3GPP TSG-RAN WG2 #113-e draftR2-2102108

Electronic meeting, Jan 25th – Feb 5th 2021

Agenda Item: 8.12.1

Source: Rapporteur (Ericsson)

Title: Summary of [AT113-e][108][REDCAP] UE identification and access restriction

Document for: Discussion, Decision

# Introduction

The document summarizes the following offline discussion:

* [AT113-e][108][REDCAP] UE identification and access restriction (Ericsson)

Scope: Continue the discussion on UE identification and access restriction based on the proposals in R2-2100985

The intention of this offline is to describe options in the TR and, whenever applicable/possible, also down-select some alternatives / provide some recommendations.

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

* + - List of proposals for agreement
    - List of proposals that require online discussions
    - Corresponding TP for the TR

Initial deadline (for companies' feedback): Monday 2021-02-01 16:00 UTC

Initial deadline (for rapporteur's summary in R2-2102018): Monday 2021-02-01 22:00 UTC

Proposals marked "for agreement" in R2-2102018 not challenged until Tuesday 2020-02-02 10:00 UTC will be declared as agreed by the session chair. For the rest the discussion will continue online.

The discussion is structured as follows: First, the text proposals in R2-2100985 for UE identification are discussed. The TP is based on potential additions to the tables RAN1 has provided in v1.0.0 of the TR for various options (Msg1/3/post-4/A) – the text proposals are copied from R2-2100985 and companies are welcome to provide their comments and potential additions especially on the pros and cons.

Secondly, few proposals in R2-2100985 for the UE identification are discussed and companies are asked on their opinions based on the analysis which has been captured in the TR already.

Third section is about access restriction, and this is discussed based on the TP in R2-2100985 and few proposals related to e.g. UAC.

Note that the relevant clause in TR 38.875 v1.0.0 is clause 11, where RAN1 has made significant updates after we discussed this during and after RAN2#112-e.

Based on the company inputs, rapporteur company will make proposals (including TPs) to be agreed over email or during the next GTW session.

# Text proposals for the study of UE identification

R2-2100985 proposes the following updates to the text in clause 11.1 of TR 38.875 v1.0.0 for the general part and Option 1 on identification in Msg1 (additions in blue):

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| 11 UE identification and access restrictions  11.1 UE identification  ~~[Editor's Note: This structure of this clause may be modified as it is populated with text proposals from RAN2.]~~  RAN1 studied feasibility, necessity, pros and cons from RAN1 perspective for the following schemes for identification of RedCap UEs:  - Option 1: During Msg1 transmission  - E.g., via separate initial UL BWP, separate PRACH resource, or PRACH preamble partitioning  - Option 2: During Msg3 transmission  - Option 3: Post Msg4 acknowledgment.  - E.g., during Msg5 transmission or part of UE capability reporting  - Option 4: During MsgA transmission  - ~~Subject to support of 2-step RACH procedure~~ [Rapp.: question regarding this can be found later below]  - E.g., in MsgA preamble part via separate PRACH resource or PRACH preamble partitioning, or in MsgA PUSCH part.  ~~RAN1 made t~~The following observations have been made regarding Option 1, Option 2, Option 3, and Option ~~3~~4. ~~Study of Option 4 was deprioritized, i.e. study of the 4-step RACH procedure was prioritized over study of the 2-step RACH procedure.~~  **Option 1: During Msg1 transmission:**  Feasibility: Identification of RedCap UE type(s) during transmission of Msg1 could be feasible from the perspective of RAN1, at least for the following solutions:  - Separation of PRACH resources (e.g., occasions and/or formats) or PRACH preambles between RedCap and non-RedCap UEs  - Separation of initial UL BWP for RedCap and non-RedCap UEs  The appropriateness of each solution, considering the number of UE type(s) to be indicated, etc., would need further considerations.  Necessity: Early identification of RedCap UE type(s) during transmission of Msg1 may be necessary for:  - Coverage recovery (including link adaptation) for one or more of: Msg2 PDCCH/PDSCH, Msg3 PUSCH and PDCCH scheduling Msg3 retransmission, Msg4 PDCCH/PDSCH or PUCCH in response to Msg4, Msg5 PUSCH and associated PDCCH, if it is determined that coverage recovery for RedCap UEs is necessary for one of more of these channels  - Identifying UE minimum processing times capabilities for PDSCH processing and PUSCH preparation, if relaxations to UE min processing times are defined for N1 and N2  - Identifying UE capability for UL modulation order for Msg3 and Msg5 scheduling, if relaxations to max UL modulation order (i.e., UL modulation order restricted to lower than 64QAM) are introduced  - Identifying UE max bandwidth capability for Msg3 and Msg5 scheduling and PUCCH in response to Msg4  Exact necessity depends on outcome of studies on UE cost/complexity reduction and coverage recovery, and the SI on Coverage Enhancements [5].  Pros and cons: The pros and cons listed in Table 11.1.1-1 are identified for identification of RedCap UE type(s) during transmission of Msg1.   * **Table 11.1.1-1: Pros and cons for identification of RedCap UE type(s) during transmission of Msg1**  |  |  | | --- | --- | | **Pros** | **Cons** | | Enables efficient handling of different UE minimum processing times between RedCap and non-RedCap UEs for: minimum timing between PDSCH carrying RAR and start of Msg3 PUSCH; minimum timing between PDSCH carrying Msg4 and the corresponding HARQ-ACK feedback; minimum timing between PDCCH with the retransmission grant and the corresponding Msg3 PUSCH retransmission, if relaxed UE min processing times are introduced for RedCap UEs. | Potential reduction in PRACH user capacity (for the options based on separation of PRACH preambles), impacting both RedCap and non-RedCap UEs respectively, e.g., if the total PRACH resources in the cell is not increased. The exact impact depends on numbers of device type(s)/sub-types/capabilities to be identified and exact details of PRACH preamble partitioning schemes. | | Enables coverage recovery, including link adaptation, for any one or more of: broadcast PDCCH, PDSCH associated with Msg2, PDSCH associated with Msg4, and PUSCH associated with Msg3, if coverage recovery is needed for these channels. | Potential increase in UL OH from PRACH (for the options based on separation of PRACH resources), impacting both RedCap and non-RedCap UEs. | | The option of configuring separate initial UL BWPs, in addition to the above pros, ~~enables~~ address congestion (if congestion may occur) in the initial UL BWP that may otherwise need to be restricted to the mandatory required BW for RedCap UEs in the band/FR. | Potential increase in UL OH and complexity in configuration and maintenance of multiple initial UL BWP for the gNB, for the option of configuring separate initial UL BWPs. | | Enables RRC connection rejection of RedCap UE in Msg4 for access restriction (for UEs coming from RRC\_IDLE). | The indication mechanisms in this category may be limiting in terms of the number of further sub-types/capabilities within RedCap device type that may be distinguished, if such sub-types/capability indication are introduced. | | Enables prioritization of non-RedCap UEs over RedCap UEs in contention resolution. | Higher impact to RAN1 and RAN2 specifications as well as increased SIB signalling OH compared to other options. | |

Please provide your comments on the additions above, whether the suggestion is agreeable and additional input to the above part of clause 11.1. Please also provide further pros and cons to be captured in TR for Msg1 indication, if identified:

|  |  |  |
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| **Company** | **Are the additions agreeable?** | **Comments / Further TP suggestions** |
| Apple | agreeable |  |
| MediaTek | See comments | As discussed in the SI, UAC can be used to priortise non-RedCap UEs over RedCap UEs even prior to RACH. As this mechanism of prioritisation is introduced on top on the UAC mechanism, it should be clarified in the text as below:  ‘In addition to UAC prioritisation prior to Msg1, this enables prioritization of non-RedCap UEs over RedCap UEs during contention resolution’  [Rapp.: OK – however possibility to distinguish RedCap vs. non-RedCap has not been agreed (see question/discussion below). Suggestion is fine however before UAC is agreed adding “in addition to potential UAC prio…”.  Furthermore, the first paragraph on minimum processing times could be removed as this is no longer in the scope of the RedCap WID.  [Rapp.: Does this refer to the first paragraph in “pros”? This is existing text in v1.0.0 of the TR agreed in RAN1 and approved] |
| Huawei, HiSilicon | Agree | There are several mechanism in legacy for access/overload control, e.g. access barring bit in MIB, UAC, BI in RAR, RRC connection reject, etc. We think all of those mechanism are useful for different stages of UE access. Thus they are not exclusive.  For RedCap UEs, ideally we think it should be possible for the gNB to prioritise non-RedCap UEs over RedCap UEs in all cases to minimise the potential performance impact on legacy UEs.  [Rapp.: Agree – however is there a text suggestion to be added?] |
| Sierra Wireless | Agree |  |
| Qualcomm | See comment | Regarding the cons of configuring separate initial UL BWPs – we are not sure how such a configuration would work in a TDD system, as DL and UL BWPs need to have the same center frequency.  [Rapp.: Is the suggestion to add a remark in cons? Note that potential separate initial UP BWP is presented as “con” already.] |
| T-Mobile USA | No | RAN2 needs to wait for RAN1 to conclude their work before making any decision on using RACH to determine UE type/capabilities and coverage recovery. This all depends on the link budget comparison between RACH and PUSCH.  Also, current procedures are adequate to determine UE capabilities |
| Samsung | Yes |  |

R2-2100985 proposes the following updates to the text in clause 11.1 of TR 38.875 v1.0.0 for Option 2 on identification in Msg3 (additions in blue):

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| **Option 2: During Msg3 transmission:**  Feasibility: Identification of RedCap UE type(s) during transmission of Msg3 is already possible for UEs coming from RRC\_INACTIVE since gNB can deduce the full UE capabilities from the UE context retrieved with the I-RNTI provided in Msg3. For UEs coming from RRC\_IDLE, a new indication may be feasible ~~from the perspective of RAN1~~, at least for the following solutions:  - Using the spare bit in existing Msg3 definition  - Extending the Msg3 size to carry additional one or more bits, indicating RedCap UE type(s)  - Extension of existing RRC message or introduction of new larger RRC message (e.g. on CCCH1)  - New MAC control element or LCID  The option of carrying identification as part of UCI multiplexed in Msg3 PUSCH was not studied. The appropriateness and feasibility of each solution, considering the number of UE type(s) to be indicated, coverage performance for Msg3, etc., would need further considerations.  Necessity: If early identification of RedCap UE type(s) via Option 1 is not supported, identification of RedCap UE type(s) during transmission of Msg3 may be necessary for coverage recovery (including link adaptation) for one or more of: Msg4 PDCCH/PDSCH, Msg5 PUSCH and associated PDCCH. Exact necessity depends on outcome of studies on coverage recovery and the SI on Coverage Enhancements [5].  Pros and cons: The pros and cons listed in Table 11.1.1-2 are identified for identification of RedCap UE type(s) during transmission of Msg3.  **Table 11.1.1-2: Pros and cons for identification of RedCap UE type(s) during transmission of Msg3**   |  |  | | --- | --- | | **Pros** | **Cons** | | Enables coverage recovery (if needed) and/or appropriate link adaptation for PDSCH (and associated PDCCH and PUCCH) for Msg4, and scheduling of Msg5. | If only the spare bit in Msg3 is used, it would consume the single spare bit currently available in Msg3 payload, and this may not be desirable. | | Limited impact to RAN1 specifications if only the spare bit in Msg3 payload is utilized. | If extended Msg3 size is introduced, mechanisms to enable detection between use of legacy Msg3 and extended Msg3 definitions necessary. | | The option of extending Msg3 size may offer good scalability in the number of bits for such UE identification; e.g., if sub-types of RedCap device types (if defined) are to be indicated in Msg3. | The option of only using the spare bit in Msg3 may scale~~s~~ poorly – limiting to a single-bit indication may not be sufficient if intending to distinguish between further sub-types/capabilities within RedCap device type, if RedCap UE sub-types/capabilities are defined in the context of RedCap UE identification. | | Enables RRC connection rejection of RedCap UE in Msg4 for access restriction (for UEs coming from RRC\_IDLE). | Cannot facilitate additional coverage recovery (including separate link adaptation) for broadcast PDCCH and/or Msg2 PDSCH, and/or Msg3 PUSCH (and associated PDCCH) for RedCap UEs. | | Enables prioritization of non-RedCap UEs over RedCap UEs in contention resolution. | If UE minimum processing times are relaxed, cannot facilitate scheduling with separate minimum timing relationships for RedCap UEs (compared to non-RedCap UEs) between PDSCH carrying RAR and start of Msg3 PUSCH; minimum timing between PDCCH with the retransmission grant and the corresponding Msg3 PUSCH retransmission. This could result in increased initial access latency for non-RedCap UEs. | |  | May degrade reliability/coverage of Msg3 in case of increased Msg3 payload size. | |  | Cannot address the issue where Msg3 is scheduled with a bandwidth/hopping range larger than the maximum RedCap UE bandwidth in the UL initial BWP. | |  | Extending RRC message or Msg3 sizes has higher impact on RAN2 specification. | |

For the “feasibility” part of Msg3 indication, the description has been updated to clarify difference between UE coming from RRC\_IDLE or RRC\_INACTIVE. Additionally, two new solutions are captured. Please comment on the changes and additions and provide further suggestions, if any:

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| **Company** | **Are the additions for “feasibility” of Option 2 agreeable?** | **Comments / Further TP suggestions** |
| Apple | We are not favourable to Msg3 based identification (option-2) | But we understand this is still SI phase.  [Rapp.: Right, this is not endorsement for any mechanism but to fully capture all options in TR on top of the existing text.] |
| MediaTek | See comments | Similar to the earlier question: UAC can be used to priortise non-RedCap UEs over RedCap UEs even prior to RACH. As this mechanism of prioritisation is introduced on top on the UAC mechanism, it should be clarified in the text as below:  ‘In addition to UAC prioritisation prior to Msg1, this enables prioritization of non-RedCap UEs over RedCap UEs during contention resolution’ |
| Huawei, HiSilicon | Globally fine with one comment | Same comment as previous question regarding the relation between UAC and other access/overload control mechanism.  In addition, regarding the following text on feasibility:  “*Identification of RedCap UE type(s) during transmission of Msg3 is already possible for UEs coming from RRC\_INACTIVE since gNB can deduce the full UE capabilities from the UE context retrieved with the I-RNTI provided in Msg3.*”  We think it is not always possible to identify the UE coming from RRC\_INACTIVE if the context is not found and the procedure fallback to RRC establishment.  [Rapp.: Agree, this comment will be taken into account in updated text proposals] |
| Sierra Wireless | Agree |  |
| Qualcomm | Agreeable |  |
| T-Mobile USA | No | RAN2 needs to wait for RAN1 to conclude their work before making any decision on using RACH to determine UE type/capabilities and coverage recovery. This all depends on the link budget comparison between RACH and PUSCH.  Also, current procedures are adequate to determine UE capabilities |
| Samsung | Yes |  |

Please comment on the additions to the pros and cons table, and provide further suggestions, if any:

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| --- | --- | --- |
| **Company** | **Are the additions for “pros and cons” of Option 2 agreeable?** | **Comments / Further TP suggestions** |
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R2-2100985 proposes the following updates to the text in clause 11.1 of TR 38.875 v1.0.0 for Option 3 on identification post Msg4 (additions in blue):

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| **Option 3: Post Msg4 transmission:**  Feasibility: Identification of RedCap UE type(s) during transmission of Msg5 or as part of UE capability reporting are feasible options from the perspective of RAN1. From RAN2 perspective any new functionality is not required, and this is already covered by existing signalling.  Necessity: If early identification of RedCap UE type(s) via Options 1, 2, or 4 are not supported, then RedCap UE type(s) need to be identified either during transmission of Msg5 or as part of existing UE capability reporting.  Pros and cons: The pros and cons listed in Table 11.1.1-3 are identified for identification of RedCap UE type(s) during transmission of Msg5 or in UE capability report.  **Table 11.1.1-3: Pros and cons for identification of RedCap UE type(s) during transmission of Msg5 or in UE capability report**   |  |  | | --- | --- | | **Pros** | **Cons** | | This option of UE capability reporting offers a simple option for indication of RedCap UE type, including possibility of indicating further RedCap sub-types/capabilities if introduced. | Cannot facilitate additional coverage recovery (if needed) or separate link adaptation for broadcast PDCCH and/or Msg2 and/or Msg4 PDSCH, and/or Msg3 PUSCH for RedCap UEs. Too conservative scheduling and link adaptation for all UEs imply increased system OH for initial access in the initial DL and UL BWPs. | | Limited or no impact to RAN1 and RAN2 specifications. | If UE minimum processing times are relaxed, cannot facilitate scheduling with separate minimum timing relationships for RedCap UEs between PDSCH carrying RAR and start of Msg3 PUSCH; minimum timing between PDSCH carrying Msg4 and the corresponding HARQ-ACK feedback; minimum timing between PDCCH with the retransmission grant and the corresponding Msg3 PUSCH retransmission. This could result in increased initial access latency for non-RedCap UEs. | |  | Cannot address the issue where Msg3 or PUCCH in response to Msg4 or Msg5 is scheduled with a bandwidth/hopping range larger than the maximum RedCap UE bandwidth in the UL initial BWP. | |  |  | |  | Cannot enable RRC connection rejection of RedCap UE in Msg4 for RedCap-specific access restriction (for UEs coming from RRC\_IDLE). | |

Please provide your comments on the additions above, whether the suggestion is agreeable and additional input to the above part of clause 11.1. Please also provide further pros and cons for post Msg4 indication, if identified:

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| **Company** | **Are the additions above agreeable?** | **Comments / Further TP suggestions** |
| Apple | Agreeable |  |
| MediaTek | See comment | Similar to the earlier question, we suggest the removal of the text related to minimum processing time as it is out of the RedCap WID scope.  [Rapp.: See above, this is added by RAN1 in SI phase] |
| Huawei, HiSilicon | Globally fine with one comment | Same comment as above for RRC\_INACTIVE. So maybe:  “*Cannot enable RRC connection rejection of RedCap UE in Msg4 for RedCap-specific access restriction (for UEs coming from RRC\_IDLE and RRC\_INACTIVE if the UE context is not found*).” |
| Sierra Wireless | Agree |  |
| Qualcomm | Agreeable |  |
| T-Mobile USA | No | RAN2 needs to wait for RAN1 to conclude their work before making any decision on using RACH to determine UE type/capabilities and coverage recovery. This all depends on the link budget comparison between RACH and PUSCH.  Also, current procedures are adequate to determine UE capabilities |
| Samsung | Yes |  |

For identification during MsgA for 2-step RACH, no analysis has been yet provided the option was down-prioritized in RAN1. R2-2100985 proposes the following addition in clause 11.1 of TR 38.875 v1.0.0 for Option 4 on identification in MsgA (additions in blue):

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| **Option 4: During MsgA transmission:**  Feasibility: Identification of RedCap UE type(s) during transmission of MsgA could be feasible, at least for the following solutions:  - Separation of 2-step RACH resources (e.g., occasions and/or formats) or MsgA preambles between RedCap and non-RedCap UEs  - Separation of initial UL BWP for RedCap and non-RedCap UEs  - Using a new indication in MsgA PUSCH part  The appropriateness of each solution, considering the number of UE type(s) to be indicated, etc., would need further considerations.  Necessity: Early identification of RedCap UE type(s) during transmission of MsgA may be necessary for:   * Coverage recovery (including link adaptation) for MsgA transmission (UE selection of RedCap specific 2-step resources, i.e. MsgA indication in preamble part). * Coverage recovery (including link adaptation) for MsgB and later messages, and associated PDCCH.   Pros and cons: Due to the differences the pros and cons for identification of RedCap UE type(s) during transmission of MsgA with indication in the MsgA preamble part are listed in Table 11.1.1-4, and the pros and cons for identification of RedCap UE type(s) during transmission of MsgA with indication in the MsgA PUSCH part are listed in Table 11.1.1-5. Note that indication in the MsgA preamble part does not have any advantages compared to the indication in MsgA PUSCH part for messages transmitted after MsgA.  **Table 11.1.1-4: Pros and cons for identification of RedCap UE type(s) during transmission of MsgA in preamble part**   |  |  | | --- | --- | | **Pros** | **Cons** | | Enables coverage recovery, including link adaptation, for any one or more of: MsgA, broadcast PDCCH, PDSCH associated with MsgB. | Potential reduction in 2-step RACH user capacity (for the option based on separation of PRACH preambles), impacting both RedCap and non-RedCap UEs respectively, e.g., if the total 2-step RACH resources in the cell is not increased. The exact impact depends on numbers of device type(s)/sub-types/capabilities to be identified and exact details of PRACH preamble partitioning schemes. | | The option of configuring separate initial UL BWPs, in addition to the above pros, address congestion (if congestion may occur) in the initial UL BWP that may otherwise need to be restricted to the mandatory required BW for RedCap UEs in the band/FR. | Potential increase in UL OH from 2-step PRACH (for the options based on separation of PRACH resources), impacting both RedCap and non-RedCap UEs. | | Enables RRC connection rejection of RedCap UE in MsgB for access restriction (for UEs coming from RRC\_IDLE). | Potential increase in UL OH and complexity in configuration and maintenance of multiple initial UL BWP for the gNB, for the option of configuring separate initial UL BWPs. | |  | The indication mechanisms in this category may be limiting in terms of the number of further sub-types/capabilities within RedCap device type that may be distinguished, if such sub-types/capability indication are introduced. | |  | Higher impact to RAN1 and RAN2 specifications as well as increased SIB signalling OH compared to other options. |   **Table 11.1.1-5: Pros and cons for identification of RedCap UE type(s) during transmission of MsgA in PUSCH part**   |  |  | | --- | --- | | **Pros** | **Cons** | | Enables coverage recovery, including link adaptation, for MsgB and later messages. | Cannot provide coverage recovery for MsgA transmission. | | Enables RRC connection rejection of RedCap UE in MsgB for access restriction (for UEs coming from RRC\_IDLE). | Either MsgA PUSCH part need to be differentiated for RedCap UEs and non-RedCap UEs, or the will be impact on non-RedCap UEs from the increases MsgA PUSCH size. | | More limited impact to specifications | May degrade reliability/coverage of MsgA PUSCH in case of increased MsgA PUSCH payload size. | | The option of MsgA PUSCH indication may offer good scalability in the number of bits for such UE identification; e.g., if sub-types of RedCap device types (if defined) are to be indicated in MsgA. |  | |

As mentioned, RAN1 has not provided analysis for 2-step RACH, the first step is to check whether companies agree that analysis of 2-step RACH should be provided:

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| **Company** | **Agree to include analysis of 2-step RACH (Option 4) in the TR?** | **Comments** |
| Apple | agreeable |  |
| MediaTek | Ok to include |  |
| Huawei, HiSilicon | Globally fine with one comment | Same comment as above for RRC\_INACTIVE. So maybe:  “*Enables RRC connection rejection of RedCap UE in MsgB for access restriction (for UEs coming from RRC\_IDLE and RRC\_INACTIVE if the UE context is not found*).” |
| Sierra Wireless | Agree |  |
| Qualcomm | See comment | We have the same comment on configuring separate UL initial BWP as the one on Msg1, i.e. we are not sure how such a configuration would work in a TDD system, as DL and UL BWPs need to have the same center frequency. |
| T-Mobile USA | No | RAN2 needs to wait for RAN1 to conclude their work before making any decision on using RACH to determine UE type/capabilities and coverage recovery. This all depends on the link budget comparison between RACH and PUSCH.  Also, current procedures are adequate to determine UE capabilities |
| Samsung | Yes |  |

The follow-up questions relate to the feasibility / necessity / pros and cons of the TP for Option 4 above.

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| **Company** | **Is the provided TP for “feasibility" of Option 4 agreeable?** | **Comments / Further TP suggestions** |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | Agreeable |  |
| T-Mobile USA | NO |  |
| Samsung | Yes |  |

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| **Company** | **Is the provided TP for “necessity” of Option 4 agreeable?** | **Comments / Further TP suggestions** |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | Agreeable |  |
| T-Mobile USA | NO |  |
| Samsung | Yes |  |

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| **Company** | **Is the provided TP for “pros and cons” of Option 4 agreeable?** | **Comments / Further pros and cons not captured above** |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | See comment | Regarding this statement “Note that indication in the MsgA preamble part does not have any advantages compared to the indication in MsgA PUSCH part for messages transmitted after MsgA.” – we don’t think it is entirely correct, because in case UE fallback from 2-step to 4-step during msgA PUSCH failure, coverage recovery is not possible if indication is by PUSCH instead of preamble.  [Rapp.: OK – can be added in the next round of text proposals] |
| T-Mobile USA | NO |  |
| Samsung | Yes |  |

# Proposals related to study of UE identification

R2-2100985 provides analysis of the different reasons for need for early identification of RedCap UE. Companies are asked to check the referred contribution and similar analyses found in other submitted contributions for further discussion and details.

In summary, R2-2100985 provides the following conclusions based on the RAN1 provided analysis in the TR:

* Early identification is not required for any of the following: UE capability for UL modulation order, UE minimum processing times capabilities, or UE FD-FDD capability.
* Early identification may be required for UE max BW capability and/or coverage compensation.
* The need for coverage compensation and the possible methods depend on the deployment scenario, i.e. different channels may require different compensations depending on the deployment.

The conclusion is that Msg3 indication should be (always) supported. Additionally, Msg1 indication should be supported and be configurable, when the deployment scenario is such that Msg1 indication is beneficial, e.g. when legacy methods are not enough to compensate the coverage loss of Msg2. Configurability of Msg1 indication avoids reduction of PRACH capability when there is no need, as determined by the NW operator, for Msg1 indication.

Therefore, R2-2100985 lists the following two proposals related to Msg1/Msg3 indication:

Proposal 1a Support early RedCap indication in Msg3.

Proposal 1b Support optionally configurable early RedCap indication in Msg1.

Please use text in TR (either v1.0.0 or based on comments above in Section 2) to motivate your opinion.

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| **Company** | **Agree to 1a and/or 1b?** | **Comments (e.g. some other preferred option)** |
| Apple | Agree to 1b, but no to 1a | We fully understand the need for identification at Msg1 (coverage compensation etc..). We are trying to see why Msg3 is useful, when the RedCap UE capabilities are anyway transferred later. The one usage is for the gNB to look at Msg3 and decide to “reject/redirect” etc.. and in our view, this can be done by broadcasting in the SIB that allows the RedCap UE to skip the RACH procedure (or even the cell re-selection procedure) altogether.  UE support of BW etc.. can also be “filtered” with SIB(1) and so Msg3 appears to be redundant when Msg1 differentiation is present. |
| MediaTek | Ok with 1a, but no to 1b | The transmissions from UE up to and including msg3 are very small and are unaffected by the RedCap max BW capability. Coverage compensation for msg3 should be insignificant due to the small size of the message, and given that these will anyways be a function of cell size and measurements based on msg1 reception by the gNB.  In short, an early indication is only needed at msg3 for the gNB to appropriately schedule subsequent grants for RedCap (the size of which can be larger than msg3) |
| Huawei | Agree to 1a and 1b | As we detailed in R2-2101256, RedCap UEs should be identified at least before Msg4.  As mentioned in Table 11.1.1-1 in the TR, Identification in Msg1 for RedCap is necessary in the following scenarios: 1) if coverage recovery is applied; 2) if the RedCap UE camps on a cell with the initial BWP larger than the one it supports; and, 3) if relaxed min processing time is introduced. Therefore, configurable early RedCap indication in Msg1 shall be supported.  Other than the above cases, early identification in Msg3 is still needed for some cases listed in Table 11.1.1-1, e.g. enables RRC connection rejection of RedCap UE in Msg4 for overload control. Therefore, from the perspective of RAN2 support early RedCap indication in Msg3 is needed. |
| Sierra Wireless | Agree to 1a and 1b | Either or both are useful, agree with Huawei comments. A high degree of flexibility in the reporting method is possible, as described in our contribution R2-2100636. |
| Qualcomm | Agree to both 1a and 1b |  |
| Samsung | Agree to both 1a and 1b | - |
| T-Mobile USA | No | UAC should be used to bar access as this doesn’t impact RACH capacity |

Further, early identification in MsgA is discussed where two possible alternatives are described:

* Indication in MsgA preamble part
* Indication in MsgA PUSCH part

Based on analysis, as in the above TP suggestion for Option 4, and similar arguments as for the previous proposal, the following are proposed for MsgA indication:

Proposal 2a For 2-step RACH, MsgA early RedCap indication in MsgA preamble part (e.g. separate preambles) is configurable.

Proposal 2b Support early RedCap indication in MsgA PUSCH.

Please use text in TR (either v1.0.0 or based on comments above in Section 2) to motivate your opinion.

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree to 2a and/or 2b?** | **Comments (e.g. some other preferred option)** |
| Apple | Agree to 2a, but no to 2b | Pls see our earlier response. |
| MediaTek | Ok with 2b, but no to 2a | Please see our earlier response. |
| Huawei, HiSilicon | Slightly prefer 2b | We think both 2a and 2b are potential solutions for 2-step RACH.  However, Proposal 2a may require to separate or introduce new RedCap preambles which increase the network complexity. Proposal 2b is easier to be implemented by i.e. adding indication or configuring specific RedCap PUSCH.  Therefore, solution 2b is preferred if no clear additional benefit is identified for solution 2a. |
| Sierra Wireless | 2a and/or 2b acceptable |  |
| Qualcomm | Agree to both 2a and 2b |  |
| T-Mobile USA | No | UAC should be used to bar access as this doesn’t impact RACH capacity |
| Samsung | Agree to both 2a and 2b | - |

Depending on company input to above proposals, draft RAN2 recommendations may be proposed in the summary.

# Proposals for the study of UE identification

R2-2100985 provides further discussion and analysis of the following access restriction methods:

1. Cell Barring
2. Access Barring (UAC)
3. RRC Connection Reject
4. Random Access Restrictions

R2-2100985 proposes the following updates to the text for general description of the feature and cell barring (additions in blue):

|  |
| --- |
| 11.2 Access restrictions  11.2.1 Description of feature  NG-RAN supports overload and access control functionality such as RACH back off, RRC Connection Reject, RRC Connection Release and UE based access barring mechanisms. The purpose of the feature is to not only provide the same functionality as for legacy UEs but to have RedCap specific access restrictions to able to avoid or limit negative impact on legacy performance. Cell barring For RedCap UEs, an explicit or implicit indication in broadcast system information can be used to indicate whether a RedCap UE can camp on the cell or not. If a RedCap UE is not allowed to camp on a cell and the cell is barred, it could be of interest to bar all cells on the frequency to ensure RedCap UEs only camp on the strongest cell. Legacy UEs have the same functionality and the IE *intraFreqReselection* configures in the UE should consider only the current cell as barred or all cell on the frequency. For RedCap it remains to be determined if the functionality should be controlled by the same *intraFreqReselection* IE or if a new separate parameter should be introduced. Further, cell barring differentiation per network, per slice, or per service can be achieved if multiple bits are used for indication in SI. |

|  |  |  |
| --- | --- | --- |
| **Company** | **Are the additions above agreeable?** | **Comments / Further TP suggestions** |
| Apple | Partly | We understand this is study item phase, but we are not really excited about UAC on RedCap. RedCap UE is similar to legacy NR UE except that it has reduced access-stratum capabilities.  We do not see any need to slap new access restrictions to RedCap.  We are ok with cell barring. |
| MediaTek | Partly | We have not discussed barring per network/slice/service in this SI and prefer not to include the last sentence in the TP. |
| Huawei | Agree, but… | We agree with the concept to indicate whether the cell is barred and whether intra frequency reselection is allowed.  However, we have concerns on the following description:  “*Further, cell barring differentiation per network, per slice, or per service can be achieved if multiple bits are used for indication in SI*.”  Currently, cell barring is not differentiated per slice or per service. We suggest not to capture the above in the TR. Optimisations can be discussed in WI if needed. |
| Sierra Wireless | Agree | These are useful options for further study if companies will support them. Flexible barring is possible as described in our contribution R2-2100636. |
| Qualcomm | Partly | We have the same comment as MTK |
| T-Mobile USA | Yes |  |
| Samsung | Partly | We agree with what MediaTek said above. |

R2-2100985 provides analysis of UAC, based on earlier agreements:

|  |
| --- |
| Agreements:   * UAC mechanism also apply to REDCAP UEs. * Further discuss enhancement of UAC for REDCAP UEs, including e.g.:   a. define new Access Identity for REDCAP UEs  b. define new Access Categories for REDCAP UEs  (for any final decision we need to check with SA1 and/or CT1) |

The following two proposals are from R2-2100985 and companies are asked to provide their comments on these. First proposal is about whether, like in existing UAC, the different access types should be differentiable with Access Categories. That is to say, for example, a single Access Category assigned to a “RedCap UE” is not feasible.

Proposal 3a Multiple Access Categories should be supported for RedCap to allow for different barring configuration for different access attempt types (e.g. alarms or video).

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| **Company** | **Agree to 3a?** | **Comments** |
| Apple | No | As stated earlier, we do not want new restrictions for RedCap UEs at access. |
| MediaTek | To be determined by SA1 | This discussion on number of access categories should take place in SA1 and not RAN2. We need to send an LS to SA1 as soon as possible to trigger these discussions in the correct WG. |
| Huawei | Agree | For RedCap UEs, the Access Categories shall be aligned with the legacy ones, as the Access Categories are not defined according to UE type. So there is no need to introduce new Access Category specific for RedCap UEs. |
| Sierra Wireless | Agree |  |
| Qualcomm | No | Access categories are more related to services. We do not think RedCap introduces new services. Hence no new, RedCap specific access categories need to be introduced.  [Rapp.: The intention of the proposal is not (necessarily) to say that any new categories are needed – but to confirm that the legacy principle is kept, that is, different Access Categories map to different services. But OK to mention in comments whether companies think new categories for RedCap are needed (this should be a separate question)] |
| T-Mobile USA | No | T-Mobile doesn’t support multiple REDCAP UE types. REDCAP defines a minimum set of capabilities for all REDCAP devices, as such no differentiation is needed |
| Samsung | Agree | We agree that UAC (and its principle) should be reused for RedCap UEs, and share the view with others above that new Red-Cap specific access categories does not have to be introduced. |

Second proposal is about whether there would be need to differentiate between possible multiple types of RedCap UEs, if such would be defined (NOTE: the number of possible types is not discussed in this offline – if there is just single type, this proposal is not needed)

Proposal 3b A common RedCap UAC is applicable for all potential types of RedCap UEs.

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| **Company** | **Agree to 3b?** | **Comments** |
| Apple | No | We do not see any difference in the “urgency”/usefulness of RedCap UEs trying to access the NW compared to legacy NR UEs. |
| MediaTek | Yes |  |
| Huawei |  | This proposal is linked to the issue about UE type. Currently, neither the definition of UE type nor how many types of RedCap UEs have been decided. Furthermore, whether same UAC will be used for RedCap and non-RedCap UEs is not determined either.  It is too early to consider this proposal. |
| Sierra Wireless |  | Agree with Huawei |
| Qualcomm | Yes | We support having a single RedCap UE type. Hence a single, common RedCap UAC is needed.  But we can understand the comment from Huawei, i.e. this decision depends on how much RedCap UE types will be defined. |
| T-Mobile USA | Yes |  |
| Samsung | Yes | - |

Not included explicitly in R2-2100985, but related to the provided discussion and text proposal, an additional proposal is suggested to be discussed by rapporteur:

Proposal 3c Network should be able to differentiate between RedCap and non-RedCap UEs using UAC (e.g. configure different parameters to RedCap and non-RedCap UEs).

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| --- | --- | --- |
| **Company** | **Agree to 3c?** | **Comments** |
| Apple | No | Pls see our comments earlier |
| MediaTek | Yes | We see UAC as necessary to allow operators to control RedCap UE accesses to the network which part of the RedCap WID as well. |
| Huawei | Agree |  |
| Sierra Wireless | Agree |  |
| Qualcomm | Agree |  |
| T-Mobile USA | Yes |  |
| Samsung | No | As indicated in our paper, R2-2100209 |

The following text proposal for UAC is provided, including options of defining new Access Identities, defining new Access categories and using operator defined Access Categories:

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| --- |
| Unified Access Control The unified access control (UAC) framework is specified in TS 22.261 and it applies to all UEs in RRC\_IDLE, RRC\_CONNECTED and RRC\_INACTIVE. This mechanism should also apply to RedCap UEs to control RedCap UEs accesses to the network. That is, there should be UAC differentiation between RedCap UEs and non-RedCap UEs [Rapp.: see proposal above related to differentiation]. In UAC each access attempt is associated with an *Access Category* and one or more *Access Identities* (defined in TS 24.501). The possible solutions for RedCap UAC that have been considered in the study are the following:   * Define a RedCap specific Access Identity. Access Identities are connected to the UE type and are used to lift the barring for certain identities, e.g. for special access classes or UEs configured for prioritized services. * Define RedCap specific Access Categories. Access Categories are related to the type of access attempt and is set per access attempt type depending on what triggered the access (set by NAS if NAS triggered, or by RRC if AS triggered). There can only be one Access Category per access attempt. To be able to treat different RedCap access attempt types differently, e.g. apply different barring for alarms than for wearables, it is preferred to support multiple Access Categories for RedCap corresponding to the legacy Access Categories. * Use some of the operator defined Access Categories for RedCap. The description of the previous solution applies also to this solution, the difference is that this solution has no specification impact but cannot be used for initial attach to the network since it depends to CN configuration of the UE. |

Companies are asked to comment whether above additions are agreeable and provide further suggestions/options, if any:

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| **Company** | **Are the additions above agreeable?** | **Comments / Further TP suggestions** |
| Apple | No | Pls see our comments above. |
| MediaTek | Partly | As we haven’t had sufficient discussion on access categories to state an explicit preference, we propose the following change:  To be able to treat different RedCap access attempt types differently, e.g. apply different barring for alarms than for wearables, ~~it is preferred to support~~ multiple Access Categories for RedCap could be defined~~corresponding to the legacy Access Categories.~~  [Rapp.: TP will be updated based on earlier questions as well] |
| Huawei, HiSilicon | No | It was also proposed to control the access of the RedCap UEs by reusing the existing access identities and categories and signalling a separate set of UAC parameters for RedCap UEs.  We suggest to capture the option into the TR with the following description:“   * *Signal RedCap specific UAC parameters. By broadcasting a separate set of UAC parameters for RedCap UEs, flexible and separate control of RedCap UEs can be achieved and impacts on the non-RedCap UEs can be avoided.*   It was also agreed that the feasibility of using new identities or new access categories should be checked with SA1. This should be captured.  [Rapp.: Agree that this option is missing and will be added in next round of TPs] |
| Sierra Wireless | Agreeable | At least Access Identities and Access Categories should be options. |
| Qualcomm | Partly | We share similar view with Huawei that broadcasting a different set of UAC parameters for Redcap UEs should also be considered. And the feasibility of introducing new access identity/category should be consulted with and decided by SA/CT.  [Rapp.: Agree – any changes to UAC need to be communicated and checked with SA1/CT1] |
| T-Mobile USA | No | As mentioned earlier there only needs to be one dedicated access identity for REDCAP UE’s. Proposed text contains too many options. |
| Samsung | No | As commented above… |

R2-2100985 proposes the following analysis related to RRC Connection Reject which has been discussed during previous meetings (additions in blue):

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| --- |
| RRC Connection Reject To save radio resources and limit negative impact on legacy it is beneficial to bar or reject UEs as early as possible, preferably without additional signaling. Therefore, cell barring and UAC is beneficial compared to RRC connection rejection. However, RRC connection rejection can provide improved differentiation among RedCap UEs compared to cell barring and UAC and also provide authorization of RedCap access based on the UE capabilities and/or subscription profile in the UE context. For the network to be able to reject the RRC connection or resumption request from a RedCap UE, early identification of RedCap UE type(s) may have to be provided in Msg1, Msg3, or MsgA. Note that for a RedCap UE in RRC\_INACTIVE, the RedCap UE type can be deduced from the I-RNTI in Msg3 (or MsgA) and no new indication is required. A rejected UE will need to wait a configurable amount of time before any reattempt, controlled by the parameter *waitTime* in the reject message which can be up to 16 seconds. If a longer back-off would be desirable for RedCap an extended wait time could be considered as in LTE. |

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| **Company** | **Is the TP above agreeable?** | **Comments / Further TP suggestions** |
| Apple | We do not prefer it | We agree that we are in SI phase…but prefer to discuss online. |
| MediaTek | No | Please see the following comments:  ‘However, RRC connection rejection can provide improved differentiation’ – how is differentiation improved?  ‘provide authorization of RedCap access based on the UE capabilities and/or subscription profile in the UE context’ – UE capabilities and subscription profile are only known to the NW only at msg5 (once the 5G-S-TMSI is known). Msg5 is sent after the opportunity for an RRC reject has passed.  ‘early identification of RedCap UE type(s) may have to be provided in Msg1, Msg3, or MsgA’ – The only discussion we’ve had is an indication of RedCap UE type. The text (taken together with the earlier line) suggests that the indication could be other information such as UE capability and subscription parameters. If so, we have not discussed these in the SI and therefore the text cannot be included in the TR. |
| Huawei, HiSilicon | Partially agreed, but… | Regarding the description of:  “*Note that for a RedCap UE in RRC\_INACTIVE, the RedCap UE type can be deduced from the I-RNTI in Msg3 (or MsgA) and no new indication is required*.”  We think it is not fully correct as in case RRC connection resume is failed, the gNB does not have the UE context (including device type) of the RedCap UE. Thus we suggest to remove the sentence. |
| Sierra Wireless | Agreeable | Barring before access and also in RRC are both useful options. |
| Qualcomm | No | We do not support using RRC Connection Reject as the means to restriction access by RedCap UEs. |
| T-Mobile USA | Partially | Support the inclusion of the first two sentences  “To save radio resources and limit negative impact on legacy it is beneficial to bar or reject UEs as early as possible, preferably without additional signaling. Therefore, cell barring and UAC is beneficial compared to RRC connection rejection.”  Remaining text needs to be deleted. |
| Samsung | Partially | Same comments as Huawei. |

R2-2100985 proposes the following analysis related to Random Access Restrictions (additions in blue):

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| --- |
| Random Access Restrictions Early identification of RedCap UE type(s) in Msg1 indication can be achieved e.g. via separate initial UL BWP, separate PRACH resource, or PRACH preamble partitioning. The separate RedCap configuration of these random access resources can be used as a means of restricting RedCap access. E.g. the RedCap PRACH configuration can be de-configured not to allow any RedCap access in the cell.  RedCap access could be further restricted by providing separate RACH configuration for RedCap UEs, or RedCap specific configuration of some RACH parameters. A lower number of maximal attempts or a longer back-off time could be configured for RedCap to limit the negative performance impact on legacy performance, e.g. with a longer RedCap-specific *scalingFactorBI*.  Further, early identification of RedCap UE type(s) in Msg1 or Msg3 would enable gNB to prioritize non-RedCap UEs in contention resolution in case of preamble collision between a RedCap UE and a non-RedCap UE. |

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| **Company** | **Is the TP above agreeable?** | **Comments / Further TP suggestions** |
| Apple | Yes, agreeable |  |
| MediaTek | Not really needed | This section is largely a repetition of what is covered in detail under the UE identification section. Furthermore, we have not discussed solutions such as backoff scaling in the SI. |
| Huawei | Agree | Regarding the following description:  “*Further, early identification of RedCap UE type(s) in Msg1 or Msg3 would enable gNB to prioritize non-RedCap UEs in contention resolution in case of preamble collision between a RedCap UE and a non-RedCap UE*.”  We suggest to remove “*Msg1*” as if Msg1 is used for identification of RedCap UE, the case of “preamble collision between a RedCap UE and a non-RedCap UE” shall not exist as the preamble configured for RedCap UE can indicate UE type.  Furthermore, rapporteur suggests to introduce longer back-off time. Currently, the back-off time could be adjusted by *scalingFactorBI* which is configured with considering the priority of the UE. We also suggest to introduce the similar mechanism as legacy, i.e. the power ramping step could also be considered. Thus we suggest to update the TP as blew:  “RedCap access could be further restricted by providing separate RACH configuration for RedCap UEs, or RedCap specific configuration of some RACH parameters. A lower number of maximal attempts ~~or~~, a longer back-off time or a lower/higher power ramping step could be configured for RedCap to limit the negative performance impact on legacy performance, e.g. with a longer RedCap-specific scalingFactorBI, or a RedCap-specific powerRampingStepHighPriority.” |
| Sierra Wireless | Agreeable |  |
| Qualcomm | No | We do not agree to use Redcap specific RACH configuration as a means to restrict access by RedCap UEs. Access restriction should be implemented by cell barring and UAC, not RACH.  [Rapp.: Perhaps it is not exactly correct to call this “access restriction”, as the intention is not to bar, but more like “access control” using RedCap specific RACH parameters] |
| T-Mobile USA | No | We don’t support the use of RACH to identify or manage REDCAP UE’s |
| Samsung | Yes |  |

Finally, for clauses 11.2.2 and 11.2.3 R2-2100985 proposes the following input related to the coexistence with legacy UEs and analysis of specification impacts: (additions in blue):

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| --- |
| 11.2.2 Analysis of coexistence with legacy UEs  The purpose of the RedCap access restrictions is to eliminate or limit the impact on legacy UEs. The only impact for enabling any of above features is at most a slight increase is in OH due to added parameters in SI broadcast.  11.2.3 Analysis of specification impacts  Cell barring would have small impact on RAN2 specification if explicit indication is used, and if a separate *intraFreqReselection* parameter is introduced for RedCap. With an implicit indication e.g. implicit from the presence of RedCap configuration in SI, there would be no additional specification impact from cell barring.  For UAC, using operator defined Access Categories for RedCap would not have any specification impact. Introducing new Access Categories or Access Identity for RedCap would have SA1 specification impact.  Supporting RRC connection reject would have no specification impact.  Random Access Restrictions would have a small impact on RAN2 specification if RedCap specific RACH configuration or parameters are introduced. |

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| **Company** | **Are the TPs above agreeable?** | **Comments / Further TP suggestions** |
| Apple | agreeable |  |
| MediaTek | Agreeable |  |
| Huawei | Agree but.. | For UAC, new access identities or categories will have impact on CT1 specifications.  As indicated in our comments to P3c, signalling a separate set of UAC parameters for RedCap is also possible. This option has impact on RAN2 specification but none on SA1/CT1.  [Rapp.: Text will be updated to take into account comments and results of earlier questions] |
| Sierra Wireless | Agreeable |  |
| Qualcomm | Agreeable |  |
| T-Mobile USA | Partially | The impact assessment should reflect the techniques agreed to in the earlier discussion. For example, if RACH isn’t mentioned then there wouldn’t be a need to mention RACH methods in the impact analysis. |
| Samsung | Yes |  |

# Summary and possible recommendations

Possible recommendations to be discussed after company inputs to above sections.

TBD

# References

1. R2-2100983, “RAN2 update to TR 38.875”, RAN2#113-e, Electronic meeting, January 2021
2. R2-2100985, “TP for UE identification and access restriction”; RAN2#113-e, Electronic meeting, January 2021

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