values for the above parameters will be introduced for Rel-18 eRedCap.*
* *For UE peak data rate reduction with UE BB bandwidth reduction (i.e., FG 48-1),*
  + *The 10-Mbps peak rate target corresponds to a vLayers·Qm·f of 3.2.*
  + *25 PRBs for and 12 PRBs for for  is always assumed in the UE supported max data rate expression in TS 38.306 for any given band.*
* *For UE peak data rate reduction without UE BB bandwidth reduction (i.e., FG 48-2),*
  + *When vLayers = 1, the 10-Mbps peak rate target corresponds to a vLayers·Qm·f of 0.75.*
  + *When vLayers = 2, the peak rate target corresponds to a vLayers·Qm·f of 0.8.*
  + *106 PRBs for and 51 PRBs for for  is always assumed in the UE supported max data rate expression in TS 38.306 for any given band.*
* *In all cases, the same value for vLayers·Qm·f is used for DL and UL.*

On summary, considering above agreements/updates, this document aims to collect companies’ inputs on the suggested TPs for the temporary CRs on RAN1 lead features, and the draft CRs on RAN2 lead features/topics.

# Companies’ point of contact (PoC)

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| **Company’s name** | **PoC’s name** | **PoC’s email address** |
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# Discussion

## [RAN1 lead features] Temporary CRs to TS 38.306 and 38.331 on UE Capabilities for eRedCap

1. Do you agree with the way eRedCap terminology is updated in the description of **FG 48-1,** i.e. *enhRedCap-r18*(related TP is highlighted in pink on the temporary CR to TS 38.306 which captures the agreed details on **RAN1 lead features** of UE Capabilities for eRedCap)? If not, please indicate your suggested TP.

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Ericsson | Yes, but | *- enhRedCap-r18* should be replaced with *eRedCap-r18* as captured in the running 38.331 CR.  - it would be better if we clarify what “separate” indicates in the statements below:  “Separate initial UL BWP for eRedCap UEs”  “Separate initial DL BWP for eRedCap UEs”  Is the initial BWP separate with respect to RedCap UEs, non-RedCap UEs or both?  - is the following a functional UE component?  “Enabling/disabling of frequency hopping for common PUCCH resources”  - It would be better if we clarify what “option 1” is in the following  “For separate initial DL BWP used in connected mode as BWP#0 configuration option 1, CD-SSB is included”  - it would be better if we capture what is applicable when an eRedCap UE does not support *notReducedBB-BW-r18*, in the following:  “- Maximum number of PDSCH/PUSCH PRBs that can be scheduled for unicast per slot of 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS.  - If eRedCap UE also supports *notReducedBB-BW-r18,* this component is not applicable”  *- enhRedCap-r18* should be replaced with *eRedCap-r18* as captured in the running TS 38.331 CR in the following:  “***notReducedBB-BW-r18***  Indicates that the UE is an eRedCap UE without reduced baseband bandwidth in FR1. UE supporting this feature shall indicate the support of *enhRedCap-r18*.” |
| Huawei, HiSilicon | Generally agree, see comment | 1. Suggest to split those descriptions for FG 48-1 into two parts, as in R1 UE feature list, i.e. components are the same as for *supportOfRedCap-r17* (28-1) and new components; 2. “eRedCap UEs” seems not necessary in following bullets, we can just remove:    * Maximum FR1 bandwidth is 20 MHz; 3. Wording suggestion to “additional separate early indication in Msg1 for eRedCap UEs”: the “additional” is not clear in specification. Maybe we can just remove it and “separate early indication in Msg1 for eRedCap UEs” should be sufficient to refer the R18 new Msg1 identification. |
| MediaTek | Mostly yes | Agree with the use of eRedCap terminology.  A few comments on the actual text itself:  1. Suggest aligning parameter name with RedCap, i.e. ‘supportOfEnhRedCap-r18’  2. Not necessary to add ‘eRedCap UE’ to all the sub-bullets as the main bullet defines the UE as an ‘eRedCap UE’. At the very least, should remove eRedCap from separate initial BWPs (as it could be read to imply that we’ve introduced new eRedCap specific initial BWPs)  3. Suggest stating peak data rate of 10Mbps, rather than peak data rate target of 10Mbps. A target of 10Mbps could imply that a UE may not achieve this target? |
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1. Do you agree with the way proposed to capture **the differences between FG 48-1 and FG 48-2,** i.e. *enhRedCap-r18* and *notReducedBB-BW-r18* (related TP is highlighted in blue on the temporary CR to TS 38.306 which captures the agreed details on **RAN1 lead features** of UE Capabilities for eRedCap)? If not, please indicate your suggested TP.

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Ericsson |  | Please see our comments above in DP 1. |
| Huawei, HiSilicon | Generally agree, see comment | We support the intention from rapporteur.  Comment 1:  “instead, DL/UL peak data rate target of 10 Mbps corresponding to *vLayers*·*Qm*·*f* = 0.75 when *vLayers* = 1 and *vLayers*·*Qm*·*f* = 0.8 when *vLayers* = 2”  This text is suggest to move to field description of *notReducedBB-BW-r18*.  Comment 2:  “Relaxed RAR-PDSCH processing timeline of 1/0.5 ms for 15/30 kHz SCS when the RAR PDSCH and MsgB PDSCH (if supported) is larger than 25/12 PRBs for 15/30 kHz SCS.  - If eRedCap UE also supports *notReducedBB-BW-*r18, this component is only applicable during initial access and contention based random access. ”  “supported” is suggested to be changed as “applicable”. In addition, this should also be applied in “CBRA in connected mode” since NW does not know whether a UE is FG 48-1 or FG 48-1a during CBRA. See the above updates. |
| MediaTek | Yes |  |
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1. Please indicate if you have any other input/comments on the temporary CRs to TS 38.306 and 38.331 which captures the agreed details on **RAN1 lead features** of UE Capabilities for eRedCap.

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| **Company’s name** | **TS #** | **Section** | **Comments, if any** |
| Ericsson | 38.306 |  | Please see our comments above in DP 1. |
|  | 38.331 |  | - In section 6.3.3, in the marked text below *enhRedCap-r18* should be replaced with *eRedCap-r18* as captured in the running 38.331 CR:  “enhRedCap-r18 ENUMERATED {supported} OPTIONAL,”  - In the same section, the parameter *notReducedBB-BW-r18* can be renamed to reflect that it is affiliated with an eRedCap UE. How about *eRedCapNotReducedBB-BW-r18* or *eRedCapReducedBB-BW-r18* and update the description of the parameter accordingly. |
| Huawei, HiSilicon | General |  | Do we need to combine the “tempCR” and “draftCR” into one document for easy review, at least for 38.306? |
| Huawei, HiSilicon | 38.331 |  | The new fields should be added in *RedCapParameters-r17* (or a new *EnhRedCapParameters-r18*), same place as R17 RedCap UE. Disagree to put those into *Phy-ParametersCommon*. |

## [RAN2 lead features/topics] Drafted CRs to TS 38.306 and 38.331 on UE Capabilities for eRedCap

1. Do you agree with the way that it is captured that **Rel-18 eRedCap UE can support all RAN2-centric Rel-17 RedCap capabilities** (related TP is highlighted in pink on the drafted CRs to TS 38.306 which captures the agreed details on **RAN2 lead features** of UE Capabilities for eRedCap)? If not, please indicate your suggested preference/TP.

This question is related to the following RAN2#123 agreement:

* *A Rel-18 eRedCap UE (both FG 48-1 and FG 48-2) can also support all RAN2-centric Rel-17 RedCap UE capabilities in the same manner.*
  + *Discuss during CR implementation how to capture this in TS 38.306: option 1) add in the field description of R18 eRedCap capability (i.e. supportOfEnhancedRedCap-r18) the following statement “all supportOfRedCap-r17 related capabilities specified in this specification remain applicable for Rel-18 RedCap UEs, unless indicated otherwise” or option 2) update the field description of the RAN2-centric Rel-17 RedCap UE capabilities to be applicable to (e)RedCap UEs.*

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Ericsson | Yes, but | - In section 4.1.2 in the marked text below *enhRedCap-r18* should be replaced with *eRedCap-r18* as captured in the running 38.331 CR:   * no smaller than 4 except for a UE supporting *enhRedCap-r18*. * 3.2 if UE supports *enhRedCap-r18* but does not support *notReducedBB-BW-r18.* * 0.75 if and UE supports *enhRedCap-r18* and *notReducedBB-BW-r18*. * 0.8 if and UE supports *enhRedCap-r18* and *notReducedBB-BW-r18*.   - In the same section for the marked text above, please see our comments above in DP 3 regarding the parameter *notReducedBB-BW-r18*.  - In section 4.2.6 for the marked description below:  “***extendedDRX-CycleInactive-r18***  Indicates whether UE supports the extended DRX in RRC\_INACTIVE with values above 1024 radio frames as specified in TS 38.331 [9]. The UE may indicate support of this capability only if it supports extended DRX in RRC\_IDLE.”  We should provide a reference to TS 38.306, so it can be either 38.306 or 38.306 and 38.331. |
| Huawei, HiSilicon | Yes, but | The specifications and capabilities of a RedCap UE are also applicable to eRedCap UEs unless stated otherwise.  We suggest to change “specifications” as “features”.  This is because that RAN2 agree the spirit to check the specification text to add (e)RedCap explicitly, which means the specification text with only “RedCap” does not directly apply to eRedCap UE. |
| MediaTek | No | Having taken a look through the temp R1 and draft R2 CRs, the generic sentence ‘*specifications and capabilities of a RedCap UE are also applicable to eRedCap UEs unless stated otherwise*’ doesn’t seem to add any value and might hinder the spec from being future proof.  The temp R1 CR lists all the components of eRedCap including those inherited from RedCap. The draft R2 CR includes an update to the definitions from RedCap to (e)RedCap. With these two CRs, it looks like we have Option 2 in place, which is clean and forward compatible. |
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1. Please indicate if you have any other input/comments on the drafted CRs to TS 38.306 and 38.331 which captures the agreed details on **RAN2 lead features/topics** of UE Capabilities for eRedCap during RAN2#123 meeting.

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| **Company’s name** | **TS #** | **Section** | **Comments, if any** |
| Ericsson | 38.306  38.331 |  | - Please see our comments above in DP 4.  - In section 6.3.3, regarding the marked text below:  extendedDRX-CycleInactive-r18 ENUMERATED {supported} OPTIONAL  It should be *extendedDRX-CycleInactive-v18xy* considering that parameter *extendedDRXCycleInactive* was introduced in Rel-17. |
| Huawei, HiSilicon | 38.306 | 4.2.21.2 | ***ncd-SSB-ForRedCapInitialBWP-SDT-r17***  Indicates that the UE supports using RedCap-specific initial DL BWP associated with NCD-SSB for SDT. If absent, the UE only supports SDT in an initial DL BWP that includes the CD-SSB. UE supporting this feature shall indicate support of *supportOfRedCap-r17* or *enhRedCap-r18* and *ra-SDT-r17 and/or cg-SDT-r17*.  This capability also applies to eRedCap UE. We should clarify as above. |
| Huawei, HiSilicon | 38.306 |  | We should also add “(e)RedCap UEs” for following parameters field descriptions:   * nr-CGI-Reporting-NPN-r16 * reportAddNeighMeasForPeriodic-r16 * nr-CGI-Reporting * eutra-CGI-Reporting * pdsch-256QAM-FR1 * supportedBandwidthUL, supportedBandwidthUL-v1710 * supportedBandwidthDL, supportedBandwidthDL-v1710 * channelBWs-UL * channelBWs-DL * bwp-SameNumerology, bwp-DiffNumerology * Rel-17 relaxed measurement for RRC\_IDLE/RRC\_INACTIVE in section 5.6 * “The number of DRBs that a UE shall support. 8 per UE, for RedCap UEs” in section 8 |
| MediaTek | 38.306 | 4.1.2 | RAN plenary agreed that peak data rate for eRedCap is 10Mbps (see revised WID RP-232671). However, current text in section 4.1.2 indicates that eRedCap UE peak data rate is ‘no smaller than’ 10Mbps. This needs to be clarified.  In addition, eRedCap UEs with reduced BW should use a different value of Nprbs (i.e. not use the channel BW value of 20MHz).  We therefore propose the following change:  *For single carrier NR SA operation, a UE that is not an eRedCap UE shall support a data rate for the carrier that is no smaller than the data rate computed using the above formula,* *with and* *component is no smaller than 4.*  *For single carrier NR SA operation, an eRedCap UE shall support a peak data rate of 10Mbps computed using the above formula, with and:*   * *if the UE does not support notReducedBB-BW-r18:*   + *component is 3.2, and;*  * + *is 25 if μ = 0;*   + *is 12 if μ = 1;* * *else:*   + *component is 0.75 if =1;*   + *component*  *is 0.8 if =2.* |

# Report <<To be added>>

*<<Report from this email discussion [to be added by rapporteur] >>*

1. xxxx.

# Conclusion

The proposals captured are the following:

**Proposal 1.** xxxx.

# Reference

1. R1-2308521, Updated RAN1 UE features list for Rel-18 NR after RAN1#114, August 2023.
2. R1-2308523, LS on Rel-18 RAN1 UE features list for NR after RAN1#114, From: RAN1, To: RAN2, Ccing: RAN4, August 2023.
3. R1-2308610, LS on reduced peak data rate for Rel-18 eRedCap UEs, Rel-18, From: RAN1, To: RAN2, Ccing: RAN4, August 2023.