**3GPP TSG RAN WG1 Meeting #103-E R1-2009317**

**e-Meeting, October 26th – November 13th, 2020**

**Source: Moderator (Intel Corporation)**

**Title: Moderator summary on RedCap - Others**

**Agenda item: 8.6.5**

**Document for:** **Discussion and Decision**

# Introduction

This document presents a summary of submitted contributions to AI 8.6.5 (Other aspects of RedCap) and some contributions to AI 8.6.4 that have discussions relevant to RedCap UE identification and access control.

Based on the submitted contributions to RAN1 #102-E meeting, the discussion points are categorized into the following topics:

* Access control
* Identification of RedCap UEs by the NW
* RRM relaxations for power savings

# Access control

The SID on RedCap lists the following objectives:

*Study functionality that will allow devices with reduced capabilities to be explicitly identifiable to networks and network operators, and allow operators to restrict their access, if desired [RAN2, RAN1].*

During RAN1 #102-e meeting, the following was discussed in RAN1 without conclusion [29]:

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| *Updated FL Proposal 1 (from RAN1 # 102-e)*   * *Further study the options to realize cell barring for RedCap UEs, including ~~at least~~ the following indication methods:*   + *Implicit or explicit indication (as may apply):*      - ***Alt. A****: Via separate SSB and/or CORESET 0.*     - ***Alt. B****: Via indication in MIB.*     - ***Alt. C****: Via indication in DCI format scheduling SIB1.*     - ***Alt. D****: Via indication in SIB1.*     - *Other methods are not precluded.*   *Note: This study intends to establish feasibility of, and pros and cons for the identified methods from RAN1 perspective, without any intention of down-selection without guidance from RAN2.* |

In the meantime, RAN WG2 decided on the following:

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| 1. An indication in system information is needed to indicate whether a REDCAP UE can camp on the cell. FFS whether the indication is explicit or implicit. 2. UAC mechanism also apply to REDCAP UEs. 3. System information indicates whether REDCAP operation is allowed/barred on a frequency. FFS reuse the legacy intraFreqReselection or introduce separate flag 4. Further discuss enhancement of UAC for REDCAP UEs, including e.g.:    1. define new Access Identity for REDCAP UEs    2. define new Access Categories for REDCAP UEs   (for any final decision we need to check with SA1 and/or CT1) |

Some contributions ([5], [9], [10], [17]) have presented discussions on access control mechanisms beyond the above-quoted RAN WG2 agreement, highlighting potential benefits from additional/supplementary mechanisms beyond RAN2 agreement of indication of support of RedCap UEs in a cell via SIB1 – specifically, via use of PDCCH/DCI format scheduling SIB1 PDSCH. However, given the agreement in RAN WG2, whether additional mechanisms are necessary or warranted is not obvious at this point (e.g., Proposal 2 in [19]).

The issue of access control is being discussed further in RAN WG2, and there exists various dependencies on decisions related to, e.g., configuration of separate DL/UL initial BWPs for RedCap UEs, support of a separate SIB1 for RedCap UEs, etc., some of which needs to rely on decisions in RAN WG2. Thus, at this point, it may be prudent to wait for RAN WG2 to make further progress, especially considering the related discussions during RAN1 #102-e meeting. This view (to wait for further progress in RAN WG2) is expressed by several contributions as well (e.g., [2], [6], [19]).

## FL Proposal 1

* *On the issue of access control for RedCap UEs, RAN1 to wait for further progress in RAN2.*

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| **Company** | **Agree (Y/N)** | **Comments** |
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# Identification of RedCap UEs

The SID on RedCap lists the following objectives:

*Study functionality that will allow devices with reduced capabilities to be explicitly identifiable to networks and network operators, and allow operators to restrict their access, if desired [RAN2, RAN1].*

As can be seen from the above, it is imperative that RedCap UEs can be identified by the network without ambiguity. Here, it is noted that such identification is relevant primarily in the context of accessing a cell (as against merely camping on a cell).

In contributions [2], [4], [5], [8], [10], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22] views on realizing the objective of access control for RedCap UEs have been presented. Please refer to Appendix A for list of observations and proposals from these contributions related to identification for RedCap UEs by the NW.

During RAN1 #103-e meeting, the following was agreed [29]:

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| *Agreements:*   * *Further study the options for identification of RedCap UEs, including ~~at least~~ the following indication methods:*   + *Opt. 1: During Msg1 transmission, e.g., via separate initial UL BWP, separate PRACH resource, or PRACH preamble partitioning.*   + *Opt. 2: During Msg3 transmission.*   + *Opt. 3: Post Msg4 acknowledgment.*      - *E.g., during Msg5 transmission or part of UE capability reporting.*   + *Opt. 4: During MsgA transmission (subject to support of if 2-step RACH)*   + *Other options are not precluded.*   + *Note: This study intends to establish feasibility of, and pros and cons for the identified options from RAN1 perspective, without any intention of down-selection without guidance from RAN2.* |

In general, how early such identification needs to be made depends on the physical layer procedures for RedCap UEs regarding random access and whether there may be differences for RedCap UEs compared to regular NR UEs. In case different handling of RedCap UEs is required for random access, then early identification either via Msg1 or Msg3 may be necessary.

Some cited motivations for early identification of RedCap UEs include:

* **Coverage:** Different coverage performance for RAR and/or Msg4 for RedCap UEs compared to regular NR UEs 🡪 this may necessitate different scheduling approaches for Msg2/Msg4 and Msg3 (use of repetitions, etc.).
  + *Even if Msg2/Msg3/Msg4 may not necessarily need coverage enhancements/recovery, the knowledge that a UE initiating a random-access procedure is a RedCap UE can be beneficial in realizing appropriate DL and UL link adaptation for Msg2/Msg3/Msg4 scheduling as well. However, the trade-off against increased OH, RACH capacity loss, etc.*
* **Initial UL BWP congestion:** Limitations to non-RedCap UEs by limiting max BW for initial UL BWP (e.g., 20 MHz in FR1, 50 MHz in FR2 (if supported))
  + *Separation of initial UL BWPs for RedCap UEs from non-RedCap UEs could alleviate the restrictions that may otherwise impact non-RedCap UEs.*
  + *However, since the initial UL BWP could be limited to random access related (Msg1, Msg3) transmissions, the overall adverse impact to non-RedCap UEs may not be significant as the non-RedCap UEs could be switched to larger UL BWPs upon RRC connection establishment.*
* **Initial UL BWP congestion:** Limitations to non-RedCap UEs by limiting max BW for initial DL BWP (e.g., 20 MHz in FR1, 50/100 MHz in FR2)
  + *This impact is primarily limited to Msg4 scheduling for non-RedCap UEs, and UE identification via Msg1 or Msg3 could facilitate more flexible resource allocation for Msg4 scheduling for non-RedCap UEs.*
* **Minimum UE requirements impacting RA procedure:** It may be necessary to identify RedCap UEs at Msg1 transmission if minimum UE processing times for RedCap UEs are relaxed compared to Capability #1 values or requirements on UL waveform are relaxed (e.g., SC-FDM only) for RedCap UEs, etc.
  + *In the absence of such knowledge upon reception of Msg1, the gNB may be forced to schedule RAR/Msg3/etc. conservatively in terms of minimum UE processing times or waveform support, thereby potentially causing adverse impact to non-RedCap UE’s control plane (CP) latency.*

On the other hand, if RedCap UEs can perform random access procedure like regular NR UEs, it may be sufficient if RedCap UEs are identified via Msg3 or even via Msg5 (upon connection establishment).

In summary, the necessity of early identification may not be clearly established until further clarity is achieved on related design choices for RedCap UE cost/complexity reduction and whether any new mechanisms related to initial access and system information acquisition are introduced (e.g., separate SIB1 for RedCap UEs, separate initial DL/UL BWPs for RedCap UEs, etc.). This is further complicated by the fact that such UE identification may not be limited to identifying RedCap UEs from non-RedCap ones, but also further identification of RedCap UEs.

Further, it has also been pointed out in several contributions that configurability of some of the features, e.g., separate RACH preambles, separate RACH resources, or separate initial UL BWP for RedCap UEs, may be considered further to realize some of the above-listed benefits for deployments that may merit from such enhancements. In other words, early identification of RedCap UEs (prior to UE capability reporting) may not be mandated but could be optionally configured by the gNB towards achieving the best trade-off between access latency, user capacity, and system OH, congestion control, and resource utilization in both DL and UL. This also implies that at least RedCap UE identification as part of UE capability reporting should be supported.

Thus, at this point, RAN1 could focus on establishing the feasibility of and identifying the pros and cons for the various options for RedCap UE identification while further details on RedCap UE capabilities/minimum requirements and related system design details attain further clarity.

## FL Proposal 2

* *As a next step, during RAN1 #103-e meeting, RAN1 to focus on establishing feasibility and identifying pros and cons for the following schemes:*
  + ***Opt. 1****: During Msg1 transmission, e.g., via separate initial UL BWP, separate PRACH resource, or PRACH preamble partitioning.*
  + ***Opt. 2****: During Msg3 transmission.*
  + ***Opt. 3****: Post Msg4 acknowledgment.* 
    - ***E****.g., during Msg5 transmission or part of UE capability reporting.*
  + ***Opt. 4:*** *During MsgA transmission*

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| **Company** | **Agree (Y/N)** | **Comments** |
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## FL Proposal 3

* *Under the assumption that RedCap UEs may be identified at least via UE capability reporting:*
  + *Optional configurability of separate resources for Msg1 transmissions for RedCap UEs via use of separate initial UL BWP, separate PRACH resource, or PRACH preamble partitioning for early identification of RedCap UEs is considered further.*

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| **Company** | **Agree (Y/N)** | **Comments** |
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# RRM relaxations for UE power savings

In contributions [4] and [13], views on RRM relaxations for RedCap UEs that may be stationary to enable reduced power consumption have been presented (see Appendix B for summary of proposals).

Following the earlier conclusion from RAN1 #102-e meeting (see below), it is recommended that these discussions be deprioritized until RAN WG2 makes further progress.

From RAN1 #102-e [29]:

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| **Conclusion:**   * *RAN1 to defer to RAN2 for further progress on studies regarding RRM relaxations and E-DRx for RedCap UEs to facilitate reduced UE power consumption.* |

# References

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2. [R1-2007538](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2007538.zip), Identification for RedCap UEs FUTUREWEI

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# Appendix A

**List of observations/proposals on access control for and identification of RedCap UEs:**

R1-2007533 UE identification and access restriction for RedCap Ericsson

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| [Proposal 1 In the TR, capture feasibility/pros/cons for different options from RAN1 perspective, considering the input in the table in this contribution. Do not make further attempts to down-select between the options in this RAN1 meeting.](#_Toc53800340)   |  |  | | --- | --- | | **Option** | **Feasibility/pros/cons from RAN1 perspective** | | Option 1: Msg1 | Feasibility:   * Yes, assuming enough PRACH resources are available for grouping   Pros:   * Msg2/3/4/5 transmission parameters can be optimized for RedCap and non-RedCap UEs, respectively * Does not require any additional bits in Msg3 (from RAN1 perspective)   Cons:   * Increased PRACH resource consumption/fragmentation; the fragmentation could multiply if Msg1 indication is further used for RedCap UE identification, Small Data transmission and slicing, possibly leading to resource depletion | | Option 2: Msg3 | Feasibility:   * Yes, assuming Msg2/3 transmission does not become an issue without earlier indication   Pros:   * Msg4/5 transmission parameters can be optimized for RedCap and non-RedCap UEs, respectively * No increased PRACH resource consumption/fragmentation   Cons:   * Msg2/3 transmission parameters cannot simultaneously be optimized for RedCap and non-RedCap UEs * Requires at least one bit in Msg3 and potentially a larger Msg3 TBS | | Option 3: Msg5+ | Feasibility:   * Yes, assuming Msg2/3/4/5 transmission does not become an issue without earlier indication   Pros:   * No increased PRACH resource consumption/fragmentation * Does not require any additional bits in Msg3 (from RAN1 perspective)   Cons:   * Msg2/3/4/5 transmission parameters cannot simultaneously be optimized for RedCap and non-RedCap UEs | | Option 4: MsgA | Feasibility:   * Yes, assuming 2-step RACH is used   Pros:   * MsgB and Msg5 transmission parameters can be optimized for RedCap and non-RedCap UEs, respectively * Pros for UE indication in MsgA preamble part are similar as for Option 1 * Pros for UE indication in MsgA PUSCH part are similar as for Option 2   Cons:   * Cons for UE indication in MsgA preamble part are similar as for Option 1 * Cons for UE indication in MsgA PUSCH part are similar as for Option 2 |   Proposal 2 RAN1 continues to prioritize study of other aspects of the study item and leave the study of access restriction to RAN2. |

[R1-2007538](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2007538.zip) Identification for RedCap UEs FUTUREWEI

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| *Observation 1: it is better to pool RACH resources between RedCap and non-RedCap UEs.*  *Proposal 1: Similar to LTE-M, PRACH preamble partitioning is used for RedCap identification*  *Proposal 2: RedCap identification in Msg 3 can be considered if RAN1 decides that no compensation for coverage is needed for Msg 3*  *Proposal 3: If two-step RACH is supported, RedCap identification in Msg A can be considered* |

[R1-2007672](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2007672.zip) RRM relaxation for Reduced Capability NR devices vivo, Guangdong Genius

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| Observation 1: IDLE mode power saving is critical for wearable devices.  Observation 2: 13.4% power saving gain in IDLE mode can be observed if serving cell RRM relaxation is introduced for high SINR UE.  Observation 3: It is feasible for RedCap UEs to process SSBs once per multiple paging cycles.  Proposal 1: Serving cell RRM relaxation for high SINR UE in idle state should be supported for RedCap UE. |

[R1-2007719](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2007719.zip) Access control and identification for Reduced Capability NR devices ZTE

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| *Observation 1: For reduced capability NR devices, an access control indication carried in DCI scheduling SIB1 is beneficial for UE’s power saving.*  *Observation 2: Early identification of RedCap UEs as early as possible is beneficial for coverage recovery and dedicated scheduling of messages during initial access.*  *Proposal 1: For reduced capability NR devices, an access control indication is carried in DCI scheduling SIB1.*  *Proposal 2: From RAN1 perspective, identification of RedCap UEs during Msg1/MsgA transmission is feasible.* |

[R1-2007866](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2007866.zip) Identification and access restriction for reduced capability NR devices CATT

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| Observation 1: *cellBarred* in MIB already provides overall barring information, which is determined comprehensively from network perspective.  Observation 2: the motivation of introducing RedCap-specific barring indication before acquiring SIB1 need further study.  Observation 3: Redcap identification during Msg1 may benefit the scheduling of largest number of channels before RRC setup, at the cost of PRACH partitioning.  Observation 4: Redcap identification during Msg3 may benefit the scheduling of small number of channels before RRC setup, at the cost of future Msg3 extendibility.  Observation 5: Redcap identification after Msg4 is considerable, if the current RACH procedure can be reused for RedCap.  Proposal1: Leave the access restriction of RedCap UE to RAN2 discussion |

[R1-2007951](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2007951.zip) On identification of and access control for RedCap UEs Intel Corporation

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| Observation 1:   * *Identification of RedCap UEs at least after Msg4 Ack (i.e., via Msg5 or UE capability reporting) is necessary as a baseline mechanism.*   Observation 2:   * *Early identification of RedCap UEs during RA procedure may not always be necessary. Such mechanisms, if introduced, could be optionally configured by the gNB via SIB signaling.*   Observation 3:   * *Early identification of RedCap UEs via Msg1 or MsgA could be beneficial, although not strictly necessary, if relaxed minimum UE processing times are introduced for RedCap UEs.*   Observation 4:   * *Early identification of RedCap UEs during the RA procedure may not be necessary from perspective of coverage recovery needs for Msg2 and/or Msg4.*   Observation 5:   * *Early identification of RedCap UEs during RA procedure may be necessary if additional or separate initial DL or UL (respectively) BWPs may be configured for Msg2/Msg4 or Msg1/Msg3 (respectively).* |

[R1-2008020](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008020.zip) Discussion on identification and access control for Reduced Capability NR devices CMCC

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| Proposal 1: Msg.3 can be used for early identification of RedCap UEs.  Proposal 2: Separate initial BWP can be used for early identification of RedCap UEs.  Proposal 3: Early access control by PBCH, type0-PDCCH, SIB1, PRACH procedure can be further studied. |

[R1-2008052](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008052.zip) Other aspects for reduced capability NR devices LG Electronics

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| Observation 1: It is beneficial to introduce a new SIB1 for REDCAP UEs e.g. for support of potential REDCAP specific common channel configuration and transmissions without any concern on SIB1 size.  Proposal 1: Study a mechanism for scheduling new SIB1 (e.g. SIB1-R) used by REDCAP UEs.  Observation 2: In LTE, MIB provides scheduling of SIB1-BR. However, it seems difficult for NR MIB to accommodate scheduling information of a new SIB1-R.  Proposal 2: If CORESET0 can be shared by REDCAP UEs and normal UEs, the DCI format 1\_0 with CRC scrambled by SI-RNTI can be used to schedule both legacy SIB1 and new SIB1-R.  Observation 3: If the DCI schedules new SIB1-R, REDCAP UEs can identify whether the cell supports REDCAP UEs based on the DCI.  Proposal 3: The DCI format 1\_0 with CRC scrambled by SI-RNTI explicitly or implicitly indicates whether the cell supports REDCAP UEs  Observation 4-1: gNB currently transmit other system information within the size of CORESET 0. However, REDCAP UEs may or may not receive legacy transmission of other system information depending on RAN1 discussion. In addition, gNB could possibly provide different configurations in other system information to REDCAP UEs and normal UEs.  Observation 4-2: It is beneficial for gNB to know whether on-demand SI is requested by REDCAP UEs or normal UEs.  Proposal 4: REDCAP specific RACH resources can be configured for gNB to transmit on-demand SI message decodable by REDCAP UEs.  Observation 5: A best beam RS would not frequently change for a certain stationary UE for which some aspects could be optimized.  Proposal 5: Study relaxed operation of RLM/BFD as well as RRM for a stationary UE. |

[R1-2008072](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008072.zip) Initial access for RedCap UEs Nokia, Nokia Shanghai Bell

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| Observation 1: The NR MIB “cellBarred” bit applies to all UEs (RedCap and non-RedCap) attempting to access the cell.  Observation 2: The NR MIB does not support enough spare bits to indicate RedCap device specific barring.  Observation 3: The DCI format 1-0 variant used to schedule SIB1 and other SI messages has 15 reserved bits.  Observation 4: The enhancement of UAC for REDCAP is pending SA1 discussions.  Proposal 1: A REDCAP UE can determine if a cell supports REDCAP without the need to read SIB1.  Proposal 2: A REDCAP UE can determine if a REDCAP capable cell is barring specific REDCAP capability types without the need to read SIB1.  Note: This level of “hard” barring compliments the SIB1 based UAC level of “soft” barring.  Proposal 3: RAN1 and RAN2 to determine if a separate SIB1 for REDCAP devices, R-SIB1, is specified.  Proposal 4: If a separate R-SIB1 is specified for REDCAP devices, then a new DCI RNTI is defined to scramble a DCI that shares the same search space as used by the current SIB1 DCI, but which schedules the new R-SIB1.  Proposal 5: If the current SIB1 is to be reused by REDCAP devices, then some of the reserved bits in the existing DCI used to schedule the SIB1 are used to indicate cell REDCAP capability.  Proposal 6:         If RAN1 determines that additional coverage recovery is needed on msg2/msgB, the network can identify REDCAP UEs at the msg1/msgA stage (options 1 and 4) of the RACH procedures.                              FFS:  The specific method(s) of identification, preamble partitioning/separate UL BWP/etc |

[R1-2008075](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008075.zip) Procedure of identification for Reduced Capability NR devices TCL Communication Ltd.

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| Proposal 1: Study the methods to partition preambles to minimize the impact on the current specifications.  Proposal 2: Study the method of identifying UE type by the location of PRACH occasion  Proposal 3: The specific identification of the reduced capability UE type post-RAR shall be considered.  Proposal 4: Further study to determine which method to be adopted. |

[R1-2008088](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008088.zip) Discussion on the access control and configuration for reduced capability device Xiaomi

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| Proposal 1: Network access control to RedCap UE should be explicitly indicated as early as possible.  Proposal 2: Mechanism for identification of RedCap UEs During Msg1 transmission should be supported. |

[R1-2008106](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008106.zip) Consideration on power saving for reduced capability NR devices Spreadtrum Communications

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| *Proposal 1: RRM measurement relaxation for neighbour cells including frequency layers with higher/equal/lower priority can be considered for stationary RedCap UEs.*  *Proposal 2:* *RRM measurement relaxation for serving cell can be considered for stationary RedCap UEs.* |

[R1-2008174](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008174.zip) UE identification and access barring Samsung

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| Proposal #1: Support early access for identification for RedCap UEs during random access. |

[R1-2008264](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008264.zip) Other considerations for reduced UE capability OPPO

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| *Observation: Identification of RedCap UEs by Msg1 will reduce the utilization efficiency of PRACH resource.*  *Proposal 1: Separate SSB and CORESET 0 are not used for cell barring indication.*  *Proposal 2: Leagacy Access Control mechanism is reused for RedCap UE as much as possible. The details are discussed in RAN2.*  *Proposal 3: Msg1 or Msg3 can be used for the identification of RedCap UE. Msg3 is slightly preferred.* |

[R1-2008291](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008291.zip) On RedCap device identification Panasonic

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| Observation 1: RedCap device type identification during Msg1 transmission allows network to compensate the coverage performance in early stage and the efficiency of Msg2 and larter could be improved.  Observation 2: In general, it is feasible to support RedCap device type identification by configuring separate PRACH resource in SIB with some specification impact.  Observation 3: Compared with separate PRACH resource in time and frequency domain, PRACH preamble partitioning may involve additional standardization efforts in RAN1 and lead to more complicated gNB implementation.  Observation 4: It would be a challenge to PRACH resource and preamble capacity for UE identification via Msg1 if more than one UE types for RedCap need to be identified.  Observation 5: Device type identification during Msg3 transmission is attractive when Msg1 resource is limited like narrower system bandwidth. There is no RAN1 specification impact.  Observation 6: For device type identification during Msg3 transmission, the network is not able to compensate the coverage performance for Msg2 and Msg3. There could also be scheduling limitation for normal UEs, although it could be regarded as the acceptable cost compared with the resource overhead of Msg1 sharing to RedCap devices.  Observation 7: The pros and cons for device type identification via Msg3 and post Msg4 transmission are quite similar. The more detailed differentiation of RedCap devices needs to use this option using the existing framework of UE capability reporting, if supported.  Observation 8: Device type identification during MsgA transmission requires additional standardization efforts.  Observation 9: The pros and cons for device type identification via MsgA is similar with that of Msg1 and Msg3, except earlier identification by MsgA than Msg3. |

[R1-2008329](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008329.zip) Other aspects for reduced capability devices Huawei, HiSilicon

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| *Observation 1: For FR1, spare bits in MIB are possible for restricting the access of RedCap UEs.*  *Observation 2*: *Compared with access restriction via SIB1, access restriction via DCI associated with SIB1 is beneficial for RedCap UE’s power saving and with minor specification impact.*  *Observation3: The earlier the network identify the RedCap UEs, the better for the gNB to separately schedule the data transmission and make network control on RedCap UEs.*  *Proposal 1: It is necessary for network to indicate its capability of whether it supports RedCap UEs accessing or not.*  *Proposal 2: Consider to restrict the access of RedCap UEs via DCI associated with SIB1.*  *Proposal 3: Consider to identify RedCap UEs via Msg1/MsgA.* |

[R1-2008337](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008337.zip) Narrowband operation and identification of RedCap UE Lenovo, Motorola Mobility

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| * **Proposal 1:** Specify a RedCap UE category(ies), each category defining a particular set of mandatory RedCap UE features and/or capabilities. * **Proposal 2:** Support indication of a RedCap UE category based on active applications or traffic types. * **Proposal 3:** For a reduced capability UE, support operating with a bandwidth smaller than a bandwidth of an active BWP. * **Proposal 4:** Study mechanisms exploiting the frequency diversity and realizing interference randomization within an active BWP, for a case that a reduced capability UE operates with a bandwidth smaller than a bandwidth of the active BWP. * **Proposal 5:** Support dynamic switching between narrowband and wideband operations within a BWP. |

[R1-2008397](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008397.zip) Identification and access restriction for reduced capability UEs Sharp

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| ***Proposal 1:*** *RedCap UEs are identified by Msg1 transmission.*  ***Proposal 2:*** *Indication of whether a RedCap UE can camp on a cell, as already agreed in RAN2, is in SIB.*  ***Observation 1:*** *The RedCap specific cell-barring indication in system information is only used when the “cellBarred” bit in MIB indicates “notBarred”.* |

[R1-2008556](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008556.zip) Discussion on UE identification for RedCap NTT DOCOMO, INC.

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| Observation 1:   * It is beneficial to identify RedCap UEs through Msg1 so that gNB can schedule RedCap UEs appropriately using the coverage recovery techniques for Msg2/3/4 |

[R1-2008585](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008585.zip) Discussion on identification of reduced capability UE ASUSTeK

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| Observation 1: There is a trade off in the base station whether it performs the coverage recovery technique when it has not identified the RedCap UE.  Observation 2: RedCap UE may fail to decode RAR and Msg4 in Opt. 2 and Opt. 3 if the base station does not deploy the coverage recovery technique when it has not identified the RedCap UE.  Proposal 1: Select Opt. 1, Opt. 4 as methods for identification of RedCap UE during random access procedure.  Observation 3: Configuring a separated initial uplink bandwidth part of RedCap UE improves the load balance and removes the restriction on configuring the legacy initial uplink bandwidth part.  Observation 4: Configuring separated RACH resource on time for RedCap UE may delay the downlink scheduling.  Proposal 2: Consider configuring a separated initial uplink bandwidth of RedCap UE for identification in random access procedure. |

R1-2008688 Device identification and access restriction for RedCap InterDigital, Inc.

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| Observation-1: Using Msg1/A for RedCap UE identification could avoid unnecessary PRACH collision increase for the other type of devices.  Observation-2: With a limited number of PRACH resource configured for the RedCap UEs, the access could be restricted naturally.  Observation-3: The use of Msg1/A for RedCap UE identification could be up to gNB configuration.  Proposal 1: Support dedicated resources of Msg1/A for the RedCap UE identification and it is up to the network whether to configure the dedicated Msg1/A resources for RedCap UEs. |

**Proposals/observations relevant to access control and UE identification from AI 8.6.4:**

R1-2007671 Framework and Principles for Reduced Capability vivo, Guangdong Genius

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| Observation 2: repetitions for initial access channels are not specific for RedCap UEs, if coverage enhancements SI/WI decide the solutions for differentiating the UEs requiring repetitions and UEs not requiring repetitions, it is desirable to reuse the solutions.  Proposal 4: further study following two options for identification of RedCap UEs:   * Opt. 1: During Msg1 transmission via separate initial UL BWP. * Opt. 5: During UE capability reporting. |

R1-2008087 Framework and Principles for Reduced Capability Xiaomi

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| Proposal 4: Early identification of RedCap capability by RACH procedure can be considered. |

R1-2008101 Discussion on Framework and Principles for Reduced Capability Spreadtrum Communications

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| *Proposal 3: Study the early indication of RedCap UE capability or the solutions that can free the configuration of the uplink initial BWP of normal UEs from the limitation of the maximum bandwidth of RedCap UEs.* |

R1-2008296 Framework and Principles for RedCap Lenovo, Motorola Mobility

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| *Observation 3: The gNB could control the access of RedCap UEs in different stages during initial access, depending on different design.*  *Proposal 3: Study the feasibility of UE access control during initial access, through*   * *Cellbarred in dedicated SSB* * *Cellbarred introduced in SIB1* * *RACH procedure*   *Proposal 4: Study UE type identification through either Msg1/MsgA or Msg3.* |

R1-2008513 On the framework for RedCap UEs MediaTek Inc.

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| 1. *A RedCap UE only camps on a cell that indicates support of RedCap operation.* 2. *Support of RedCap operation in a cell is broadcasted by the network.* 3. *A RedCap UE that is registered to a network is identified by the network at msg5.* |

[R1-2008623](file:///C:\Users\dchatt2\OneDrive%20-%20Intel%20Corporation\Documents\work\3gpp\RAN1\Contribution%20reviews\RAN1_103E_contribution_review\allTdocs_R1-103e\R1-2008623.zip) Standardization Framework and Design Principles for RedCap Devices Qualcomm Incorporated

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| *Proposal 4: Support early indication of RedCap device type by Type-1 and Type-2 RACH procedures.* |

# Appendix B

**List of observations/proposals on RRM relaxations for RedCap UEs:**

R1-2007672 RRM relaxation for Reduced Capability NR devices vivo, Guangdong Genius

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| Observation 1: IDLE mode power saving is critical for wearable devices.  Observation 2: 13.4% power saving gain in IDLE mode can be observed if serving cell RRM relaxation is introduced for high SINR UE.  Observation 3: It is feasible for RedCap UEs to process SSBs once per multiple paging cycles.  Proposal 1: Serving cell RRM relaxation for high SINR UE in idle state should be supported for RedCap UE. |

R1-2008106 Consideration on power saving for reduced capability NR devices Spreadtrum Communications

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| *Proposal 1: RRM measurement relaxation for neighbour cells including frequency layers with higher/equal/lower priority can be considered for stationary RedCap UEs.*  *Proposal 2:* *RRM measurement relaxation for serving cell can be considered for stationary RedCap UEs.* |