3GPP TSG-RAN WG2 Meeting#111-e Draft\_R2-2008192

Online, 17th - 28th August 2020

Agenda Item: 8.12.2.2

Source: Huawei

Title: [Draft] Summary of offline 110 - Identification and access restriction

Document for: Discussion and Decision

# Introduction

This document is for the following offline discussion on identification and access restriction for REDCAP UEs:

* [AT111e][110][REDCAP] Identification and access restriction (Huawei)

Scope: Discuss the proposals in [R2-2007345](file:///C:\Data\3GPP\RAN2\Docs\R2-2007345.zip), [R2-2006661](file:///C:\Data\3GPP\RAN2\Docs\R2-2006661.zip), [R2-2006786](file:///C:\Data\3GPP\RAN2\Docs\R2-2006786.zip) and [R2-2007493](file:///C:\Data\3GPP\RAN2\Docs\R2-2007493.zip). The intention is to identify design alternatives, collect company views and, whenever possible, also narrow down the proposals.

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

* + - List of agreeable proposals (if any)
    - List of proposals that require online discussions

Initial deadline (for companies' feedback): Monday 2020-08-24 22:00 UTC

Initial deadline (for rapporteur's summary in R2-2008192): Tuesday 2020-08-25 02:00 UTC

The following contributions are summarised in this document:

[R2-2006661](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2006661.zip) Coexistence between legacy UEs and RedCap UEs Samsung

[R2-2006786](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2006786.zip) Discussion on RedCap UE’s identification and access control OPPO

[R2-2007345](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2007345.zip) Identification and access restriction of REDCAP UE Huawei, HiSilicon

[R2-2007493](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2007493.zip) On UE identification and access restrictions MediaTek Inc.

# Discussion

According to the proposals in above contributions, the following issues are summarised:

* Camping criteria for REDCAP UE
* When/How to identify REDCAP UE
* UAC for REDCAP UE
* How to ensure REDCAP UEs for intended use cases

## Camping criteria

Regarding whether the REDCAP UE is allowed to camp on a cell, corresponding proposals in above contributions are listed as follows:

|  |  |  |
| --- | --- | --- |
| **Tdoc number** | **Company name** | **Proposals** |
| R2-2006661 | Samsung | Proposal 1: RAN2 to confirm that a gNB that supports RedCap UEs also supports legacy UEs simultaneously.  Proposal 2: The legacy MIB signalling is re-used to accommodate legacy UEs.  Proposal 3: The legacy UE determines whether it can access the cell based on the legacy values of controlResourceSetZero.  Proposal 4: If a RedCap UE does not support the bandwidth from the controlResourceSetZero of a cell, it considers the cell as barred.  Proposal 5: The field intraFreqReselection is reused to determine whether a RedCap UE performs cell selection/reselection to intra-frequency cells if the cell is barred. |
| R2-2006786 | OPPO | Proposal 1 A separate cellBarred indication can be added in MIB/SIB1 for RedCap UEs, to differentiate from cellBarred indication for normal UEs. |
| R2-2007345 | Huawei, HiSilicon | Proposal 1: Allow a REDCAP UE to camp on a cell with larger initial DL/UL BWP than supported by REDCAP UE to avoid negative impact on legacy UEs.  Proposal 4: Consider to indicate whether REDCAP UEs are allowed to camp on in MIB/SIB1 to avoid REDCAP UE camping in a legacy network and allow network to bar all REDCAP UE. |
| R2-2007493 | MediaTek Inc. | Proposal 1: A RedCap UE only camps on a cell that indicates support of RedCap operation  Proposal 2: Support of RedCap operation in a cell is broadcasted by the network  Proposal 3: RAN2 to discuss further if RedCap support is indicated per cell or per frequency by the network. |

Above proposals are summarised as 3 camping criterions and the use of *intraFreqReselection* if the UE cannot camp on.

**Criterion 1: The bandwidth of CORESET#0**

This criterion corresponds to proposals 1 to 4 in R2-2006661.

According to the following RAN1 agreements, for FR2, it is possible that the maximum bandwidth of REDCAP UE is smaller than the bandwidth of CORESET#0 indicated by MIB.

|  |
| --- |
| * For FR1, study at least 20MHz maximum UE bandwidth at least for initial access   + Other bandwidths FFS * For FR2, study 50MHz and 100 MHz maximum UE bandwidth at least for initial access   + Other bandwidths FFS |

In this case, the UE should consider the cell as barred and do not camp on the cell.

**Question 1.** If the maximum bandwidth of REDCAP UE is smaller than the bandwidth of CORESET#0 indicated by MIB, do you agree that the UE should consider the cell as barred and do not camp on the cell?

|  |  |  |
| --- | --- | --- |
| ***Company name*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes | That’s how it works in legacy |
| Xiaomi | - | Even though the bandwidth of REDCAP UE can cover all the configurations of CORESET for Type0-PDCCH, it is hard to say the cell is barred or not for Redcap. It only means the Redcap UE can read CORESET#0 as the legacy UE. Whether the cell is barred or not depends on how the gNB gives UE the indication.  The question is related to Q2 and Q3. We prefer to wait for RAN1’s input. |
| Nokia | Yes |  |
| OPPO | - | RAN1 is still discussing whether RedCap UEs can read SIB1 even if its bandwidth is smaller then the CORESET#0 bandwidth. We prefer to wait for RAN1’s agreement on this. |
| Futurewei | - | We can wait for more RAN1 progress on RedCap handling of CORESET#0. |
| Ericsson | FFS (RAN1) | For FR1, there should be no issue but further discussion is being done in RAN1 for FR2. Even if the supported BW is lower compared to CORESET#0, it could be possible for UE to monitor and acquire the necessary information but possibly with some performance penalty. In any case, this should be discussed in more detail in RAN1 and RAN2 should wait for RAN1 conclusion. |
| Apple | Yes, but | We think RAN1 already made progress (or progessing) in avoiding such cases? RedCap UEs might be required to support the legacy mandatory CORESET#0 PRBs? |
| Convida Wireless | - | Wait for RAN1 decision |
| Sequans | - | Depends on RAN1 decisions |
| NEC | Yes |  |
| Samsung | Yes | As indicated in our paper R2-2006661. |
| CATT | Yes | Yes if there is such case based on R1 output. |
| Intel | FFS | We have to wait for RAN1 on this. |
| Huawei, HiSilicon | Yes |  |
| vivo | - | For FR1, the answer is Yes. But we think there may be no such case according to the current discussion on RAN1. As far as I know, RAN1 will try to avoid this case.  For FR2, whether RedCap UEs can obtain SIB1 if the maximum bandwidth of REDCAP UE is smaller than the bandwidth of CORESET#0 is being discussed in RAN1. Thus, we prefer to wait for more progress in RAN1. |
| Fujitsu | - | It may depend on UE implementation to continue to acquire SIB1 on the CORESET#0 or consider the cell as barred. Besides, if RedCap UE would have a specific CORESET#0 configuration, RedCap UE can select to ignore the legacy CORESET#0 configuration. |
| MediaTek | FFS | Agree with others that R1 discussions on this topic need to conclude for RAN2 to make an informed decision. |
| Lenovo | - | This depends on RAN1 evaluation. |
| LG | FFS | We prefer to wait for RAN1 progress. |
| Spreadtrum | - | No strong view. |
| ZTE |  | Wait for RAN1 decision. |
| InterDigital | FFS (RAN1) | As mentioned by other companies this depends on RAN1 discussion e.g. CORESET#0 and supported RedCap BW in especially FR2 |

**Summary for Question 1:**

22 companies commented on Question 1:

* 7 companies think that the UE should not camp on the cell if the maximum bandwidth of REDCAP UE is smaller than the bandwidth of CORESET#0 indicated by MIB.
* 15 companies indicate that RAN1 is discussing the same issue and we should wait for RAN1 input (at least for FR2).

Considering that RAN1 is still discussing this issue for FR2, it seems better to wait for RAN1 conclusion first.

**Proposal 1: Wait for RAN1 input regarding whether REDCAP UEs can camp on a cell with the bandwidth of CORESET#0 not supported by the UE.**

**Criterion: REDCAP UEs are allowed to access the cell**

This criterion corresponds to proposal 1 in R2-2006786, proposal 4 in R2-2007345 and proposals 1, 2 in R2-2007493.

The existing NR cell works based on the assumptions that the 100M minimum bandwidth and (2 or 4) RX antennas are mandatory for the UE. For REDCAP Ues, above requirements for legacy NR devices will be relaxed. Thus, on one hand, a REDCAP UE should not camp on a legacy NR cell which does not support REDCAP operation. On another hand, it should be possible for the network to bar the access of REDCAP UE.

Based on above, an indication is needed in system information to indicate whether a REDCAP UE is allowed to camp on the cell.

**Question 2.** Do you agree that an indication is needed in system information to indicate whether a REDCAP UE is allowed to camp on the cell?

|  |  |  |
| --- | --- | --- |
| ***Company name*** | ***Yes/No?*** | ***Comments*** |
| Qualcomm | Yes | gNB may want to dynamically control whether RedCap Ues can access it or not, e.g. base on its loading etc. So we think such an indication in system information is necessary. |
| Xiaomi | - | We agree that not all the network implement the Redcap functions. Therefore, it suggests the gNB can indicates the reduced capability NR devices that it is allowed to access or not.  However, the gNB can give UE the indication explicitly or implicitly. A possible way is putting an indication SI, e.g., MIB or RSMI to indicate whether Redcap Ues should be allowed to camp on the cell. Another implicit way is by the presence of Redcap specific configuration e.g. Initial DL BWP configured by RMSI exceeding Redcap bandwidth means to bar the Redcap UE.  We need some RAN1’s inputs. |
| Nokia | Yes | Network may want to restrict the access of RedCap Ues and this would be efficient way. |
| OPPO | Yes | This indication is new and separate from the existing cellBarred indication. |
| Futurewei | Yes | The exact format, explicit or implicit, can be decided after more details on RedCap design (for various use cases) become available. |
| Ericsson | Yes | Agree with Futurewei. Details can be decided in normative phase. |
| Apple | Yes | This is essential first step |
| Convida Wireless | Yes | The actual indication may be explicit or implicit |
| Sequans | Yes | Explicit or implicit should be decided later |
| NEC |  | RAN1 is defining the UE capabilities of RedCap UE. Also, RAN2 is considering to introduce a device type as discussed in Offline [109]. So far, it is still not yet clear how RedCap Ues camp on a cell where legacy Ues are also camping. It is too early to decide for this SIB indication, although we can see some benefit. We can wait RAN1’ progress before making decision. |
| Samsung | Yes | Depending on the RedCap feature (e.g. relaxed processing delay), RedCap Ues with such feature may not be able to access the cell, even if it meets the bandwidth capability. So, explicit indication for such case would be beneficial. |
| CATT | yes |  |
| Intel | Yes | The network can control whether to allow the Redcap UE to access the network. But details need further discussion. |
| Huawei, HiSilicon | Yes | We think such indication is useful from both the UE and the gNB perspectives. The details of this indication can be discussed in WI phase. |
| vivo | - | The indication in system information is helpful for a RedCap UE to determine whether it can be served by the cell when the UE attempts to camp on the cell. But whether an explicit indication is needed or just implicitly indicate by the network design to support RedCap UEs can be further discussed after more progress on the reduced capability definition. |
| Fujitsu | Yes | An indication on the support of RedCap is simple. |
| MediaTek | Yes | Agree with Huawei |
| Lenovo | Yes | Allow the gNB to restrict all the RedCap UEs to access the cell is a necessary and efficient way for some special cases. |
| LG | Yes | The gNB can indicate whether RedCap UEs are allowed to access or not. |
| Spreadtrum | Yes |  |
| ZTE | Yes | A cell may not be accessible for RedCap UE due to either network capability or RRM police decision.  Another related question is whether RedCap access only cell is allowed, i.e. regular NR UE is barred while RedCap UE is not. |
| InterDigital | Yes | Agree with Qualcomm. There may be many RedCap devices within a cell and methods to enable/disable RedCap access would be beneficial for e.g. load control. Details regarding indication (e.g. implicit vs explicit) can be discussed in normative phase. |

**Summary for Question 2:**

22 companies commented on Question 2:

* 19 companies think that an indication is needed in system information to indicate whether a REDCAP UE is allowed to camp on the cell.
  + Some companies further indicate that the indication can be either explicit or implicit, the details of this indication can be further discussed, e.g. in WI phase.
* 3 companies did not reply YES. According to the comments, they also think the indication is useful, but they think whether the indication should be explicit or implicit need further discussion.

It seems all companies think that the indication in system information is useful. But the details of the indication may need further discussion, i.e. explicit or implicit indication.

**Proposal 2: One indication in system information is needed to indicate whether a REDCAP UE can camp on the cell.**

**Proposal 2a: Further discuss whether the indication is explicit or implicit.**

The following options for the indication is mentioned in the contributions:

* MIB
* SIB1

Thus, if the answer to Question 2 is Yes, please indicate which option do you prefer to introduce the indication:

**Question 2a.** If the answer to Question 2 is Yes, which system information should be used to indicate whether a REDCAP UE is allowed to camp on? MIB/SIB1/other?

|  |  |  |
| --- | --- | --- |
| ***Company name*** | MIB/SIB1/other? | ***Comments*** |
| Qualcomm | SIB1 | SIB1 is where access barring/control information is signalled and hence the right place for indicating whether access by RedCap UE is allowed or not. |
| Nokia | MIB or SIB1 | Both MIB and SIB1 can be considered. It would be more efficient to use MIB, because then the UE would not be required to decode SIB1 for this purpose. It needs to be discussed whether there is space available in MIB for this purpose. |
| OPPO | MIB or SIB1 | Both can be considered although MIB has only one spare bit left. |
| Futurewei | SIB1 | It doesn’t look necessary to use the only spar bit in MIB for RedCap UE, as its performance requirement would be less stringent. |
| Ericsson | SIB1 | At the moment, SIB1 seems viable as the space in MIB is limited and should be used only after throughout consideration.  We are open to discuss and study the alternatives and down select when we understand the pros and cons of each solution.  Note that in corresponding RAN1 discussion, other alternatives are also being discussed. |
| Apple | SIB1 | We do not think MIB is a viable option. |
| Convida Wireless | MIB or SIB1 | We agree with Nokia that both can be considered, but the MIB would be more efficient, provided there is space available in the MIB for this purpose. |
| Sequans | MIB or SIB1 | Agree that SIB1 seems more appropriate, but MIB would be ideal so should not be removed offhand, so we prefer to postpone the decision for now |
| NEC | SIB1 | only if it is to be introduced, it should be SIB1. MIB having only one spare is too expensive for this purpose. |
| Samsung | MIB or SIB1 | Even though to indicate it in MIB would be beneficial from UE perspective, we only have one remaining bit in MIB. Hence, considering support of legacy UEs, it is okay to use SIB1 to indicate such information. |
| CATT | SIB1 |  |
| Intel | MIB or SIB1 | Further discussion is needed to consider the pros and cons. But considering only 1 bit left for MIB, SIB1 should be sufficient. |
| Huawei, HiSilicon | MIB/SIB1 | The indication could be either included in MIB or SIB1.  If in MIB, the REDCAP UEs could be aware of the accessibility of the corresponding cell from SSB. If the support of the REDCAP UEs are not indicated, the REDCAP UEs could stop accessing this cell. This will reduce REDCAP UE power consumption. However, MIB only have one spare bit.  If in SIB1 (in PDCCH scheduling SIB1, or in SIB1 message), more spare bits are available.  It could be decided in WI phase. |
| vivo | MIB or SIB1 | From the UE point of view, the indication in MIB is preferred since it allows the UE to perform cell reselection again with the lowest latency if the UE’s camping is not allowed in the current cell.  However, if there is no extension bit in MIB for the indication, we are fine with the indication in SIB1.  In SI phase, we think both options are applicable. We can make the decision in WI phase, after more discussion on the use cases. |
| Fujitsu | SIB1 | Since there is only 1 bit left in MIB. The indication can be included in SIB1. |
| MediaTek | MIB or SIB1 | Agree with Samsung, i.e. as we have just 1 spare bit in MIB, SIB1 may be the only real choice available. |
| Lenovo | MIB or SIB1 | The access barring information for all the RedCap UEs should be indicated as early as possible. Therefore, indicating in MIB is more efficient. If companies have the concern on the less spare bit in MIB, we think including the related indication in SIB1 is acceptable. |
| LG | SIB1 | We are open to discuss the pros of using MIB. |
| Spreadtrum | MIB or SIB1 |  |
| ZTE | MIB or SIB1 | Either MIB or SIB1 is acceptable.  RAN1 has similar discussion in progress with some options, e.g. indication in MIB, SIB1 and DCI for SIB1 scheduling. |
| InterDigital | MIB or SIB1 | Can consider both, however preference is for SIB1 considering limited space in MIB.  Note: this may also depend on the method of identifying a RedCap UE. For example, if the cell barring mechanism is based on device type and more than one RedCap device type is introduced (e.g. a “high priority” or “low priority” RedCap UE), then only having one bit in MIB would be restrictive as NW may not be able to provide selective access for different RedCap UE categories. |

**Summary for Question 2a:**

21 companies commented on Question 2a:

* All companies think that SIB1 can be considered.
* 14 companies are also OK to consider MIB.

Although SIB1 is supported by all companies, most companies (more than 50%) are also open to consider MIB at this stage. It seems whether to use MIB or SIB1 is stage-3 details. Thus it is proposed to further discuss both options.

**Proposal 2b: Further discuss whether the indication is transmitted in MIB or SIB1.**

**Criterion 3: The bandwidth of initial UL/DL BWP configured by SIB1**

This Criterion corresponds to proposal 1 in R2-2007345.

Initial UL/DL BWP can be configured by SIB1, which may have larger bandwidth compared with the maximum bandwidth supported by REDCAP UEs. Whether a REDCAP UE can camp on the cell in this case needs to be discussed.

If a REDCAP UE is not allowed to camp on the cell with larger initial UL/DL BWP than supported by the UE, there will be restriction on the network configuration to support REDCAP UE, i.e. in case REDCAP UEs are supported in the cell, the network needs to guarantee that the configured initial UL/DL BWP is smaller or equal to the bandwidth supported by REDCAP UEs.

If a REDCAP UE is allowed to camp on in this case, the REDCAP UE needs to be identified at early stage as the gNB needs to schedule Msg3/Msg5 transmission properly.

**Question 3.** Do you agree with above analysis and whether a REDCAP UE should be allowed to camp on a cell with larger initial DL/UL BWP than supported by the UE?

|  |  |  |
| --- | --- | --- |
| ***Company name*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes/no | As long as a RedCap UE can support the coreset #0 in the initial DL BWP, it should be allowed to camp on it. Network implementation can ensure all PDSCH during paging or initial access is transmitted within the same frequency locations.  But we are not sure how UL may work out if a cell has wider initial UL BWP than the one supported by UE. |
| Xiaomi | - | See above. We need some RAN1’s inputs. |
| Nokia | Yes |  |
| OPPO | Yes | We think with early RedCap UE’s identification, NW can schedule UE within the CORESET#0’s bandwidth.  For UL, network can configure a separate PRACH resource for RedCap UEs to use. |
| Futurewei | Yes | We assume it is not a good practice to reduce initial DL/UL BWP just for the coexistent REDCAP UE, as it’d degrade the performance of normal UE. |
| Ericsson | Yes/FFS | In general, we should avoid any performance losses to the system when introducing Redcap.  Again, details are being discussed in RAN1, but in case the BWP would be larger than supported BW, there could be possibility for Redcap UE e.g. to retune within BWP so that no restrictions would be imposed on scheduling of existing NR UEs. This is not a RAN2 topic though, therefore we should wait before agreement. |
| Apple | Yes | We agree with comments above |
| Convida Wireless | - | Wait for RAN1 input |
| Sequans | FFS | Wait for RAN1, as solutions are currently discussed there. |
| NEC | FFS | This is actually the fundamental aspects that RAN2 should study. Although this also needs RAN1 study, at this moment we have similar considerations as QC. From RAN2 point of view, we may consider a need of broadcasting additional initial DL/UL BWP information (i.e. other than legacy one) to allow RedCap UEs having smaller channel bandwidth capability. |
| Samsung | - | We have similar view to Qualcomm, and think it also depends on the RAN1 discussion (e.g. a separate initial BWPs for RedCap UEs) |
| CATT | See comments | The observations are generally OK, but maybe it is better to wait until more progress in R1. |
| Intel | FFS | This is RAN1 discussing, and RAN2 should wait for RAN1. |
| Huawei, HiSilicon | Yes | It is clear that the bandwidth supported by REDCAP UEs would not be large. So, it is very likely that the initial BWP of the network is larger than that supported by it. Regarding the legacy camping criteria, the cell would be considered as barred. However, decreasing the initial BWP will degrade the performance of the network and legacy UEs.  In order to avoid the impact on legacy UEs, we think above case should be allowed. |
| vivo | - | We agree with the above analysis. But we should careful the system performance degradation after introducing RedCap UEs. Thus, we prefer to wait for more progress in RAN1. |
| Fujitsu | Yes | RedCap UEs can camp in a cell with larger initial BWP to be coexistent with legacy UEs in the same cell. And RedCap UE may also have a separate initial DL/UL BWP it can support. When the initial BWP for legacy UE is shared to RedCap UE and the bandwidth of initial UL BWP is not supported by RedCap UE, a separate RACH configuration for RedCap UEs is needed to facilitate their random access. |
| MediaTek | No/FFS | If a network indicates that it supports RedCap operation (as in Q2), it must operate with the assumption that RedCap devices are attempting initial access.  Therefore the initial BWP configuration must be aligned with RedCap UE capabilities.  We should wait for the RAN1 discussions on this topic to conclude. |
| Lenovo | - | We think it is possible that the network configures a larger initial BWP than the RedCap UE BW. However, the RedCap UEs can still access to the network if the network could identify the UE type early. Therefore, it doesn’t mean the cell will bar the RedCap UEs when configuring a larger initial BWP to the UE. |
| LG | FFS | We prefer to wait for RAN1 progress on this topic. |
| Spreadtrum | Yes | Agree with Qualcomm, with some enhancement for RACH procedure. |
| ZTE | - | Agree with Ericsson that we should wait for RAN1 input. |
| InterDigital | FFS | Agree with analysis, however should wait for RAN1 input. |

**Summary for Question 3:**

22 companies replied Question 3:

* 9 companies think that a REDCAP UE should be allowed to camp on a cell with larger initial DL/UL BWP than supported by the UE.
* 13 companies think we should wait for RAN1 input for the following reasons:
  + RAN1 is discussing whether a separate initial UL/DL BWP can be configured for REDCAP UEs.
  + RAN1 may restrict that if REDCAP UEs are supported in one cell, the initial BWP configuration must be aligned with REDCAP UE capabilities.

Considering that there are related RAN1 discussion ongoing, it seems better to wait for RAN1 input first.

**Proposal 3: Wait for RAN1 input regarding whether REDCAP UEs can camp on a cell with larger initial DL/UL BWP than supported by the UE.**

**The use of *intraFreqReselection***

The use of *intraFreqReselection* is discussed by proposal 5 in R2-2006661 and proposal 4 in R2-2007493.

In NR, if the UE considers the cell is barred and cannot camp on the cell, the field *intraFreqReselection* in MIB can be used to indicate whether frequency is barred.

For a REDCAP UE, in case the UE considers the cell is barred and cannot camp on the cell due to any of above criteria, whether the current *intraFreqReselection* applies to REDCAP UE needs to be discussed.

**Question 4.** In case a REDCAP UE considers the cell is barred and cannot camp on:

* Option 1. The UE checks legacy *intraFreqReselection* to determine whether the frequency is barred
* Option 2. A separate flag in system information is introduced for REDCAP UE to determine whether the frequency is barred for REDCAP UEs

|  |  |  |
| --- | --- | --- |
| ***Company name*** | ***Option?*** | ***Comments*** |
| Qualcomm | Option 1 | We do not see strong use case that would require the use of a separate flag in system information for the same purpose but just for RedCap UE. |
| Xiaomi | Option 1 | The legacy flag is enough. |
| Nokia | Option 1 |  |
| OPPO | Option 2 | We think *intraFreqReselection* works with *cellBarred* in a paired manner. If a separate *cellBarred* is introduced for RedCap UEs, then we prefer also a separate *intraFreqReselction* flag for RedCap UEs. This allows for more flexibility in the network. |
| Futurewei | Option 1 | It is not clear that enhancement on this is warranted, as there should be less stringent performance on Redcap UE. |
| Ericsson | Option 1 | We haven't identified use case for Opt 2 yet |
| Apple | Option 1 |  |
| Convida Wireless | Option 2 | Introducing a separate flag in system information is more flexible since it would allow barring of a frequency for RedCap UEs but not legacy UEs or vice versa. |
| Sequans | Option 2? | Agree with OPPO, if a separate *cellBarred* is introduced, it makes sense to have a separate *intraFreqReselction* |
| NEC | Option 1 | No special requirement for RedCap UE to use an additional flag. |
| Samsung | Option 1 |  |
| CATT | Option 1 |  |
| Intel | Option 1 | Same as others, it is unclear why option 2 is needed. We may come back on this once the situation is clear. |
| Huawei, HiSilicon | FFS | We think both options can work. It may be beneficial if we introduce a separate indication for REDCAP UEs.  This is stage-3 details thus can be discussed in WI phase. |
| vivo | Option 1 and 2 | RedCap UE needs to check both the legacy intraFreqReselection and new flag, for different cases. For example:  Case1: NW intends to bar both normal and RedCap UEs in Freq1.  In this case, Cells working on Freq1 set intraFreqReselection as “not allowed”. Both normal and RedCap UE can bar the frequency after obtaining MIB.  Case2: NW intends to bar only RedCap UEs in Freq2.  In this case, Cells working on Freq2 set intraFreqReselection as “allowed” and set the new flag as “not allowed”  Only RedCap UE will bar the frequency after obtaining the new flag.  The new flag can be indicated in SIB1.  Thus, we should first discuss what is the reasonable use cases. |
| Fujitsu | Option 1 or Option 2 | We are fine with both options. |
| MediaTek | Option 2 | Such an indication is beneficial to avoid requiring the UE to read SIB1 of neighbour UEs, to work out which neighbour cells support RedCap operation. Re-using the legacy flag may lead to confusion on its interpretation. |
| Lenovo | Option 1 |  |
| LG | Option 1 |  |
| Spreadtrum | Option 1 |  |
| ZTE | FFS | The use case can be studied first. Then RAN2 can make a chose. |
| InterDigital | Option 2 | We would like to not immediately exclude this option and think we can further evaluate after progress has been made on the cell-barring discussion in Q2 and Q2a. |

**Summary for Question 4:**

20 companies replied Question 4:

* 13 companies prefer to reuse legacy *intraFreqReselection* for REDCAP UEs.
* 5 companies prefer to have similar but separate indication for REDCAP UEs.
* 3 companies are OK to consider both.

**Proposal 4: The legacy flag *intraFreqReselection* is reused for REDCAP UEs.**

## When/How to identify REDCAP UE

Proposals in above contributions related to when and how to identify REDCAP UE are listed as following:

|  |  |  |
| --- | --- | --- |
| **Tdoc number** | **Company name** | **Proposals** |
| R2-2006786 | OPPO | Proposal 4 RAN2 wait for RAN1’s input before considering the need of early RedCap UE’s identification, e.g. in Msg1 or Msg3. |
| R2-2007345 | Huawei, HiSilicon | Proposal 2: REDCAP UE could be identified by Msg1/Msg A or by different initial UL BWP. |
| R2-2007493 | MediaTek Inc. | Proposal 6: A RedCap UE that is registered to a network is identified by the network at msg5.  Proposal 7: The UE can indicate that it is a RedCap UE as part of msg5. |

In above proposals, the following options were mentioned:

* Option 1: Separate initial UL/DL BWP for REDCAP UE
* Option 2: Msg1/A
* Option 3: Msg3
* Option 4: Msg5

Whether a REDCAP UE needs to be identified by the gNB at early stage depends on:

* Whether the UE is allowed to camp on a cell with larger initial UL/DL BWP than supported by the UE, see Question 3.
* Whether special handling is needed for scheduling of REDCAP UE during RACH procedure, e.g., scheduling of RAR or Msg4.

**Question 5.** Which option do you prefer for the gNB to identify RECCAP UE?

|  |  |  |
| --- | --- | --- |
| ***Company name*** | ***Option?*** | ***Comments*** |
| Qualcomm | Option 2 | RedCap UE has reduced coverage due to its reduced capabilities. Among the four messages in a RACH procedure, PUSCH Tx in msg3 hence is the bottleneck and repetition is very likely to be introduced for it to help recover the reduced coverage. But for network to decide whether to schedule repetition for msg3 for a UE, it has to be able to identify RedCap UE since msg1/A. |
| Xiaomi | - | Whether a REDCAP UE needs to be identified by the gNB at early stage depends on RAN1’s input.  And how to achieve this early identification still depends on RAN1’s input. |
| Nokia | Option 2/3 | The options are not necessarily exclusive, even in case the REDCAP UE had separate initial UL/DL BWP, likely the Option 2 and/or 3 is still required. |
| OPPO | - | We should wait for RAN1’s input on the need of early identification of RedCap UEs.  One note: option 1 can be categorized into option 2, since it is anyway Msg1/A, instead of the BWP, to be transmitted and identified by the network. |
| Futurewei | - | From RAN2 perspective, Option 2 seems more suitable. But the decision needs RAN1 input. |
| Ericsson | Option 3 / Msg A / based on capabilities | Should option 3 be Msg3/MsgA instead?  Among the listed options, we'd prefer option 3 if there is no compelling technical reason to adopt an even earlier indication – this depends on further RAN1 input. In short – if possible we would like to avoid Msg1 indication as that would require either fragmenting preamble space or defining new RACH resources or other similar solution.  However, after Msg3/MsgA it is also possible for gNB to receive the UE capabilities stored in CN, and determine whether the UE is a Redcap UE or not. This should be included as one of the options and studied – however details further depend on the UE type and capability discussion. |
| Apple | - | Wait for RAN1 input. In our view, other than barring, any additional methods in RACH are only needed if RAN1 requires this. |
| Convida Wireless | - | In our view, it would be better to first decide whether a REDCAP UE needs to be identified by the gNB at early stage. Once that is decided, we can then decide which of these options to use. |
| Sequans | FFS | Wait for RAN1. It would be better to avoid MSG1/A if possible without affecting UE performance |
| NEC | Option 2 (only if required) | At this moment, it is not very clear such early identification is necessary. As Rapporteur indicated, this aspect put on hold until other fundamental issues become clearer. Especially, option 2 needs RAN1 study. |
| Samsung | Option 1/2/3 | It is difficult to narrow down the option at this stage, but maybe it is inevitable to introduce a separate initial BWP for RedCap UEs (by RAN1). If we would not go with Option 1, then both Option 2 and 3 can be considered. |
| CATT | Option 2/3 | We are open to disucss on option 2 and 3.  Option 1 seems in ran1 scope, can wait. |
| Intel | - | Wait for RAN1 inputs. The RAN2 impact depends on what RAN1 will agree, e.g. whether the reduced capabilities cause different handling on legacy UE and redcap UE in initial access. |
| Huawei, HiSilicon | Options 1, 2 and 3 | We think REDCAP UE should be identified in RACH procedure at least to ensure network to configure specific transmission of Msg2/Msg4 to ensure coverage of REDCAP UE.  As for option1, option 2, or option 3, it could be decided by RAN1 because PUSCH hopping of Msg3 and PUCCH hopping for Msg4 have impact on the final decision. |
| vivo | FFS | Firstly, we should decide whether the early indication for RedCap UEs is needed, and what the intended use cases. As far as we known, this part is also being discussed in RAN1. Moreover, this is also related to the reduced capability definition and UE types.  After that, we can discuss which solution should be adopted for the identified use cases. |
| Fujistu | Option 1/2 | See Question 3. We are ok to introduce separate initial BWP for RedCap UE, RedCap UEs should be allowed to access a cell for legacy UEs. The separate initial BWP is necessary especially the initial UL BWP in case RedCap UE cannot support the legacy initial UL BWP of the cell to facilitate the UL transmission of RedCap UE during random access. In case RedCap UEs can support the legacy initial BWP of the cell, sharing the initial BWP configuration to RedCap UEs can mostly save the signalling overhead and in this case separate RACH configuration is needed to identify RedCap UE for msg1/MsgA. |
| MediaTek | Option 3/MsgA | Option 5 is actually the baseline today (as the UE is identified at msg 5, and corresponding UE capabilities can be queried by the gNB from the CN).  We agree with Ericsson that Option 3 should be Msg3/MsgA. We also agree with them that we should avoid fragmenting the RACH preamble space or requiring new RACH resources, and should only look at other options if RAN1 identify issues with Msg3/MsgA transmission. |
| Lenovo | Option 1/2/3 | Option 2 and Option 3 can be used for the case of no Separate initial UL/DL BWP for REDCAP UE. And for all the potential cases, we think all the options can be supported. |
| LG | FFS | We should further discuss when the gNB or CN needs UE capabilities. Also, RAN1 progress is needed especially for Option 1. |
| Spreadtrum | - | In Option 1 and option 2, separate resources are used for RedCap UEs. In Option 3 and Option 4, the sharing resources are used, with an indication used to identify the UE type. Maybe we can discuss whether separate or sharing resources should be used firstly. |
| ZTE | - | Wait for RAN1 input. If repetition or other special treatment is needed for msg2/3/4, UE should be identified on msg1/msgA. Either option 1 or option 2 can support this purpose. |
| InterDigital | - | Agree with Convida |

**Summary for Question 5:**

22 companies commented Question 5:

* 5 companies support separate initial UL BWP.
* 9 companies support Msg1 for 4-step RA.
* 7 companies support Msg3 for 4-step RA.
* 11 companies support MsgA for 2-step RA.
* 12 companies think that we should wait for RAN1 input for the following reasons:
  + RAN1 is discussing the same issue.
  + One reason to identify REDCAP UEs at early stage is that the network may need special handling for RAR/Msg3/Msg4 scheduling of REDCAP UEs, which is discussing in RAN1.
  + Option 1 and 2 have RAN1 impact.

There is not clear majority view. Considering that RAN1 has email discussion on the same issue, maybe it is better to wait for RAN1 input first.

**Proposal 5: Wait for RAN1 input regarding when and how to identify REDCAP UEs.**

## UAC for REDCAP UE

In order to achieve load balancing, UAC mechanism for REDCAP UEs is proposed in above contributions as follows:

|  |  |  |
| --- | --- | --- |
| **Tdoc number** | **Company name** | **Proposals** |
| R2-2006786 | OPPO | Proposal 2 Existing UAC framework can be reused for RedCap UEs.  Proposal 3 After concluding on the number of RedCap UE types, RAN2 ask CT1 to define access identity(ies) for RedCap UEs. |
| R2-2007345 | Huawei, HiSilicon | Proposal 5: Study whether to enhance UAC mechanism for REDCAP UEs. |
| R2-2007493 | MediaTek Inc. | Proposal 4: The UAC mechanism is re-used to control the access of RedCap devices to the network.  Proposal 5: Send an LS to SA1 to determine if changes are needed to the UAC mechanism to support RedCap access control. |

The following enhancements are mentioned in above proposals

* Option 1: Introduce a set of additional UAC configuration including UAC parameters of all access categories and access identities for REDCAP UEs
* Option 2: Define new Access Identity for REDCAP UEs (need SA1 work)
* Option 3: Define new Access Categories for REDCAP UEs (need SA1 work)

**Question 5.** Do you agree to use UAC mechanism for REDCAP UEs?

|  |  |  |
| --- | --- | --- |
| ***Company name*** | ***Yes/No?*** | ***Comments*** |
| Qualcomm | Yes |  |
| Xiaomi | Yes | Existing UAC framework can be reused for RedCap UEs. More details need to be considered.  If the traffic models identified are different from the existing services related access categories, it is reasonable to add new access categories or reuse the reserved ones.  Regarding to new UE type, for instance, if new types of UEs can be identified for clearer UE categorization for industrial wireless sensor scenarios, additional access identities can be considered. |
| Nokia | No | SA/CT groups are not included in the study. We think that RAN based mechanism such as barring, RRC reject, MAC back off are sufficient on top of current UAC. |
| OPPO | Yes |  |
| Futurewei | Yes | It’d be better to apply a uniform approach to Redcap UE. |
| Ericsson | Yes | UAC is an extensible mechanism and should be included in the study from RAN2 perspective. If changes are eventually agreed to, we can coordinate such changes with SA/CT during the normative phase. |
| Apple | Yes |  |
| Convida Wireless | Yes |  |
| Sequans | Yes |  |
| NEC | Yes | UAC mechanism will work for RedCap UEs as well.  On the other hand, some enhancements as listed need SA1 guidance. So, what RAN2 can do in SI is to assume we will reuse the UAC. That’s it. |
| Samsung | Yes | We also think that the existing UAC framework can be reused, and are open to both Options 2 and 3. |
| CATT | yes |  |
| Intel | Yes | UAC should be considered to restrict the usage of services for redcap UE. |
| Huawei, HiSilicon | Yes | At least the current UAC mechanism can be reused. |
| vivo | Yes | Access control of RedCap UE is necessary to avoid impact to normal UE when congestion occurs. Current UAC mechanism is easy to be used as the baseline for RedCap UEs. |
| Fujitsu | Yes |  |
| MediaTek | Yes |  |
| Lenovo | Yes |  |
| LG | Yes |  |
| Spreadtrum | Yes |  |
| ZTE | yes | UAC serves as a congestion control mechanism in NR system which should also be applied for RedCap access. |
| InterDigital | Yes |  |

**Summary for Question 6:**

22 companies commented on Question 6, where 21 companies think that UAC mechanism also apply to REDCAP UEs.

**Proposal 6: UAC mechanism also applies to REDCAP UEs.**

**Question 6a.** If the answer to Question 6 is Yes, do you think enhancements to the current UAC mechanism listed above are needed?

|  |  |  |
| --- | --- | --- |
| ***Company name*** | ***Option?*** | ***Comments*** |
| Qualcomm | Option 2 | We agree with Proposal 2 & 3 in R2-2006786. We don’t see any strong use case that would require introduction of new access categories. RedCap-specific access causes can be supported through operator defined access categories. |
| Xiaomi |  | If Redcap UEs requires coverage recovery and the additional enhancement will be carried out on the repetition transmission (depends on more RAN1’s input), it seems reasonable that the access could be configured to be more restrictive for Redcap UEs. It seems CE-level-based access class barring can be considered as in R15 narrowband. |
| OPPO | Option 1 and 2 | The existing UAC parameters are only applicable to access identities {1,2,11,12,13,14,15} and new UAC parameters need to be defined for the new access identity(ies) for RedCap UEs. |
| Futurewei | Options 1, 2, and 3 | All these options may be considered to accommodate a very diverse set of Redcap use cases |
| Ericsson | Option 2/3 | At the moment option 2 or 3 seem viable but we can study further what is the intended behaviour and what is needed to achieve that behaviour. |
| Apple | All options are viable |  |
| Convida Wireless | Option 2 | One or more access identities should be defined for REDCAP UEs. |
| Sequans | All options | Though option 2 seems the most likely |
| NEC |  | maybe option 2 or 3, but it should be investigated in SA1/CT1 whether a new access id or a new access category is necessary or not. |
| Samsung | Option 2/3 | As said above, we are open to have Option 2 and 3. If 3GPP decides to introduce a new Access Identity/Category, the current UAC mechanism can be reused as it is, and the RAN2 specification impact would be minimum. |
| CATT | Option 2/3 | Option to consider both 2 and 3. |
| Intel | Option 2 | Tend to agree with QC, do not see the strong need on new access category, unless new services are identified. |
| Huawei, HiSilicon | Option 2 | Option 1 consumes too many SIB1 bits.  Option 3 is not very suitable because the current access category is differentiated from the dimension of traffic/access type. |
| vivo | Option 2/3 | In our understanding, option 1/2/3 can be applied to different use cases. But option 1 leads to too much signalling overhead and we don’t see strong motivation for this option. If we can identify valid use case this option, we can also discuss it. Otherwise, we prefer to define new Access Identities and Categories for RedCap UEs to enable NW to differentiate the access request from high-end, low-end IIoT and low-end wearable devices. |
| Fujitsu | Option2/3 | We think that Option 1 introduces more signalling overhead which is not needed. Option 2 and/or Option 3 is simple and can be used to control access from RedCap UEs. |
| MediaTek | Option 2 | Agree with QC that there isn’t a strong need for a new access category at this time. |
| Lenovo | Option 1 | To separately restrict the access of RedCap UEs and maximally reuse the existing structure of UAC, we prefer Option 1. |
| LG | Option 3 | Option 2 can be also considered. |
| Spreadtrum | - | Suggest leaving this discussion to SA. |
| ZTE | Option 1 or option 3 | **Option1:** this option is easy to achieve full differentiation in access control for RedCap device although it requires more signaling overhead. Note that RAN1 is discussing whether there is separate SIB1 for RedCap. If SIB1 is separately transmitted for RedCap UE, it results in option 1 naturally.  **Option 2:** with this option, barring configuration of a Access category is shared for regular NR UE and RedCap UE. And adding a new redcap access identity also means RedCap UE cannot be configured with access class 11 to 15 or configured for MPS and MCS. Thus this option is not preferred.  **Option 3:** access category represent the reason of access attempts, e.g. MT access, emergency, MO exception data, delay tolerate, MO signaling... same as normal UE, redcap UE may initiate access attempt with these access reasons. To achieve full differentiation access control, another set of access categories are needed (RedCap MT, RedCap MO, RedCap signaling...). It is viable if a set of RedCap access categories can be defined by using reserved bis or operator defined access categories. |
| InterDigital | Option 2/3 | Option 2 and 3 can be the baseline for further study. |

**Summary for Question 6a:**

22 companies commented on Question 6a:

* 6 companies are OK to consider to introduce a set of additional UAC configuration including UAC parameters of all access categories and access identities for REDCAP UEs
* 16 companies are OK to consider to define new Access Identity for REDCAP UEs
* 12 companies are OK to consider to define new Access Categories for REDCAP UEs
* 1 company prefers to consider CEL based barring mechanism.

Option 2 (define new Access Identity for REDCAP UEs) and Option 3 (define new Access Categories for REDCAP UEs) are supported by more than 50% of companies but there is no clear majority view between Option 2 and Option 3. Thus, it is proposed to further discuss Option 2 and Option 3 as enhancement of UAC for REDCAP UEs.

**Proposal 6a: Further discuss the following enhancement of UAC for REDCAP UEs:**

* **define new Access Identity for REDCAP UEs**
* **define new Access Categories for REDCAP UEs**

# Conclusion

This offline discussion focused on proposals for identification and access restriction of REDCAP UEs. The proposals based on above discussion are summarized as following:

Propose to agree as there is clear majority view:

**Proposal 2: One indication in system information is needed to indicate whether a REDCAP UE can camp on the cell.**

**Proposal 6: UAC mechanism also apply to REDCAP UEs.**

Propose to further discuss as there is no clear majority view:

**Proposal 2a: Further discuss whether the indication is explicit or implicit.**

**Proposal 2b: Further discuss whether the indication is transmitted in MIB or SIB1.**

**Proposal 4: The legacy flag *intraFreqReselection* is reused for REDCAP UEs.**

**Proposal 6a: Further discuss the following enhancement of UAC for REDCAP UEs:**

* **define new Access Identity for REDCAP UEs**
* **define new Access Categories for REDCAP UEs**

Propose to further discuss as RAN1 input maybe needed:

**Proposal 1: Wait for RAN1 input regarding whether REDCAP UEs can camp on a cell with the bandwidth of CORESET#0 not supported by the UE.**

**Proposal 3: Wait for RAN1 input regarding whether REDCAP UEs can camp on a cell with larger initial DL/UL BWP than supported by the UE.**

**Proposal 5: Wait for RAN1 input regarding when and how to identify REDCAP UEs.**

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