3GPP TSG RAN WG2 Meeting #114 [Draft] R2-2106521

**Electronic meeting, 19th-27th May 2021**

**Agenda item:** 8.12.2.1

**Source:** Intel Corporation

**Title:** Summary of [AT114-e][105][RedCap] Definition of RedCap UE and reduced capabilities (Intel)

**Document for:**  Discussion and decision

# Introduction

This document is the summary of following offline discussion:

**[AT114-e][105][RedCap] Definition of RedCap UE and reduced capabilities (Intel)**

Initial scope: Discuss the proposals from [R2-2106462](file:////Users/etuotir/OneDrive%20-%20Ericsson/3gpp/RAN2/114/Tdocs/)

Initial intended outcome: Summary of the offline discussion with e.g.:

  List of proposals for agreement (if any)

  List of proposals that require online discussions

  List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Thursday 2021-05-20 07:00 UTC

Initial deadline (for rapporteur's summary in [R2-2106521](file:////Users/etuotir/OneDrive%20-%20Ericsson/3gpp/RAN2/114/Tdocs/)): Thursday 2021-05-20 09:00 UTC

# Discussion

## Definition and capability signaling

### Capability design principle

**Summary in [20]on “how to capture RedCap capabilities” is cited as following:**

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| **Observation 1:** Regarding the capability design principle, the main difference between alternative 1 and 2 is whether to define an new independent container to contain all optional features for RedCap UEs;**Alternative 1** (to extend UE-NR-Capability using NCE for optional capabilities): 5 companies (vivo, Intel, Ericsson, CATT, Huawei)**Alternative 2**: Introduce an new container to contain all optional features:**Alternative 2.1** (introduce an new container to contain all optional features even if they are same (same value range) as legacy) : 2 companies (ZTE, CTC)**Alternative 2.2** (introduce an new container to contain all optional features except capabilities with same value range as legacy): 1 (Qualcomm)Accordingly to the WID [19], “o The existing UE capability framework is used; changes to capability signalling are specified only if necessary.”, Rapporteur considers Alternative 1 is more aligned with the guidance. However there is no clear majority on this. Considering the main difference between alternative 1 and 2 is whether to introduce a container to carry the RedCap UE capabilities, Rapporteur proposes:**Proposal 1:** [To discuss] Ask RAN2 to discuss whether to extend UE-NR-Capability (using non-critical extension) to include alternative 1) optional capabilities for Redcap UEs (5 support) or alternative 2) introduce an new independent container to contain all optional features for RedCap UEs (with alternative 2.1 even if some of them are same as legacy non-RedCap UE capabilities (2 support), or alternative 2.2 except capabilities with same value range as legacy (1 support)).  |

**Discussion point 1: how to capture RedCap capabilities (new container or not):**

**Option 1** (to extend UE-NR-Capability using NCE for optional capabilities): 5 companies (vivo, Intel, Ericsson, CATT, Huawei)

**Option 2**: Introduce an new container to contain all optional features:

**Option 2.1** (introduce an new container to contain all optional features even if they are same (same value range) as legacy) : 2 companies (ZTE, CTC)

**Option 2.2** (introduce an new container to contain all optional features except capabilities with same value range as legacy): 1 (Qualcomm)

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| **Company’s name** | **Option(s)** | **Comments, if any** |
| OPPO | Option 1 | If RedCap-specific capabilities are only a few, it seems that extending UE-NR-Capability would be sufficient. |
| ZTE | Option 2.1 with comments | We think no matter which option is selected, we (RAN2/1/4) need to analysis all existing UE features case by case, in order to identify whether a feature is applicable/not applicable to RedCap. So the difference between Option 1 and Option 2.1 is whether to put the identified applicable capabilities into a separate container. If network or operators want to prevent RedCap UE from using non-intended use case, then Option 2.1 is straightforward because RedCap can only report the capabilities that are applicable to RedCap. (easy to do what described in Proposal 7)In addition, RedCap is intended for low complexity devices, we should try to limit the number of features required for RedCap, otherwise, the distinction between RedCap and non-RedCap will become increasingly blurred. By using Option 2.1, all new (advanced) features introduced in other WIs are considered as “**not applicable”** to RedCap by default, so it is helpful for limiting the features required for RedCap. (This also relates to discussion point 2)  |
| Ericsson | Option 1  | First, we think the exact location where any new signaling is captured is a stage-3 detail and should not be decided until we understand the details, e.g. which new capabilities are needed. We do not think there is need to define many new capabilities, and as we have discussed in our paper [R2-2105234](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_114-e/Docs//R2-2105234.zip) [7] the existing signaling should be sufficient in many cases. There should be no reason to duplicate existing capabilities in two different locations if existing signaling can be used. As also indicated in the WID, the legacy framework should be used as much as possible, and Option 1 follows that principle. We don’t think a new container is needed. |
| Apple | Option 1 | We do not see the need to deviate from the usual way capabilities are added in RAN2. |
| MediaTek | Option 1 | We agree with Ericsson that the location to capture new signaling is a stage-3 detail and should not be decided until we know the details. As a starting assumption, we see no reason to deviate from the way capabilities are captured today or to duplicate existing capability signaling unnecessarily |
| Qualcomm | Option 2.2 | In our view, a new RedCap container is a cleaner way to signal capabilities for which RedCap UEs are different from non-RedCap UEs. So Option 2 is a better way to go. Between Option 2.1 and Option 2.2, we prefer Option 2.2 but can support 2.1 too if it is preferred by the majority.  |
| Sequans | Option 2.2? | This s a Stage 3 detail that should be decided later. Current signalling already has containers (e.g. for IMS, sidelink,…) so we do not think this is an issue of diverging from legacy.Having a separate container would make things more straightforward, but in general as long as applicable features are clearly marked as such all options can work.To limit rediscussing this issue later we would be fine with reaching a WA. |
| Intel | Option 1 | More aligned with WID description “ The existing UE capability framework is used; changes to capability signalling are specified only if necessary.”. Do not see the need to introduce new container. |
| Lenovo | Option.1 | It is related to the details in stage.3, generally, it is not necessary to introduce a new container to change the legacy way on capability signaling. |
| LGE | Option 1 | Agree with Ericsson that stage-3 detail should not be decided until we know the details.  |

**Summary in [20]on “RedCap capabilities design principle” is cited as following:**

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| [11] provided the full lists as below:

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| **Proposal 3b: Specify RedCap UE capabilities according to the principles below:****3-1: For RedCap UE’s mandatory without signalling features, which are optional or mandatory with capability signalling or mandatory without capability signalling but with different value(s) for non-RedCap UE (e.g. 20M bandwidth for FR1 and 100M bandwidth for FR2) or newly introduced in R17 (if any), clarify in TS 38.306 in the new section for RedCap UEs;****3-2: For RedCap UE’s optional features, which are mandatory without capability signalling for non-RedCap UEs (if any), or newly introduced in R17 for RedCap (e.g. HD-FDD, 1Rx/2Rx in some 4Rx mandatory band), add new UE capability signalling in TS 38.331 and capture them in the new section for RedCap UEs in TS 38.306;****3-3: For RedCap UE’s optional features, which are optional for non-RedCap UE but with different value (if any), either add new capability signalling or extend the legacy capability signalling, and also capture them in TS 38.306;****3-4: For the features not applicable to RedCap UE but optional supported or mandatory supported with capability signalling by non-RedCap UE, clarify in the definitions for parameters in TS 38.306 that “This capability is not applicable to RedCap UE” (e.g. CA, DC, 256QAM);****3-5: For the features not applicable to RedCap UE but mandatory without capability signalling supported by non-RedCap UE, clarify in TS 38.306 in the new section for RedCap UEs (e.g. bandwidths above 100MHz for FR2).** |

Rapporteur considers this as a good starting point, and would suggest:**Proposal 2** [To discuss] Ask RAN2 to discuss whether following capability design principle can be agreed or not: **Proposal 2.1** For RedCap UE’s mandatory without signalling features, which are optional or mandatory with capability signalling or mandatory without capability signalling but with different value(s) for non-RedCap UE (e.g. 20M bandwidth for FR1 and 100M bandwidth for FR2) or newly introduced in R17 (if any), clarify in TS 38.306 in the new section for RedCap UEs;**Proposal 2.2** For RedCap UE’s optional features, which are mandatory without capability signalling for non-RedCap UEs (if any), or newly introduced in R17 for RedCap (e.g. HD-FDD, 1Rx/2Rx in some 4Rx mandatory band), add new UE capability signalling in TS 38.331 and capture them in the new section for RedCap UEs in TS 38.306;**Proposal 2.3** For RedCap UE’s optional features, which are optional for non-RedCap UE but with different value (if any), either add new capability signalling or extend the legacy capability signalling, and also capture them in **TS 38.306;****Proposal 2.4** For the features not applicable to RedCap UE but optional supported or mandatory supported with capability signalling by non-RedCap UE, clarify in the definitions for parameters in TS 38.306 that “This capability is not applicable to RedCap UE” (e.g. CA, DC, 256QAM);**Proposal 2.5** For the features not applicable to RedCap UE but mandatory without capability signalling supported by non-RedCap UE, clarify in TS 38.306 in the new section for RedCap UEs (e.g. bandwidths above 100MHz for FR2). |

Rapporteur noticed that the design principle also mentioned examples, we should discuss the principle first without mentioning these examples, i.e.

***Proposal 2.1*** *For RedCap UE’s mandatory without signalling features, which are optional or mandatory with capability signalling or mandatory without capability signalling but with different value(s) for non-RedCap UEor newly introduced in R17 (if any), clarify in TS 38.306 in the new section for RedCap UEs;*

***Proposal 2.2*** *For RedCap UE’s optional features, which are mandatory without capability signalling for non-RedCap UEs (if any), or newly introduced in R17 for RedCap , add new UE capability signalling in TS 38.331 and capture them in the new section for RedCap UEs in TS 38.306;*

***Proposal 2.3*** *For RedCap UE’s optional features, which are optional for non-RedCap UE but with different value (if any), either add new capability signalling or extend the legacy capability signalling, and also capture them in* ***TS 38.306*** *in the new section for RedCap UEs* ***;***

***Proposal 2.4*** *For the features not applicable to RedCap UE but optional supported or mandatory supported with capability signalling by non-RedCap UE, clarify in the definitions for parameters in TS 38.306 that “This capability is not applicable to RedCap UE”;*

***Proposal 2.5*** *For the features not applicable to RedCap UE but mandatory without capability signalling supported by non-RedCap UE, clarify in TS 38.306 in the new section for RedCap UEs.*

**Discussion point 2: Do you support the RedCap capability design principle listed in above proposal 2 series?**

**Please justify your response if any.**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes |  |
| ZTE | No to Proposal 2.4 | If Option 1 or Option 2.2 is adopted for capability signalling design, then we do have strong concern on Proposal 2.4. As we indicated before, we doubt whether other WIs or Rel-18/19 WIs will discuss the applicability of RedCap when introducing each new feature in the future. So the best/safest way is to do the opposite, i.e. to indicate in TS 38.306 that “This capability is applicable to RedCap UE.”So all new (advanced) UE features can be considered as not applicable to RedCap by default. e.g. eDCCA, NTN…So we suggest to reword Proposal 2.4 as :***Proposal 2.4*** *For the features ~~not~~ applicable to RedCap UE and ~~but~~ optional supported or mandatory supported with capability signalling by non-RedCap UE, clarify in the definitions for parameters in TS 38.306 that “This capability is ~~not~~ applicable to RedCap UE”* |
| Ericsson | Clarifications needed | We’d like to clarify the intention of Proposal 2.1 – if there is existing capability bit or field already, that should be re-used. The Proposal seems to say that something else would be done e.g. for capabilities which are mandatory with capability signaling. Such signaling should be reused.P2.2 and P2.3 look fine in principle, but not sure whether a new section is needed – this can be decided later after we e.g. know what kind of definition we have for RedCap.P2.4 we have different view from ZTE. Also, technically what P2.4 proposes shouldn’t even be needed. Details case-by-case depend on what we have already in the signaling, e.g. CA would be implicit from band combinations which RedCap UEs shouldn’t indicate. P2.5 looks fine in principle.  |
| Apple | Ok except for a clarification of 2.1, 2.3 | *P2.1: For RedCap UE’s mandatory without signalling features, which are optional or mandatory with capability signalling or mandatory without capability signalling but with different value(s) for non-RedCap UE or newly introduced in R17 (if any), clarify in TS 38.306 in the new section for RedCap UEs;*It is not clear what does ‘clarify’ mean? If there is already a capability defined for nonRedCap, we can say that RedCap should mandatorily signal this capability. From that aspect, we are not sure what would be the meaning of *RedCap UE’s mandatory without signalling features*. For 2.3, we are not sure if a new section is needed. But no strong view. |
| MediaTek | Ok except for P2.3 | P2.3: Whether a new section is needed can be decided when we are in stage-3 discussions |
| Qualcomm | Yes | Regarding the comment by ZTE on P2.4: we think it is important to explicitly capture features/capabilities that are either supported by **all** RedCap UEs or not supported by **all** RedCap UEs. Everything else, i.e. those not explicitly captured in the new RedCap section should be optional for individual implementation. |
| Sequans | No to 2.4OK with the rest with comments; | Whether or not a new section is used is a Stage 3 detail, but we would be OK to reach a WAP2.1 – Agree with the previous comments that where existing signalling exists it should be used and just mandated for RedCap UEsP2.4 – Agree with ZTE it is preferable to explicitly include rather than explicitly exclude |
| Intel | See comments on 2.1, 2.2, 2.3 and 2.5 | Do not see the strong need to introduce new section for RedCap UE in TS38.306.We could add these RedCap specific description in the definitions of RedCap UE capability bit (proposed in discussion point 4) and/or the definitions of corresponding parameters in TS38.306;***Proposal 2.1*** *For RedCap UE’s mandatory without signalling features, which are optional or mandatory with capability signalling or mandatory without capability signalling but with different value(s) for non-RedCap UEor newly introduced in R17 (if any), clarify in the definition for new RedCap UE capability bit in TS 38.306 ~~in the new section for RedCap UEs~~;****Proposal 2.2*** *For RedCap UE’s optional features, which are mandatory without capability signalling for non-RedCap UEs (if any), or newly introduced in R17 for RedCap , add new UE capability signalling in TS 38.331 and capture ~~them in the new section for RedCap UEs~~ the restriction in the definitions for parameters, in TS 38.306 e.g. the capability is not applicable for non-RedCap UE;****Proposal 2.3*** *For RedCap UE’s optional features, which are optional for non-RedCap UE but with different value (if any), either add new capability signalling or extend the legacy capability signalling, and also capture ~~them~~ the restriction in the definitions for parameters, in* ***TS 38.306*** *e.g. the value is not applicable for RedCap UE or only applicable for RedCap UE****;******Proposal 2.4*** *For the features not applicable to RedCap UE but optional supported or mandatory supported with capability signalling by non-RedCap UE, clarify in the definitions for parameters in TS 38.306 that “This capability is not applicable to RedCap UE”;****Proposal 2.5*** *For the features not applicable to RedCap UE but mandatory without capability signalling supported by non-RedCap UE, clarify in the definition for new RedCap UE capability bit in TS 38.306 ~~in the new section for RedCap UEs~~.* |
| Lenovo | Yes | Same view as Qualcomm. |
| LGE | Yes | We are generally fine with the principles listed. |

### Capabilities for RedCap UE

**Summary in [20]on “how to apply the capability design principle for RedCap specific capabilities” is cited as following:**

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| R2-2104927 Intel, R2-2105234 Ericsson and R2-2105634 Huawei also proposed how to design capabilities for them. **Summary how to apply the capability design principle for RedCap specific capabilities:** If the capability design principle in proposal 2 can be agreed. Rapporteur think it would be good to further discuss how to apply the principle for RedCap specific capabilities which we already know, and therefore propose:**Proposal 3:** [2nd priority topic ] If the capability design principle in proposal 2 is agreed, to further discuss how to apply the capability principle for following features: Maximum bandwidth (20M for FR1 and 100M for FR2)Minimum number of Rx branches (1 )Maximum number of DL MIMO Layers (1 DL MIMO layer for 1 RX and 2 DL MIMO layer for 2 Rx)Relaxed maximum modulation order (optionally support 256QAM for DL)Not support carrier aggregation, dual connectivityHD-FDD type A with the minimum specification impact (Note that FD-FDD and TDD are also supported.) |

Based on [11], how to apply the capability design principle (proposal 2 seriers) for RedCap specific capabilities is listed as below:

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| **Capability** | **Design principle** |
| Maximum bandwidth (20M for FR1 and 100M for FR2) | ***Proposal 2.1*** *For RedCap UE’s mandatory without signalling features, which are optional or mandatory with capability signalling or mandatory without capability signalling but with different value(s) for non-RedCap UE (****e.g. 20M bandwidth for FR1 and 100M bandwidth for FR2****) or newly introduced in R17 (if any), clarify in TS 38.306 in the new section for RedCap UEs;****Proposal 2.5*** *For the features not applicable to RedCap UE but mandatory without capability signalling supported by non-RedCap UE, clarify in TS 38.306 in the new section for RedCap UEs (****e.g. bandwidths above 100MHz for FR2****).* |
| Minimum number of Rx branches (1 ) | ***Proposal 2.2*** *For RedCap UE’s optional features, which are mandatory without capability signalling for non-RedCap UEs (if any), or newly introduced in R17 for RedCap* ***(e.g. HD-FDD, 1Rx/2Rx in some 4Rx mandatory band****), add new UE capability signalling in TS 38.331 and capture them in the new section for RedCap UEs in TS 38.306;* |
| Maximum number of DL MIMO Layers (1 DL MIMO layer for 1 RX and 2 DL MIMO layer for 2 Rx) | ? |
| Relaxed maximum modulation order (optionally support 256QAM for DL) | ***Proposal 2.4*** *For the features not applicable to RedCap UE but optional supported or mandatory supported with capability signalling by non-RedCap UE, clarify in the definitions for parameters in TS 38.306 that “This capability is not applicable to RedCap UE” (e****.g. CA, DC, 256QAM****);* |
| Not support carrier aggregation, dual connectivity | ***Proposal 2.4*** *For the features not applicable to RedCap UE but optional supported or mandatory supported with capability signalling by non-RedCap UE, clarify in the definitions for parameters in TS 38.306 that “This capability is not applicable to RedCap UE” (****e.g. CA, DC, 256QAM****);* |
| HD-FDD type A with the minimum specification impact (Note that FD-FDD and TDD are also supported.) | ***Proposal 2.2*** *For RedCap UE’s optional features, which are mandatory without capability signalling for non-RedCap UEs (if any), or newly introduced in R17 for RedCap* ***(e.g. HD-FDD, 1Rx/2Rx in some 4Rx mandatory band),*** *add new UE capability signalling in TS 38.331 and capture them in the new section for RedCap UEs in TS 38.306;* |

**Discussion point 3: Do you agree the handling on RedCap specific capabilities listed in above table? Please indicate your comments/suggestions if any.**

**Note: Discussion point 3 depends on the outcome of discussion point 2.**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes |  |
| ZTE | See comments | We think RAN2/1/4 should discuss all UE features one by one, not only above listed ones. So we think it is not hurry to agree anything now. Considering the workload and limited time in Q3, we prefer to discuss UE features via long term discussion as early as possible (e.g. after May meeting). And LS can be sent to RAN1/4 to ask them to trigger the discussion on UE features.  |
| Ericsson | Not clear | The proposals or right column say that 256QAM is not applicable to RedCap, which is incorrect, it is optional to support for DL. The table is not crystal clear on what is actually proposed for each of the features. Wouldn’t it be easier to see the current signaling for the related (RedCap) features, whether any signaling exists already or not and then decide what to do? We don’t think we should go through all existing features like ZTE proposes. For maximum bandwidth, it is not clear what is proposed – existing signaling can be reused as all code points are there already. There’s existing capability for MIMO layers which can be reused. It can be further discussed whether same capability is re-used to indicate Rx chains, for which there are no current capabilities. For 256QAM signaling can be made optional for RedCap. HD-FDD within a single carrier likely needs a new capability, but can wait for RAN1 details on this.  |
| Apple | We are ok with this, but pls see comments | We think that 20M BW/100M BW for RedCap is not a mandatory without capability signaling. It is stated that these BWs are to be supported, but no explicit agreement that capability is not needed. And we already have the capability signaling which can be reused with necessary clarification in 38.306.  |
| MediaTek | Yes | As far as possible, we should reuse existing capability signaling with clarifications in 38.306 |
| Qualcomm | See comment | Regarding 256QAM, it is optional for DL for RedCap. So P2.2 should be applied instead.We are fine with other capabilities and their associated principles.  |
| Sequans | No | Agree with ZTE, the capabilities discussion should be done comprehensively.We are fine to agree a principle such as the one stated by MediaTek, to reuse existing capability signaling as much as possible, with clarifications in 38.306 |
| Intel | See comments | **Maximum BW (not same as the table)**: Considering there is “SupportedBandwidth” and some values are mandatory, we have different view, i.e. not same as the behaviour shown in the table. It should follows the behaviour described by P2.4 of discussion point 2 (including the suggested changes provided)**Max Rx**: we share the view shown in the table (i.e. this capability follows the behaviour described by P2.2) of discussion point 2 (including the suggested changes provided)**MIMO-Layer (not in the table)**: this capability was not included in above table but we understand that it follows the behaviour described by P2.4 of discussion point 2 (including the suggested changes provided)**256QAM** (same as table): we share the view shown in the table (i.e. this capability follows the behaviour described by P2.4) of discussion point 2 (including the suggested changes provided)**CA/DC** (same as table): we share the view shown in the table (i.e. this capability follows the behaviour described by P2.4) of discussion point 2 (including the suggested changes provided)**HD-FDD** (same as table): we share the view shown in the table (i.e. this capability follows the behaviour described by P2.2) of discussion point 2 (including the suggested changes provided)Note: based on updated proposal as commented in Discussion point 2.  |
| Lenovo | Yes |  |
| LGE | - | Need further check |

### Others

**Summary in [20]on “how the network is aware of RedCap UE” is cited as following:**

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| **Summary on how network is aware of RedCap UE:**Option 1 RedCap device type is indicated as part of the capability signalling.: 5 companies (Intel, Huawei, Ericsson, Samsung, ViVO)Option 2 Define a new IE specifically for RedCap UEs containing RedCap-specific capabilities. The IE is included in the signalling only by Redcap UEs.: 1 company (vivo)Option 3 The network identifies RedCap UEs based on identification solution (see Section 11.1), e.g. during Msg1, Msg3, MsgA, etc, (pending RAN1 conclusion). The identification is forwarded it to target gNB during handover: 2 companies (Ericsson, CMCC)Option 4: The network identifies RedCap UE based on the reported capabilities, assuming the identification can be done through RedCap-specific capabilities not used by non-RedCap UEs.Considering the new indication is clear solution, and can also handle the handover case. Rapporteur would suggest:**Proposal 4: [To agree]** [5/8] introduce an explicit capability to indicate when the UE is a RedCap UE (as per option 1). |

**Discussion point 4: Do you support the proposal 4 in the summary paper [20], i.e.** introduce an explicit capability bit to indicate RedCap UE in the UE capability when the UE is a RedCap UE (as per option 1).**? If not, please justify your response.**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes | This explicit bit can be used for network to do RedCap UE’s capability check. |
| ZTE | No | This relates to the discussion on early identification, we prefer to discuss this later.  |
| Ericsson | Yes | This is a separate issue from early indication – a “RedCap capability” would make it unambiguous for the gNB capability processing function that the UE is a RedCap UE.  |
| Apple | We are ok with option 1, although it can be derived by the UE capability.  | We do not support option 3. |
| MediaTek | Yes | This explicit bit unambiguously identifies the baseline capabilities of the device to the NW. |
| Qualcomm | See comment | We can support such an indication in Msg3, for network to ensure constrained use of RedCap. We do not support adding such an indication in capability signaling, because we prefer using a new IE for RedCap-specific capabilities in capability signaling (i.e. Option 2).  |
| Sequans | No | This is also a Stage 3 issue..If early identification, e.g. in Msg1, is already mandatory, we do not see the benefit of having a dedicated capability bit |
| Intel | Yes | It is a clear way and can also resolve handover problem. |
| Lenovo | No | Since cell barring and early indication are supported, it can work with option 3. |
| LGE | Yes |  |

**Summary in [20]on “the definition of RedCap UE type” is cited as following:**

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| the definition of the RedCap UE types can be based on one of:- Option 1: All the reduced capabilities recommended at the end of the RedCap study- Option 2: Only include the reduced capabilities that the network needs to know during initial access, if any. **R2-2105319 CATT**- Option 3: All the recommended reduced capabilities as well as recommended power saving features- Option 4: The corresponding minimum set of the reduced capabilities that one RedCap UE type shall mandatorily support : **R2-2104910 VIVO, R2-2105160 ZTE, R2-2105234 Ericsson, R2-2105634 Huawei****- Option 4a: The set of mandatory features that all RedCap UEs shall support, as well as the set of features not supported by any RedCap UEs (e.g. CA, DC, etc). R2-2104774 Qualcomm.****- Option 5: Only one RedCap UE type and the associated capabitlies would be using the discussion above (via UE capability)..? (Apple)****Summary on definition of RedCap UE type:** Rapporteur would consider that further discussion is needed, and RAN2 could wait for RAN1 on this. **Proposal 5**: [2nd priority topic ] Postpone the discussion on the definition of RedCap UE type and wait for RAN1 input.  |

**Discussion point 5: Which option do you prefer**.**? Please justify your response.**

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| **Company’s name** | **Options** | **Comments, if any** |
| OPPO |  | Wait for RAN1 input. |
| ZTE | Option 4 | This is under RAN1 discussion, and all the options were listed by RAN1 during SI phase, so we are also fine to wait for RAN1’s input.  |
| Ericsson | Option 4 | Can also wait further for any progress in RAN1. We could start the discussion on RAN2 though on what the “RedCap UE type” means from RAN2 point of view.  |
| Apple | Option 5 | We think there is no need to define different RedCap UE types…while the UE capabilities provide the needed info about the RedCap UE. |
| MediaTek | Option 4 | This definition provides the baseline capabilities of the RedCap device. Capabilities beyond this baseline are optionally signaled. |
| Qualcomm | Option 4a |  |
| Sequans | Option 4,Maybe 4a | Agree with MediaTekOption 4a is related to our comment in DP7 for P7.1 – it depends on how we decide to treat UEs that “over signal” capabilities. In any case this is better be clarified or left FFS |
| Intel | Option 4 | Would be ok to wait for RAN1 input.  |
| Lenovo | Option 4 | It is simple from the view of implementation.  |
| LGE | Option 4 | We would like to wait for RAN1 input. |

**Summary in [20]on “**only one UE type is supported**” is cited as following:**

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| R2-2105160 clarified that only one UE type is supported based on the WID [19] and asked RAN2 to confirm.**Summary on the maximum number of RedCap UE type:** Rapporteur considers this as stage 3 details, but would be ok to clarify this. **Proposal 6**: [To agree ] Ask RAN2 to confirm that only one RedCap UE type is defined for both FR1 and FR2. |

**Discussion point 6: Do you support the proposal 6 in the summary paper [20], i.e.** only one RedCap UE type is defined for both FR1 and FR2.**? If not, please justify your response.**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO |  | Maybe good to clarify the difference from “one RedCap UE type is defined per FR” since this was also not clear during RANP discussion. |
| ZTE | Yes | This is under RAN1 discussion, and we are fine to wait for RAN1’s input.  |
| Ericsson |  | Proposal needs some clarifications, e.g. if UE is RedCap in FR2, is it always then also RedCap in FR1 (and vice versa)?  |
| Apple | Per-FR is ok if majority wants it |  |
| MediaTek | Yes |  |
| Qualcomm | Yes |  |
| Sequans | Yes | We are fine to wait for RAN1 input |
| Intel | Yes | It would be good to confirm this.  |
| Lenovo | Yes | Defining only one RedCap UE type for both FR1 and FR2 aligns with the WID. |
| LGE | Yes |  |

## Constrain the use of RedCap

**Summary in [20]on “**Constrain the use of RedCap**” is cited as following:**

|  |
| --- |
| Following 4 options were captured in the TR:* **Option 1**: RRC Reject based approach

When the network knows the UE is a RedCap UE and the type of the service requested, RAN can reject an RRC connection establishment attempt if the service the UE requests is not allowed for RedCap UEs. The service type can be known, e.g., based on the establishment cause provided in Msg3, through higher layer mechanisms or other ways.**3 companies (CATT, Interdigital, CMCC)****Option 2**: Subscription validation (Note: SA2, CT1 confirmation is needed)During the RRC connection setup, the UE indicates that it is a RedCap UE to the core network, e.g. - UE includes this indication in NAS signalling message to core network; or - UE informs this indication during its RRC connection establishment procedure to RAN; RAN then informs core network of the UE’s RedCap type in the Initial UE Context message to core network.The network validates UE’s indication against its subscription plan, which includes information such as the set of services allowed for the UE. Network then decides whether to accept or reject UE’s registration request. For example, network may reject UE if UE indicates RedCap, but its subscription does not include any RedCap-specific services.**6 companies** **(Qualcomm, vivo, Intel, Ericsson, CMCC, CTC, ZTE)*** **Option 3**: Verification of RedCap UE, i.e. Network performs capability match between UE’s reported radio capabilities and the set of capability criteria associated with UE’s RedCap type

**9 companies (Qualcomm, OPPO, vivo, Intel, ZTE, Ericsson, LG, Interdigital, CTC)*** **Option 4**: Left up to network implementation to ensure RedCap UE uses intended services and/or resources.

**1 company (CATT)**For option 3, 6 companies (CMCC, LG, Ericsson, VIVO, OPPO, Intel) consider it as a network implementation. I.e., if the UE reported capabilities do not match RedCap type, the network may reject the UE or not configure corresponding capabilities. In addition, 6 companies think LS to SA2/CT1 is needed at least for option 2. **Proposal 7:** [To agree] [9/11]To prevent RedCap UEs from using capabilities not intended for RedCap UE, RAN2 to agree option 3, i.e. “Verification of RedCap UE, i.e. Network performs capability match between UE’s reported radio capabilities and the set of capability criteria associated with UE’s RedCap type”.**Proposal 7.1:** [To agree] If the reported capabilities do not match the RedCap UE type, how network prevents its usage is left up to network implementation. For example, the network may reject UE or not configure non-RedCap UE specific configurations to the UE, e.g. CA, DC, etc.**Proposal 8:** [To discuss] Ask RAN2 to discuss whether option 1 (RRC reject based approach [3/11])) and/or option 2 (Subscription validation [6/11]) are needed to prevent RedCap UEs from using capabilities not intended for RedCap UE. .**Proposal 8.1:** [To discuss] If option 2 (Subscription validation) is confirmed as needed by RAN2, to consult SA2/CT1 whether there is any specification impact to perform subscription validation. |

**Discussion point 7: Do you support the proposal 7 and 7.1 in the summary paper [20], i.e.**

**Proposal 7:** [To agree] [9/11]To prevent RedCap UEs from using capabilities not intended for RedCap UE, RAN2 to agree option 3, i.e. “Verification of RedCap UE, i.e. Network performs capability match between UE’s reported radio capabilities and the set of capability criteria associated with UE’s RedCap type”.

**Proposal 7.1:** [To agree] If the reported capabilities do not match the RedCap UE type, how network prevents its usage is left up to network implementation. For example, the network may reject UE or not configure non-RedCap UE specific configurations to the UE, e.g. CA, DC, etc.

**If not, please justify your response.**

|  |  |  |
| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes |  |
| ZTE | Yes to Proposal 7, See comments to Proposal 7.1 | We think it is important to discuss and conclude whether a RedCap **is allowed** to report a capability that is not intended for RedCap use case?For instance, whether a RedCap type UE can report CA/DC capabilities?The wording of objective in WID is “***preventing*** *RedCap UEs from using capabilities not intended for RedCap UEs including at least carrier aggregation, dual connectivity and wider bandwidths.* ”So our interpretation is that UE is not allowed to report those capabilities, e.g. CA/DC capabilities. Based on this, the proposal 7.1 should be revised as:**Proposal 7.1:** [To agree] If the reported capabilities do not match the RedCap UE type, how network prevents its usage is left up to network implementation. ~~For example,~~ e.g. the network may reject UE ~~or not configure non-RedCap UE specific configurations to the UE, e.g. CA, DC, etc~~. |
| Ericsson | Agree 7.1 | There doesn’t seem to be need for any specification changes, if 7.1 is agreed it seems 7 is not needed? |
| Apple | Re-wording needed | We want to understand what is meant by RedCap UE type in “*Verification of RedCap UE, i.e. Network performs capability match between UE’s reported radio capabilities and the set of capability criteria associated with UE’s RedCap type”.* Better to say “Verification of RedCap UE, i.e. Network performs capability match between UE’s reported radio capabilities and the set of capability criteria associated with ~~UE’s~~ RedCap UE ~~type~~”.” |
| MediaTek | Agree with Apple |  |
| Qualcomm | Yes | We think some minor signaling enhancements the existing capability match procedure is needed to support RedCap. We may leave that to SA2 to confirm.We also support the rewording suggested by Apple. |
| Sequans | Yes P7P7.1 reject only for now | This also depends on DP4; option 4 there cannot be agreed with 7.1We do not think P7.1 contradicts the WID, but we think treating UEs as RedCap UEs even if their capabilities don’t match requires more discussion. This may be an opening for all UEs to operate “in CE”, congesting the NW for real RedCap UEs.We can agree to 7.1 with reject only and leave the rest FFS. |
| Intel | Yes |  |
| Lenovo | Yes |  |
| LGE | Yes  |  |

**Discussion point 8: For option 1 -RRC Reject based approach, i.e. RAN can reject an RRC connection establishment attempt if the service the UE requests is not allowed for RedCap UEs.**

**Is option 1 needed? If yes, please justify your response.**

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | No |  |
| ZTE | No |  |
| Ericsson | Not clear | There are no establishment causes specific to RedCap so how would gNB reject based on requested service? Or does the discussion point mean there should be some information between gNB and CN regarding the service requested or what is the intention? [Rapporteur] Updated option 1 based on solution captured in the TR. The intention is to discuss whether the option is needed or not.  |
| Apple | No |  |
| MediaTek | No |  |
| Qualcomm | Not clear | Need more details on how the scheme works, e.g. whether this decision is completely made by RAN, or RAN forwards a RedCap indication to CN after receiving RedCap establishment cause.  |
| Sequans | Not clear | Agree with Ericsson, QC |
| Intel | No |  |
| Lenovo | No |  |
| LGE | No |  |

**Discussion point 9: For option 2 Subscription validation (Note: SA2, CT1 confirmation is needed), i.e. RedCap UE identifies itself during its RRC connection establishment procedure; RAN then informs core network, which then decides whether to accept or reject UE’s registration/connection request.**

**Is option 2 needed? If yes, please justify your response.**

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | No |  |
| ZTE | Yes with comments | Regarding how to inform CN the UE is RedCap, TR also includes another option:“UE includes this (RedCap) indication in NAS signalling message to core network”. So we think “i.e.” should be changed to “e.g.”, it is up to SA2/CT1 to decide whether NAS signalling or AS identification is needed/used. In addition, seems we were missing from the supported company list of Option2, we have modified the counting accordingly.  |
| Ericsson | Not necessary from RAN2 | From RAN perspective this is not needed. We are open to send an LS to SA2 regarding whether core network should know the UE is a RedCap UE.  |
| Apple | Yes with comments | No RAN extra action is needed. |
| MediaTek | Not needed from a R2 perspective | Agree with Ericsson that we do not see a need for this from a R2 perspective |
| Qualcomm | Yes | We think it is needed from design perspective but agree it needs to be confirmed by SA2/CT1. Since those WGs don’t have TUs for RedCap, RAN2 have to agree first and then send LS to them to trigger their discussion. |
| Sequans | No |  |
| Intel | Yes | It is needed to prevent RedCap UEs from using services not intended for RedCap UE. RedCap UEs requesting services restricted for this kind of UEs (i.e. applicable only to non-RedCap UEs) may be blocked or rejected access by the core network (i.e. core network may perform subscription validation, i.e. validates UE’s indication against its subscription plan, which includes information such as the set of services allowed for the RedCap UE); |
| Lenovo | No |  |
| LGE | No |  |

**Discussion point 9.1: If option 2 needed, should RAN2 send LS to consult SA2/CT1 whether there is any specification impact to perform subscription validation?**

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| ZTE | Yes | Option 2 involves core network behaviour, so SA2/CT1 should be consulted.  |
| Ericsson | Yes |  |
| Apple | Yes | We are ok with an LS. |
| Qualcomm | Yes |  |
| Sequans | Yes |  |
| Intel | Yes |  |
| LGE | Yes |  |

## UE complexity reduction techniques for higher layers

**Summary in [20]on “**2.3 UE complexity reduction techniques for higher layers**” is cited as following:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Companies ‘s views are shown as below:

|  |  |  |  |
| --- | --- | --- | --- |
| Tdoc number | Company | Related proposals and views |  |
| R2-2105136 | Apple | **Proposal 1: The maximum number of DRBs supported is a mandatory with signaling capability and is provided as part of UE capability for RedCap devices. Range is FFS****Proposal 2: The support of 18-bit SN for PDCP is optional with capability signaling for RedCap UEs.****Proposal 3: The support of 18-bit SN for RLC AM mode is optional with capability signaling for RedCap UEs.****Proposal 4: RRC processing delay requirements for RedCap UEs can be different from legacy NR UEs. FFS on the actual values.**  |  |
| R2-2105539 | Spreadtrum | **Proposal 1: Support scalingFactor report for REDCAP UE, considering some additional smaller values or the REDCAP UE specific values to match the requirement of REDCAP UE use case better.**   |  |
| R2-2105634 | Huawei | **Proposal 6: Consider to reduce the number of DRBs mandatorily supported by RedCap UEs.** **Proposal 7: Consider to reduce the length of PDCP and RLC AM sequence number to be mandatorily supported for RedCap UE (e.g. mandatory 12-bit SN).****Proposal 8: Do not consider to further reduce the L2 buffer size calculated in TS 38.306.****Proposal 9: Do not consider to relax the RRC processing delay for RedCap UEs.** |  |

**Summary on 2.3 UE complexity reduction techniques for higher layers:**Based on the revised WID [19], the UE complexity reduction techniques for higher layers have not been listed as objective for the WI. It would be good for RAN2 to clarify whether it is in the scope or not before any discussion. **Proposal 9:** [To discuss] RAN2 to discuss whether the study of UE complexity reduction techniques for higher layers is or not in the scope for Rel-17. |
|  |

**Discussion point 10: Is the study of UE complexity reduction techniques for higher layers in the scope for Rel-17?**

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| --- | --- | --- |
| **Company’s name** | **Yes/No** | **Comments, if any** |
| OPPO | Yes |  |
| ZTE | Yes |  |
| Ericsson |  | It is not explicitly mentioned in the WID. We can discuss proposal by proposal but we don’t think these are necessary for the work.  |
| Apple | Yes |  |
| MediaTek | No | This is not in the scope of the WID. We are open to discussing this on a per-proposal basis, but this is not an essential aspect of the WI. |
| Qualcomm | Yes | Reduction of upper-layer capabilities are not excluded by WID. And some of the proposals (e.g. reduction in maximum number of DRBs) have already been agreed in the SI phase. |
| Sequans | No, but | Agree with E//, MediaTek. These are generally beneficial (and some agreed in SI as QC mentions), but are not essential. |
| Intel | No | Agree with Ericsson and MediaTek. |
| Lenovo | No | Agree with MediaTek. |
| LGE | No | Agree with Ericsson and MediaTek |

# Conclusion

To be added

# Reference

1. R2-2104774 Definition and constrained use of RedCap UEs Qualcomm Incorporated
2. R2-2104808 Discussion on constraining of reduced capabilities OPPO
3. R2-2104910 UE type definition and constraining for RedCap UEs vivo, Guangdong Genius
4. R2-2104927 RedCap UE capability and constraining of reduced capabilities Intel Corporation
5. R2-2105136 Resolution on some basic mandatory capabilities for RedCap UEs for faster product development Apple Inc
6. R2-2105160 Define and Constrain Reduced Capability for RedCap ZTE Corporation, Sanechips
7. R2-2105234 Definition of RedCap UE and first look on capability signaling Ericsson
8. R2-2105319 On Redcap UE capabilities and type CATT
9. R2-2105471 Capability for RedCap UEs and its early indication Samsung
10. R2-2105539 Discussion on L2 buffer size reduction for Redcap UE Spreadtrum Communications
11. R2-2105634 Definition of RedCap UE type and reduced capabilities Huawei, HiSilicon
12. R2-2105882 How to prevent RedCap UEs from using capabilities not intended for RedCap Ues LG Electronics UK
13. R2-2105910 On RedCap UE capabilities Nokia, Nokia Shanghai Bell
14. R2-2106053 Constraint of RedCap UE to intended use cases InterDigital
15. R2-2106098 RedCap UE capability and constraining of reduced capabilities Intel Corporation
16. R2-2106230 Discussion on the definition and constraining of reduced capabilities CMCC
17. R2-2106276 The capability and the constrain of RedCap UE China Telecommunications
18. TR 38.875
19. RP-210918, “Revised WID on support of reduced capability NR devices”
20. R2-2106462 Summary 8.12.2.1 - Definition of RedCap UE and reduced capabilities (Intel)