3GPP TSG-RAN WG2 Meeting #115e DRAFTTdoc R2-21xxxxx

Online, August 9th – 27th 2021

Agenda: 8.12.2.2

Source: Ericsson (rapporteur)

Title: [Pre115-e][104][RedCap] Summary of AI 8.12.2.2 - Identification, access and camping restrictions (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This document summarizes the proposals from the tdocs submitted to AI 8.12.2.2.

The relevant objectives from the revised RedCap WID are the following:

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| * Specify functionality that will enable RedCap UEs to be explicitly identifiable to networks through an early indication in Msg1 and/or Msg3, and Msg A if supported, including the ability for the early indication to be configurable by the network. [RAN2, RAN1]
* Specify a system information indication to indicate whether a RedCap UE can camp on the cell/frequency or not; it shall be possible for the indication to be specific to the number of Rx branches of the UE. [RAN2, RAN1]
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Therefore, the following topics, explicitly mentioned in the WID, and related open issues are the main focus of this summary:

* Functionality to enable RedCap UEs to be explicity identifiavble through early indication, that is, whether Msg1 and/or Msg3 indications should be supported and details of such.
* System information indication to indicate whether RedCap UE can camp on the cell/frequency, that is, details related to signaling of such access restrictions or barring and details of intra-frequency cell reselection indicator (IFRI).

Additionally, the following topics are summarized where further discussion is proposed in case time permits:

* Possible provision of neigboring cell information on access restrictions
* Possible RedCap-specific cell (re)selection parameters, thresholds and priorities.

All proposals in the referred contributions (see the References) are not included in the summary, e.g. some proposals with one or two companies supporting or details which should be further discussed once the stage-2 or basic concepts are agreed.

# 2 Summary of remaining issues

## 2.1 Early identification of RedCap UEs

Early identification and RedCap indication in Msg1/Msg3 and/or MsgA is discussed in [1], [4], [5], [6], [7], [8], [9], [11], [13], [14], [15], [18], [19], [22], [23] and [27] (16 papers).

Early identification in Msg1

RAN1 has informed RAN2 in LS [R1-2106329](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_105-e/Docs/R1-2106329.zip) on RAN1 working assumption that Msg1 indication can be configured to be enabled/disabled. Thus, the rapporteur understanding is that Msg1 indication will be specified in one form or another. RAN2 can confirm the Msg1 indication but the details need to be discussed further, also taking into the discussion in AI 8.18 RACH indication and partitioning.

No company in RAN2 proposes to not support Msg1 indication.

Details of Msg1-based indication are discussed e.g. by HW [4], Spreadtrum [6], Intel [13], ZTE [15], Nokia [22]. There seems to be common understanding that both dedicated ROs for RedCap as well as dedicated PRACH preambles in case of shared ROs can be supported. Couple of companies propose to wait further RAN1 progress e.g. vivo [7], ZTE [15] before discussing further details.

The following are proposed, first based on RAN1 working assumption and second as basis for further discussion:

1. [Easy] Msg1 indication which can be configured to be enabled/disabled can be specified from RAN2 point of view.
2. [To discuss] Both dedicated ROs and dedicated PRACH preambles in case of shared ROs are supported. Details are FFS and discussions in AI 8.18 should be taken into account.

Early identification in Msg3

One open issue is whether a Msg3 indication is specified. The companies input and views on this open issue are divided like follows (one company per paper mentioned):

* **Do not specify Msg3 indication (assuming Msg1 indication is specifed)**: OPPO [1], Spreadtrum [6], Xiaomi [8], Apple [11], Intel [13], LG [14], ZTE [15], NEC [19]

The main arguments for this view are that Msg1 indication covers more scenarios and that there would be limited benefit using Msg3 indication or that it would be redundant. There would be no possibility to affect Msg2/3 scheduling and earliest possible indication is preferred for that reason. Also, more specification effort in RAN2, security issues and that reject based on Msg3 indication should not be preferred as access control mechanism were mentioned.

* **Specify Msg3 indication (i.e. both optional Msg1 and Msg3)**: Huawei [4], Qualcomm [5], Sierra [9], DENSO [18], Nokia [22], Ericsson [23]

The main arguments for supporting Msg3 indication include ability to use early indication in the case Msg1 indication is not configured e.g. when avoiding further PRACH fragmentation. The mentioned benefits include possibility to affect Msg4/5 scheduling in case Msg1 indication is not configured, possibility to configure PUCCH frequency hopping for Msg4 feedback, and the possibility to use RRC reject. It was also mentioned that in most scenarios Msg1 based indication wouldn’t be needed and configured.

* **RAN to confirm that network should identify RedCap UE before Msg4**: CATT [27]

Argument for this option is that the NW should identify RedCap UE at least in Msg1 or Msg3 (not later).

* **Wait for further RAN1 discussion**: vivo [7]

Argument for this option is that the reasons for early indication are mostly RAN1.

Possible solution for Msg3 indication was discussed in few papers e.g. by HW [4], QC [5], Ericsson [23]. All these propose to use an LCID-based solution which would not result in large specification impact or larger Msg3 size. Such solution is also preferred by Nokia [22].

*Rapporteur comment:* There is support for both not specifying and specifying a Msg3-based solution. With the proposed LCID-based solution the specification impact would be low and Msg3 size the same as currently, and the drawback of Msg3-based indication would be that it is later compared to Msg1 indication. There doesn’t seem to be other technical reasons for not supporting, which would be different for Msg3 compared to Msg1 (e.g. RRC reject based on indication, even if not preferred, is also possible with Msg1-based solution). If Msg1 indication is not configured at all, the situation with scheduling Msg2/3 would be the same regardless solution, i.e. no network knowledge, but with no possibility to impact Msg4/5 scheduling either if there is no Msg3 indication.

Therefore, it is proposed to further discuss whether the following proposal is acceptable:

1. [To discuss] A Msg3 early indication based on LCID is supported.

MsgA indication

RAN1 has agreed to support 2-step RACH, and it remains to be discussed how the early indication is provided in that case. Few of the submitted papers, e.g. by HW [4], Intel [13], Nokia [22] and CATT [27] propose to specify a MsgA early indication. However, one company prefers LCID based solution (assuming such is specified for Msg3), one company prefers similar solution as Msg1 (assuming no Msg3 indication), one company prefers to have solution with both MsgA preamble and PUSCH indications and one company prefers to leave details up to RAN1 discussion.

As the solution for Msg1/Msg3 discussion may impact the details of MsgA solution, it is proposed to confirm that a solution will be specified but discuss the details further.

1. [Easy] Solution for early indication in MsgA will be specified.
2. [Postpone] Discuss the details of MsgA based early indication after Msg1/Msg3 discussion has progressed.

## 2.2 Access/camping restrictions

The following papers discuss access restrictions, cell barring or network support for RedCap UEs and relevant indications in MIB/SIB1: [2], [7], [8], [9], [10], [12], [13], [14], [16], [18], [19], [21], [23], [24], [25], [26] and [27] (17 papers).

On cellBarred in MIB

It is stipulated by the WID and agreed in RAN2 already that SIB1 indicates barring for 1 Rx and 2 Rx branches separately for RedCap UEs. However, and open issue is what to do with the relevant *cellBarred* and IFRI indications broadcasted in MIB.

The following have been proposed by companies in the submitted papers:

* **UE ignores the existing *cellBarred* in MIB:** OPPO [2], vivo [7], Apple [10], CATT [27]

The main arguments for this option include no need for UE to check barring indication twice (in MIB and SIB1), thus simpler for implementation, more future proof considering possible RedCap-only cells or SSBs, similar solution as IAB-MT adopted.

* **UE follows the existing *cellBarred* in MIB:** Xiaomi [8], Intel [13], DENSO [18], Ericsson [23], CMCC [25]

The main arguments for this option include that there’s no need to support RedCap-specific cells and for such case other solutions exist already (e.g NPN), cellBarred should apply to all UEs e.g. when the cell is in maintenance, there can be negative impact on power consumption when UE needs to check SIB1 instead of just MIB for barring.

* **Depends on the agreement for IFRI**: NEC [20]

Arguments for this option is that barring should be done based on information in the same message i.e. MIB or SIB1.

*Rapporteur comment:* The views are split, and there seem to be valid technical points on both sides, thus it is difficult to formulate proposal on either direction.

1. [To discuss] Continue discussion on whether UE ignores or applies the existing *cellBarred* in MIB.

On SI barring indication

The details of the barring indication or cell support indication are discussed in number of papers and the following proposals are made:

* **System information indicates whether 1 Rx / 2 Rx branch RedCap UE is supported**: vivo [7] , Sierra [9]

Arguments for this option are that similar structure was adopted for IAB and that the default should be no Redcap support in the cell (thus no indication in SIB1).

* **Specify cell barring in SIB1 separately for UEs with 1 Rx / 2 Rx branch(es):** Fujitsu (barring or support can be discussed) [12], LG [14], Nokia [21], Ericsson [23], Futurewei [24], CMCC [25], China Telecom [26]

The main argument for this option is that this is the intention of WID.

* **Specify cell barring using one indication in SIB1 for all RedCap UEs, i.e. revise WID objective**: Samsung [16]

Argument for this option is that if UE can receive SIB1, it can also receive DL transmissions, thus there should be no difference in support protocol-wise between 1 Rx or 2 Rx.

* **Wait for RAN1 on how to provide barring indication:** Xiaomi [8]

Arguments for this option is that RAN1 is discussing how to provide barring indication.

*Rapporteur comment:* Details of such indication is in RAN2 domain and the need and differentiation has been discussed in plenary already. Rapporteur thinks it time to make a decision in RAN2. The support for barring indication is larger compared to a “support” indication, therefore the following is proposed:

1. [Easy] Specify separate indications in SIB1 for barring RedCap UEs with 1 Rx chain and 2 Rx chains.

Note that optimizations and slightly different solutions were proposed by different companies, the details can be discussed in stage-3 implementation.

On inter-frequency reselection indicator:

The following options have been proposed for IFRI handling for RedCap:

* **Introduce RedCap specific IFRI in SIB1 (ignore legacy IFRI when broadcast) and**
	+ **differentiate 1 Rx and 2 Rx**: Qualcomm [5], vivo [7], LG [14], IDT [17], Nokia [21], CATT [27]

The main arguments for this option are that RedCap UEs may impact NW capacity, thus separate indication is preferred flexibility and should follow similar agreement (and WID formulation) for barring. Interference avoidance and differentiation to avoid possible confusion together with barring indications were also mentioned.

* **do not differentiate Rx branches (or not explicitly mentioned):** OPPO [2], Xiaomi [8], Fujitsu [12], DENSO [18], NEC [20], Futurewei [24], China Telecom [26]

Some of the main arguments for this option apply also for the previous option, i.e., independence of IFRI for RedCap and non-RedCap, possibility to control need for coverage enhancement and that RedCap specific IFRI should be supported in any case. Some companies argue that differentiation between Rx branches would not be needed for IFRI, however.

* **Re-use existing IFRI in MIB for RedCap, do not introduce new fields in SIB1**: Intel [13], Samsung [16], Ericsson [23], CMCC [25]

The main arguments for this option include that separate treatment for IFRI is not needed, it is an optimization and all UEs can use the same indication as there should be no difference in IFRI configuration between RedCap and non-RedCap UEs.

* **RAN2 to discuss the need for RedCap specific IFRI**: Huawei [4]

Additionally, at least LG [14] points out that if the cell doesn’t support RedCap, then the existing IFRI indication in MIB should be supported. Rapporteur agrees that this case should also be discussed, i.e. the UE behavior in case the cell doesn’t support RedCap.

*Rapporteur comment*: Althought the view on different options is split, there is larger support for introducing a RedCap specific IFRI. It can be further discussed whether the IFRI should be differentiated on supported Rx branches or not. However, it should be noted that there is no agreement on any coverage enhancement requirement for 1 Rx vs 2 Rx UE.

1. [Easy] Specify a RedCap specific IFRI in SIB1.
2. [To discuss] Specify IFRI separately for RedCap UEs with 1 Rx and 2 Rx branches.
3. [To discuss] If RedCap-specific IFRI is not broadcasted, the existing IFRI in MIB is followed.

## 2.3 Other topics

This section summarizes additional topics which are not explicitly part of the WID but with more than two companies proposing enhancements. Similar proposals have been discussed briefly during earlier meetings, but these topics have not been prioritized.

Number of companies, e.g. THALES [3], QC [5], Apple [10], Fujitsu [12], Intel [13], ZTE [15], Samsung [16], CMCC [25], CATT [27] discuss possible provision of indications on whether neighboring cells support or bar RedCap UEs. The following options are discussed:

* **Provide such information on neighboring cell support/barring:** Apple [10], Fujitsu [12], Samsung [16], CMCC [25], CATT [27]

The main argument is that such indications may reduce the UE power consumption as UE would not need to measure cells which do not support RedCap.

* **Provide such information and also differentiate 1 Rx / 2 Rx**: QC [5], ZTE [15], THALES [3]

The same main argument on power consumption applies for this option. Additionally, it is mentioned cell barring may be more dynamic thus it is not enough to rely on UEs’ previous understanding of cell support.

* **Do not introduce such indications in SI**: Intel [13]

Arguments: Dedicated frequency priority seems sufficient assuming frequencies are upgraded at the same time (Intel)

*Rapporteur comment*: There is some support for introducing neighboring cell information, but based on earlier discussion there is also some opposition. If such enhancement is introduced, the technical details should be discussed further, such as how often such information is expected to change (and e.g. impact on SI updates), higher layer (RAN3) impact, and whether the indication is for cell support or barring in neighboring cells or whether lists of allowed cells are provided as suggested by some companies.

1. [To discuss] Whether information on neighboring cell acceptance of RedCap UE access is provided in system information.

Introduction of RedCap-specific cell selection parameters, separate Qrxlevmin and Qualmin and separate cell (re)selection priorities are discussed and proposed in [4], [5], [12], [13], [15], [16], [18], [25] and [27] as follows (Note the following are not necessarily mutually exclusive):

* **Introduce RedCap specific cell (re)selection parameters:** HW [4], Intel [13], CMCC [25], CATT [27]

The main arguments for introducing such is that UE may experience reduced antenna efficiency and bad UL coverage (different performance in general) or that RedCap UEs could be directed towards certain frequencies supporting RedCap.

* **Optionally configure separate Qrxlevmin and Qualmin**: QC [5], Fujitsu [12], Samsung [16], DENSO [18]

The main arguments are that different parameters should be configured in case NW schedules RedCap UEs differently compared to non-RedCap, prioritization of certain cells for RedCap and that 1 Rx UEs may require higher minimum signal strength to access the cell.

* **RedCap UEs can be configured with separate cell (re)selection priorities:** QC [5], Fujitsu [12], ZTE [15], Samsung [16], CMCC [25]

The main arguments are the possible need to direct RedCap UEs e.g. towards lower frequencies for better coverage and to avoid interference.

*Rapporteur comment:* The support for various options seems to be similar as it was during the last meeting and offline discussion ([ATT114-e][106]). The solutions seem to address different problems, as one example need for coverage enhancement and as another example possibility for operator to steer RedCap UEs towards specific frequencies. RAN2 should discuss further if there are particular issues which should be resolved, and if there are, which would be good solutions.

1. [To discuss] Whether to support RedCap specific cell (re)selection parameters and/or priorities (e.g. Qrxlevmin, Qualmin, offsets, cellReselectionPriorities, etc.)

# 4 Conclusion

The following are proposed in this summary:

[Proposal 1 [Easy] Msg1 indication which can be configured to be enabled/disabled can be specified from RAN2 point of view.](#_Toc79614198)

[Proposal 2 [To discuss] Both dedicated ROs and dedicated PRACH preambles in case of shared ROs are supported. Details are FFS and discussions in AI 8.18 should be taken into account.](#_Toc79614199)

[Proposal 3 [To discuss] A Msg3 early indication based on LCID is supported.](#_Toc79614200)

[Proposal 4 [Easy] Solution for early indication in MsgA will be specified.](#_Toc79614201)

[Proposal 5 [Postpone] Discuss the details of MsgA based early indication after Msg1/Msg3 discussion has progressed.](#_Toc79614202)

[Proposal 6 [To discuss] Continue discussion on whether UE ignores or applies the existing *cellBarred* in MIB.](#_Toc79614203)

[Proposal 7 [Easy] Specify separate indications in SIB1 for barring RedCap UEs with 1 Rx chain and 2 Rx chains.](#_Toc79614204)

[Proposal 8 [Easy] Specify a RedCap specific IFRI in SIB1.](#_Toc79614205)

[Proposal 9 [To discuss] Specify IFRI separately for RedCap UEs with 1 Rx and 2 Rx branches.](#_Toc79614206)

[Proposal 10 [To discuss] If RedCap-specific IFRI is not broadcasted, the existing IFRI in MIB is followed.](#_Toc79614207)

[Proposal 11 [To discuss] Whether information on neighboring cell acceptance of RedCap UE access is provided in system information.](#_Toc79614208)

[Proposal 12 [To discuss] Whether to support RedCap specific cell (re)selection parameters and/or priorities (e.g. Qrxlevmin, Qualmin, offsets, cellReselectionPriorities, etc.)](#_Toc79614209)

Proposals categorized per easy / to discuss / postpone further:

“Easy” proposals:

Proposal 1 [Easy] Msg1 indication which can be configured to be enabled/disabled can be specified from RAN2 point of view.

Proposal 4 [Easy] Solution for early indication in MsgA will be specified.

Proposal 7 [Easy] Specify separate indications in SIB1 for barring RedCap UEs with 1 Rx chain and 2 Rx chains.

Proposal 8 [Easy] Specify a RedCap specific IFRI in SIB1.

To discuss further:

Proposal 2 [To discuss] Both dedicated ROs and dedicated PRACH preambles in case of shared ROs are supported. Details are FFS and discussions in AI 8.18 should be taken into account.

Proposal 3 [To discuss] A Msg3 early indication based on LCID is supported.

Proposal 6 [To discuss] Continue discussion on whether UE ignores or applies the existing cellBarred in MIB.

Proposal 9 [To discuss] Specify IFRI separately for RedCap UEs with 1 Rx and 2 Rx branches.

Proposal 10 [To discuss] If RedCap-specific IFRI is not broadcasted, the existing IFRI in MIB is followed.

Proposal 11 [To discuss] Whether information on neighboring cell acceptance of RedCap UE access is provided in system information.

Proposal 12 [To discuss] Whether to support RedCap specific cell (re)selection parameters and/or priorities (e.g. Qrxlevmin, Qualmin, offsets, cellReselectionPriorities, etc.)

Postpone:

Proposal 5 [Postpone] Discuss the details of MsgA based early indication after Msg1/Msg3 discussion has progressed.

# 4 References

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