3GPP TSG-RAN WG1 Meeting #106 bis-e R1-210xxxx

e-Meeting, 11th – 19th October 2021

**Agenda Item: 8.6.2**

**Title: FL summary #1 on RAN1 aspects for RAN2-led features for RedCap**

**Source: Moderator (Apple)**

**Document for: Discussion, Decision**

# Introduction

This feature lead (FL) summary (FLS) concerns the Rel-17 work item (WI) for support of reduced capability (RedCap) NR devices [1]. Earlier RAN1 agreements for this WI are summarized in [2].

This document summarizes contributions [3] – [33] submitted to agenda item 8.6.2, agenda item 8.6.3 and captures this email discussion on RAN1 aspects for RAN2-led features for RedCap:

|  |
| --- |
| [106bis-e-NR-R17-RedCap-04] Email discussion regarding RAN1 aspects for RAN2-led features (except those related to UE features which will be handled under 8.17.6) – Hong (Apple)* 1st check point: October 14
* Final check point: October 19
 |

The issues in this document are tagged and color coded with High Priority or Medium Priority.

In this round of the email discussion, please comment on the issues tagged ‘FL1’ before Tuesday 12th October 05:00 (AM) UTC.

Follow the naming convention in this example:

* *RedCapR2ledFLS1-v000.docx*
* *RedCapR2ledFLS1-v001-CompanyA.docx*
* *RedCapR2ledFLS1-v002-CompanyA-CompanyB.docx*
* *RedCapR2ledFLS1-v003-CompanyB-CompanyC.docx*

If needed, you may “lock” the discussion document for 30 minutes by creating a checkout file, as in this example:

* Assume CompanyC wants to update *RedCapBwFLS1-v002-CompanyA-CompanyB.docx*.
* CompanyC uploads an empty file named *RedCapBwFLS1-v003-CompanyB-CompanyC.checkout*
* CompanyC checks that no one else has created a checkout file simultaneously, and if there is a collision, CompanyC tries to coordinate with the company who made the other checkout (see, e.g., contact list in Annex).
* CompanyC then has 30 minutes to upload *RedCapBwFLS1-v003-CompanyB-CompanyC.docx*
* If no update is uploaded in 30 minutes, other companies can ignore the checkout file.
* Note that the file timestamps on the server are in UTC time.

In file names, please use the hyphen character (not the underline character) and include ‘v’ in front of the version number, as in the examples above and in line with the general recommendation (see slide 10 in [R1-2106403](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_106-e/Docs/R1-2106403.zip)), otherwise the sorting of the files will be messed up (which can only be fixed by the RAN1 secretary).

To avoid excessive email load on the RAN1 email reflector, please note that there is NO need to send an info email to the reflector just to inform that you have uploaded a new version of this document.

The following is an outline of the summary:

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# Early indication of RedCap UEs

## Early indication in 2-step RACH

### Issue 1: Early indication for Redcap by MsgA PRACH in 2-Step RACH

The following was agreed in RAN1 105 e-meeting that 2-step RACH [2]:

|  |
| --- |
| Agreements:* Support 2-step RACH for RedCap UEs as an optional feature
	+ FFS details of early indication in MsgA, e.g.:
		- Separation of 2-step RACH resources or MsgA preambles
		- Separation of initial UL BWP
		- Using a new indication in MsgA PUSCH part
	+ Note: Discussion on 4-step RACH for early indication should be prioritised
 |

In addition, the following was agreed in RAN1 106-e meeting to enable early indication of Redcap UEs in 4-step RACH procedure [2]:

|  |
| --- |
| Agreements:Confirm the following working assumption with the modifications in red:* For 4-step RACH, support the early indication of RedCap UEs at least in Msg1.
	+ The early indication in Msg1 can be configured to be enabled/disabled via SIB
	+ From RAN1 perspective, the following methods can be used for early indication both for shared initial UL BWP and separate initial UL BWP (if supported)
		- separate PRACH resource
		- PRACH preamble partitioning

Whether/how to support early indication of RedCap UEs in Msg3 in Rel-17 is up to RAN2. |

Many contributions [5, 6, 9, 10, 11, 12, 14, 16, 17, 22, 23, 24, 29] discussed the details of early indication for Redcap UEs for 2-step RACH. Companies’ positions are briefly summarized in Table 1 below.

**Table 1: Early indication of RedCap UEs in PRACH resource of 2-step RACH**

|  |  |  |
| --- | --- | --- |
| Description | Yes | No |
| Companies | Num. of companies | Companies | Num. of companies |
| * Separate PRACH resource in Msg.A
* PRACH preamble Partitioning in Msg.A
 | Ericsson [5], Spreadtrum [6], CATT [9], China Telecom [10], CMCC [11], ZTE [14], Samsung [16], Intel [17], IDC [22], LGe [23], Sharp [24], Lenovo [29]  | 12 | Nokia ([12], less useful, only 4-step RACH fallback case) | 1 |

Contribution [5,10,14, 24] additionally propose that the early indication in MsgA preamble should be configured to be enabled/disabled via SIB, as handled for 4-step RACH. The rationale in [5] is that the indication in MsgA PUSCH is enough for early indication of Redcap in most cases. The indication in MsgA preamble is needed only to Case 4 where coverage recovery of MsgB PDSCH carrying fallback RAR when MsgA preamble is detected but MsgA PUSCH is not decoded correctly (or if MsgA PUSCH is not transmitted).

* <1st Round Comments>

Given the almost unanimously proposals for 2-step RACH and the configurability can address the concern of usefulness in [12], FL therefore proposes the following for PRACH in 2-step RACH, which is aligned with the agreements made for 4-Step RACH

**FL1 High Priority Proposal 2.1-1:**

* **For 2-step RACH, support the early indication of RedCap UEs at least in MsgA PRACH.**
	+ **The early indication in MsgA PRACH can be configured to be enabled/disabled via SIB**
	+ **From RAN1 perspective, the following methods can be used for early indication both for shared initial UL BWP and separate initial UL BWP (if supported)**
		- **separate MsgA PRACH resource**
		- **MsgA PRACH preamble partitioning**

Companies are invited to provide feedback with briefly justification if change is needed.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | Y |  |
| vivo |  | For early indication based in 2-Step RACH, either using PRACH or PUSCH part are possible for gNB to perform proper MSG B scheduling. However, the cost of using PRACH part is significantly higher than using the PUSCH part, therefore we prefer to discuss the early indication by PUSCH part first (including the confirmation by RAN2), and using PRACH part is supported only when there is extra gain/use case on top of using PUSCH part for early indication.  |
| CATT | Y | Though early indication in MsgA PUSCH is possible, the gNB may fail to decode MsgA PUSCH and use fallback scheduling of Msg3. In this case, early indication in MsgA PRACH is more robust.  |
| OPPO | Y | Early indication in MsgA PRACH can be configurable. Since further PRACH partitioning is required, gNB can configure it or not according to the PRACH resource utilization. If it is not configured, MsgA PUSCH can be used for earlier indication.  |
| DOCOMO | Y | We are fine with the proposal while we prefer to prioritize the discussion on indication in MsgA PUSCH. As pointed out by some companies, the indication in MsgA preamble is needed only when MsgA preamble is detected but MsgA PUSCH is not decoded correctly.Also, based on the following agreement in RAN1#106-e, “(if supported)” in the proposal can be deleted.Agreements:Confirm the following working assumption from RAN1#105-e regarding RACH occasions.* For enabling/supporting that the RACH occasion (RO) associated with the best SSB falls within the RedCap UE bandwidth, support separate initial UL BWP for RedCap UEs (which is not expected to exceed the maximum RedCap UE bandwidth), and this separate initial UL BWP for RedCap includes ROs for RedCap UEs.
	+ Note: these ROs can be dedicated for RedCap UEs or shared with non-RedCap UEs.
 |
| Sharp | Y |  |
| Huawei, HiSilicon | Y |  |
| LG | Y |  |
| ZTE, Sanechips | Y |  |
| Xiaomi | Y |  |
| Ericsson | Y, with modification | We are fine with the proposal with the following note:* Whether/how to support early indication of RedCap UEs in MsgA PUSCH part in Rel-17 is up to RAN2.

We would also be fine with early indication in the MsgA PUSCH part only, i.e., no early indication in the MsgA PRACH part, since our understanding is that the early indication in the MsgA PRACH part might only be beneficial in the special case when MsgA PRACH has been received but MsgA PUSCH has not been successfully received, and in this case, we believe that it may be enough to do fallback to 4-step RACH. |

### Issue 2: Early indication for Redcap by MsgA PUSCH in 2-Step RACH

On early indication of Redcap using MsgA PUSCH, companies views are captured in Table 2. One contribution [5] stated that there is no need to have a “configurable” MsgA PUSCH indication, i.e., RedCap UEs should always indicate CCCH using the RedCap-specific LCID.

**Table 2: Early indication of RedCap UEs in MsgA PUSCH of 2-step RACH**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Description | Companies | # Of Companies |
| Alt.1:  | Up to RAN2 | Ericsson [5], China Telecom [10], Nokia [12], ZTE [14], | 4 |
| Alt.2 | Support | Spreadtrum [6], CATT ([9], same as Msg3 of 4-step RACH), Intel [17], IDC [22], Sharp [24, Same dedicated LCID],  | 6 |

* <1st Round Comments>

For early indication of Redcap in 4-step RACH procedure, it was agreed to leave for RAN2 to decide whether and how to use Msg3. It is moderator’s understanding that similarly MsgA PUSCH for early indication can leave for RAN2 for the consistency. .

**FL1 High Priority Question 2.1-1:** **Which one of the following alternatives do you support for early indication by MsgA PUSCH in 2-step RACH?**

* **Alt.1: It is up to RAN2 regarding whether/how to support early indication of RedCap UEs in MsgA PUSCH in Rel-17**
* **Alt.2: Early indication of RedCap UEs in MsgA PUSCH is supported by indicating CCCH using the RedCap-specific LCID.**

Please provide brief justification for the preferred alternative.

|  |  |  |
| --- | --- | --- |
| **Company** | **Alternative** | **Comments** |
| Qualcomm | Alt. 1 | gNB may not receive msgA PUSCH when msgA PRACH is detected. CCCH and LCID are not relevant to RAN1 discussion. |
| vivo | Alt1 |   |
| CATT | Alt.2 | Alt.2 should be workable and consistent with 4-step RACH. Also fine to leave it to RAN2. |
| OPPO | Alt 2, slightly | RAN2 has agreed the early indication in Msg3 by indicating CCCH using the RedCap-specific LCID. The same mechanism can also allow the early indication in MsgA PUSCH. We think it is more desirable to alleviate PRACH partitioning in 2-step RACH case than in 4-step RACH case. Since early indication in Msg3 is accepted, it is feasible that early indication in MsgA PUSCH is also supported. RAN1 can discuss whether early indication in MsgA PUSCH is supported. If supported, LS can be sent to RAN2 for some feedback. |
| DOCOMO | Alt.1 | For the consistency with 4-step RACH, RAN1 can defer to RAN2 |
| Sharp | Fine with either one | In our view, solution for Msg3 PUSCH early indication by using RedCap-specific LCID can be naturally and automatically applied to MsgA PUSCH early indication. It is also fine to leave to RAN2 to make a formal confirmation. |
| MediaTek | Alt.1 |  |
| Huawei, HiSilicon | Alt 1 |  |
| LG | Alt. 1 | As RAN1 agreed for 4-step RACH, we can leave the issue on MsgA PUSCH for RAN2 decision. |
| ZTE, Sanechips | Alt1. |  Similar as msg3 identification, it is up to RAN2. |
| Xiaomi | Alt.1 |  |
| Ericsson | Alt. 1 or 2 | We would be fine with either alternative, with a slight preference for Alt. 1 since we think that such discussion should be left for RAN2. |

## Early indication in 4-step RACH

In RAN1 106 e-Meeting, the following was agreed:

|  |
| --- |
| Agreements:Confirm the following working assumption with the modifications in red:* For 4-step RACH, support the early indication of RedCap UEs at least in Msg1.
	+ The early indication in Msg1 can be configured to be enabled/disabled via SIB
	+ From RAN1 perspective, the following methods can be used for early indication both for shared initial UL BWP and separate initial UL BWP (if supported)
		- separate PRACH resource
		- PRACH preamble partitioning

Whether/how to support early indication of RedCap UEs in Msg3 in Rel-17 is up to RAN2. |

RAN2 #115-e Meeting made the following agreement for Msg1-based and Msg3-based early identification:

|  |
| --- |
| Agreements:* Msg1 identification which can be configured to be enabled/disabled can be specified from RAN2 point of view.

Agreements online:1. A Msg3 early identification based on dedicated LCID is supported (if SA3 confirms there is no problem) |

### Issue 3: Configuration of Msg1-based and Msg3-based early indication

UE behavior regarding early indication of Redcap UEs using Msg-1 and/or Msg-3 are discussed by a few contributions [9, 13, 19]. Companies’ views can be summarized as follows

* P1 [CATT, 9]: For 4-step RACH,
	+ If RedCap-dedicated RO/preambles are configured, the RedCap UE shall indicate RedCap UE type during Msg1. In this case, the RedCap UE will not indicate RedCap UE type during Msg3.
	+ If RedCap-dedicated RO/preambles are NOT configured and if separate initial UL BWP is configured, the RedCap UE shall indicate RedCap UE type during Msg3.
	+ For 4-step RACH, if RedCap-dedicated RO/preambles are NOT configured and if separate initial UL BWP is NOT configured, the RedCap UE does not indicate RedCap UE type during Msg3
* P2 [Lenovo,13] [LGe, 23]:
	+ The enable/disable of early identification of RedCap UEs in Msg1 is implicitly signalen by whether separate RACH resource is configured for RedCap UEs.
* P3 [Sierra Wireless, 19]:
	+ Msg3 early RedCap UE indication can be configured to be enabled/disabled via SIB
	+ SIB can indicate which RedCap devices will use Msg1 or Msg3 early indication based on UE capabilities. UE Capabilities at least include
		- 1 RX or 2 RX Antenna
		- FD-FDD or HD-FDD
		- FFS: Other capabilities
	+ One example was provided in [19] regarding the SIB indication approach as shown in Table below:

|  |  |
| --- | --- |
| **SIB Configurations** | **Interpretation** |
| Msg 1 and Msg3 are not used  | Network does not need to know RedCap early indication b/c system BW is 20MHz and coverage is not an issue |
| Msg 1 – 1 RX RedCap UEsNothing – All Other Redcap UEs | Network needs to apply additional coverage for 1 RX devices but not for 2 RX device. No issue with scheduling all devices within 20MHz. |
| Msg 1 – 1 RX RedCap UEsMsg 3 – All Other Redcap UEs | Network needs to apply additional coverage for 1 RX devices but not for 2 RX device. Network wants to schedule RedCap devices differently than legacy UEs.  |
| Msg 1 – 1 RX RedCap UEsMsg 3 – HD-FDD RedCap UEs | Network needs to apply additional coverage for 1 RX devices but not for 2 RX device. Network wants to schedule HD-FDD differently than FD-FDD RedCap UEs and legacy UEs |

Table 3: Example SIB configurations for Msg1 and Msg3 early indication [19]

* P4 [Sierra Wireless, 19]:
	+ If more than one LCID is available for signaling of RedCap, then it can be used to inform the network of other capabilities, such as FD-HDD.
* P5: [Sharp, 24]
	+ For 4-step RACH, RedCap UEs shall indicate CCCH using the dedicated LCID in Msg3 PUSCH, regardless of whether the RedCap UEs perform early indication in Msg 1 or not.
* <1st Round Comments>

**FL1 High Priority Question 2.2-1: Which one(s) among the listed P1/P2/P3/P4/P5 above should be discussed and decided in RAN1, instead of RAN2?**

Please provide justification for your preference.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | P2 can be further discussed in RAN1.  |
| vivo | P1 should be discussed in RAN2.P2 can be discussed either in RAN1 or RAN2..P3 (#Rx part) have been excluded already by the following conclusion**Conclusion:*** + No consensus to support early identification of the number of Rx branches in Msg1/Msg3/MsgA for Redcap UE in Rel-17

P4 is beyond the WID scope for early indication. P5 can be discussed either in RAN1 or RAN2, our view is that simultaneously enabling MSG1 and MSG3 based early indication is not well justified.  |
| CATT | P1/2/5 can be further discussed. Better in RAN1, or leave it to RAN2 if no enough time or no consensus in RAN1. Anyway, a clear conclusion on the early indication phase is needed, due to 2 different early indication methods are supported in 4-step RACH. P3 is against the conclusion and P4 seems out of scope. |
| OPPO | P1, P2, P3 are acceptable for us. For P4, it is another issue to be discussed whether other capabilities of RedCap UE should be further early indicated, e.g. in Msg3. We are open for this issue. For P5, same early indication in both Msg1 and Msg3 should be justified. If it is reasonable, we are fine with P5, since it has no impacts on RAN1.  |
| DOCOMO | None of them should be discussed in RAN1. If RAN2 needs RAN1 input, it can be communicated via LS |
| Sharp | P1 and P5 can be further discussed in RAN1. Msg 1 early indication is involved in P1 and P5. RAN1 can discuss them and provide some information at least from RAN1 perspective to RAN2, if necessary.P2, P3(first bullet) and P4 can be left to RAN2. On P2, in last RAN2 meeting, they have a following agreement to specify how to enable/disable Msg 1 identification.

|  |
| --- |
| Agreements:* Msg1 identification which can be configured to be enabled/disabled can be specified from RAN2 point of view.
 |

P3(first bullet) is related to Msg 3 early indication configuration and should be better discussed in RAN2. Remaining bullets of P3 are against RAN1 conclusion made in RAN1 105-e, as pointed out by vivo/CATT.On P4, LCID design belongs to RAN2’s scope. |
| MediaTek | The listed issues are best discussed in RAN2. |
| LG | Considering which WG makes decision on Msg1/Msg3 based early indication, how to enable Msg1 should be discussed in RAN1 while how to enable Msg3 should be discussed in RAN2. Thus, we think that P2 can be further discussed in RAN1.  |
| ZTE, Sanechips | P2 can be discussed in RAN1. Others are RAN2 issues. |
| Xiaomi | P1 shall be discussed in RAN1, especially for the following subbullet* + If RedCap-dedicated RO/preambles are NOT configured and if separate initial UL BWP is configured, the RedCap UE shall indicate RedCap UE type during Msg3.

This subbullet would impact the reception of the PUCCH carrying HARQ feedback of Msg.4. RAN1 should provide such information to RAN2 |
| Ericsson | We agree with DOCOMO and others that none of them should be discussed in RAN1 unless RAN2 explicitly asks RAN1 for input. |

### Issue 4: PRACH preamble partitioning for Msg1-based early indication

PRACH partitioning for 4-step and 2-step RACH procedure was discussed by several contributions [4,12,13,23,26,28,29, 30]. Contribution [12,13,23,30] indicates that PRACH resource handling across multiple new features was discussed in RAN2 115 Meeting under AI ‘8.18 RACH indication and partitioning’ and the following was concluded by RAN2 [34].

|  |
| --- |
| **Agreements:**1. Preamble partitioning is defined on a feature and/or feature combination basis. FFS on signalling. 2step RA and CE is excluded, if RAN1 decided to exclude2. Preambles associated with a Rel-17 feature should never be chosen by legacy UEs in the case of RO sharing. 3. New feature and/ feature combination specific preambles can be defined in a) Separate time-frequency resources, not defined through legacy RRC signalling, b) Within the Contention free preamble resources (i.e. within the preambles not used for contention based) defined through legacy RRC signalling. FFS on c) Within the “not available” preambles defined at the end of a RO through the legacy totalNumberOfRA-Preambles4. A common RRC CR capturing the signalling framework for RACH resource configuration across all the WIs should be used and this CR should be maintained as part of the common RACH agenda item. Each WI is expected to provide the necessary parameters to include in the signalling.5. A common MAC CR capturing the changes to sections 5.1.1 and section 5.1.1a of the MAC spec can also be considered and if agreeable, this CR should also be maintained as part of the common RACH agenda item.6. As a baseline, the RA procedure design for Rel-17 should adhere to the following general principles: a: Carrier selection (between NUL/SUL) should happen ahead of the initial RACH resource selection (i.e. feature combination is not considered in carrier selection). b: Initial RACH resource should be selected based on the selected carrier for the selected feature combination (i.e., selected slice, SDT or not, REDCAP or not etc). Only the RACH resource matching the feature and/or feature combination of current RACH procedure will be considered as available in the RACH resource selection.c: As a general rule, all RACH retransmissions (if any are needed, until RACH failure happens) shall be performed over the same RACH resources (and same carrier – NUL/SUL) as the one selected for initial RACH resource. However, we can discuss fallback on a case by case basis if there is a strong motivation and discuss them together in this AI. |

Given the RAN2 conclusion and ongoing discussion, contributions [12,13,23,28] further suggest deferring the discussion of PRACH preamble partitioning to RAN2, including support of Redcap early indication. One contribution [26] proposes to explicitly configure offset and number of consecutive preambles for the RedCap UE early identification irrespective of ROs are shared with non-RedCap UEs or not. However, one contribution [30] proposed to at least support the following PRACH resource configuration: 1) “RedCap UE with CE’, ‘RedCap UE without CE”, ‘non-RedCap UE with CE’ and ‘non-RedCap UE without CE’ to have different PRACH resources; 2) ‘RedCap UE without CE’ and ‘non-RedCap UE with CE’ to have different PRACH resources.

* <1st Round Comments>

**Medium Priority Proposal 2.2-1:**

* **It is up to RAN2 for PRACH preamble partitioning for Msg1-based early indication**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| LG | Y | The issue on PRACH preamble partitioning suddenly became related to other features. Considering RAN2 started to discuss PRACH preamble partitioning across multiple features, RAN1 could defer such discussion to RAN2. |
| ZTE, Sanechips |  | In order to avoid the signalling wasting and duplicated work, which cases are supported or excluded should be discussed in RAN1.From RAN1 perspective, we already have decided the following cases for PRACH resource configuration are supported:Case 1: For RedCap UE with CE and RedCap UE without CE, non-RedCap UE with CE and non-RedCap UE without CE, they have different PRACH resources.Case 4: RedCap UE with CE and non-RedCap UE with CE share PRACH resources, RedCap UE without CE and non-RedCap UE with CE have different PRACH resources.We can further discuss whether the following cases for PRACH resource configuration are supported:Case 2: RedCap UE with CE and non-RedCap UE with CE share PRACH resources, RedCap UE without CE and non-RedCap UE with CE have different PRACH resourcesCase 3: RedCap UE with CE and non-RedCap UE with CE have different PRACH resources, RedCap UE without CE and non-RedCap UE with CE share the PRACH resources.The details can be found in [30]. |
| Ericsson | Y |  |

One contribution [6] states that the configuration of early indication in 2-step RACH should be in line with 4-step RACH, which is motivated by the operation that a UE may fall back to 4-step RACH. one example provided in [6] is that if early indication in Msg1 is configured, for 2-step RACH early indication in MsgA preamble part is also configured.

# Definition of Redcap UE Type

## Issue 4: Redcap UE Type Definition

The WID stipulates that only one RedCap UE type should be specified [1]. Moreover, the following agreement was also made by RAN2 during RAN2#114-e [3].

|  |
| --- |
| Agreements:1. […]
2. At least for early identification there will be only one RedCap UE (no need to define separate RedCap UE types for FR1 and FR2)
3. […]
 |

With regards to the definition of the RedCap UE type, the following agreement was made by RAN1 during RAN1#106-e [4]:

|  |
| --- |
| Agreements:* A RedCap UE type from RAN1 point of view supports a maximum bandwidth of 20MHz for FR1 and 100MHz for FR2
* Further discuss whether to capture also one or more of the following capabilities to RedCap UE type description
	+ Supports either 1 or 2 Rx branches and corresponding maximum DL MIMO layers
	+ Supports either FD-FDD or Type A HD-FDD operation for FR1 FDD bands
	+ Supports either DL up to 64 QAM or up to 256 QAM for FR1
	+ Does not support CA/DC
 |

Table 3 summarized companies’ preference on Redcap UE type definition with brief notes:

**Table 3: Definition of Redcap UE Type**

|  |  |  |  |
| --- | --- | --- | --- |
| Proposal | ‘Yes’, or Partially ‘Yes’ | ‘No’ | Others |
| Adding the following components for Redcap device type definition: * Supports either 1 or 2 Rx branches and corresponding maximum DL MIMO layers
* Supports either FD-FDD or Type A HD-FDD operation for FR1 FDD bands
* Supports either DL up to 64 QAM or up to 256 QAM for FR1
* Does not support CA/DC
 | Ericsson [5], CATT [9, no need CA/DC], China Telecom [10], CMCC [11], Nokia [12], Lenovo [13], ZTE [14, no need HD-FDD, no need DL Modulation order], Xiaomi [15], Sierra Wireless [19], Panasonic ([21], No need of HD-FDD/FD-FDD); Sharp [24], Nordic [26] (capture *“Supports reduced number of Rx branches in bands where 4Rx branches are required*) | Only capabilities related to initial access procedure need to be included in the minimum capability set for RedCap UEs: * Huawei [3], vivo [7], Intel [17], DCM [18, defined by FG 28-1 in R1-2108679], NEC [20]
 | * Samsung [16]: Discuss in UE feature AI.
 |

It was observed by moderator that preferences from companies were almost no change compared to RAN1 #106 e-Meeting. Instead continue debating here, it seems more efficient to discuss this under ‘UE features for Redcap’ AI as recommended by [16] as well. It is moderator’s understanding that any components that agreed as part of ‘basic feature groups’ for Redcap device are essentially part of ‘Redcap device type’ as it can be assumed by network once UE claims to be ‘Redcap device’.

* <1st Round Comments>

**FL1 High Priority Question 3-1: Which Alternative is preferred by**

* + **Alt.1: Add support reduced number of Rx branches (i.e., 1 Rx/2 Rx branches) in addition to reduced BW**
	+ **Alt.2: Leave ‘Redcap Device Type’ definition to UE features of Redcap AI.**
		- **Note that: UE features that are defined as part of ‘Basic feature group’ for Redcap are included in the ‘Redcap Device Type’ definition.**
	+ **Alt.3: No additional component to be added for ‘Redcap Device Type’ definition.**

Moderator strongly recommends companies to compromise as much as possible on this issue, given the fact of lengthy and extensive discussions in past and only two meetings were left. Sticking to own preference is really no way to progress and move forward.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | Alt 3 | A RedCap UE type from RAN1 point of view supports a maximum bandwidth of 20MHz for FR1 and 100MHz for FR2 |
| vivo | Alt3 | BW is enough to identify RedCap UE type, other features (e.g. #Rx, duplexing) can be optionally signaled by UE capability.  |
| CATT | Alt.1 or 2 |  |
| OPPO | Alt 2 | Besides BW, HD-FDD capability is also relevant to the initial access procedure. Also, the assumption of Rx branches can be used for optimization during initial access procedure. The performance will benefit from the ‘Basic feature group’ for Redcap.  |
| DOCOMO | Alt.2 or Alt.3 | RedCap UE type can be defined by FG 28-1 in R1-2108679. We are fine to further discuss in UE features of Redcap AI |
| Sharp | Alt.2 |  |
| MediaTek | Alt.2 is acceptable | Alt.3 is not acceptable. As an example, #Rx can’t be optional for RedCap UEs as suggested by some companies, what the gNB should assume if the UE doesn’t report it? There must be some “basic” support for this features, e.g. RedCap UE supports at least 1Rx, (and then 2Rx can be optional in this case). |
| Huawei, HiSilicon | Alt. 3 or leave to RAN2 | The issue mentioned by MTK is a signaling issue that RAN2 can handle. Also, there was a similar discussion regarding capturing URLLC related features of R15 in recent RAN e-meeting, and it was concluded that some texts can be summarized and captured for informative in TR instead of TS. This approach could be referred to by RAN2 if they need. From RAN1 perspective, there is no need to further discuss this. |
| LG | Alt 3 | Since we agree to support only one RedCap UE type, we prefer to avoid having multiple choices (e.g. 1 RX or 2 RX) for the RedCap UE type. |
| ZTE, Sanechips | Alt. 1 or alt 2. | Alt. 1 is preferred. As the WID description, the motivation of RedCap type definition is to identify a RedCap UE or preclude a non-RedCap UE.Only bandwidth is not enough to declare itself a RedCap UE. For example, a UE with 20M bandwidth also reports 4Rx capability. Therefore, Rx also should be included.‘Not support CA/DC’ can determine a UE is not RedCap UE, therefore, it also can be considered for the RedCap type definition. |
| Xiaomi | 1st priority: Alt.12nd priority: Alt.2  | In our view, only including the maximum UE bandwidth is not sufficient considering the motivation to define RedCap UE type as described in the WID *  For RedCap UE identification
*  For constraining the use of those RedCap capabilities only for RedCap UEs
*  For preventing RedCap UEs from using capabilities not intended for RedCap UEs including at least carrier aggregation, dual connectivity and wider bandwidths

In our understanding, the second bullet implies that non-RedCap could use the capabilities not included in the RedCap’s definition and the third bullet implies RedCap are not constrained in the capabilities not included the RedCap definition. For example, if reduced Rx is not included in the RedCap definition, the consequence may become that the RedCap may use the same number of Rx with non-RedCap e.g., 20MHz+4Rx in TDD band or the non-RedCap devices may support reduced number of Rx e.g., 100MHz+1Rx in TDD band. On the other hand, we are also OK with Alt.2 for progress |
| Ericsson | Alt. 2 | This discussion can be handled in the Rel-17 RedCap UE feature list discussion. |

# 4. Cell Access Restriction

## Issue 5: Cell Access Restriction

One of objectives for Redcap WI is to support to indicate through SIB information about cell camping for Redcap UE as follows [1]:

|  |
| --- |
| * 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]
 |

RAN1 106-e Meeting made the following conclusion related to cell camping indication for Redcap [2]:

|  |
| --- |
| Conclusion* There is no consensus in RAN1 on whether to have the access barring indication in DCI scheduling SIB1, and RAN1 can come back if triggered by RAN2.
 |

Contributions [3] discussed the cell access restriction with the following proposals:

|  |  |  |
| --- | --- | --- |
|  | Proposals | Motivations |
| P1 [3] | Consider to restrict the access of RedCap UEs via SIB1* Access control specific to RedCap UEs with 1Rx or 2Rx via DCI associated with SIB1
 | Beneficial for power saving of the UEs and control flexibility of the gNB.  |
| P2 [3] | Different cell selection/reselection time for 1Rx or 2Rx can be configured by gNB. |

* <1st Round Comments>

**Medium Priority Proposal 4-1:**

* **Can we agree ‘P1’ and/or ‘P2’ listed above?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| LG |  | We agree P1. |
| Ericsson | N | RAN1 does not need to continue the discussion about cell access restriction unless requested by RAN2. |
|  |  |  |

# 5. Other aspects

## Issue 6: Need of separate SIB1 for Redcap

Contribution [31,32] discussed SIB1 for Redcap UEs. In [31], it prefers to reuse the existing SIB1 and incorporate the new system information for RedCap. It was also pointed out in [31] that some modifications on short message field ‘*systemInfoModification*’ in paging DCI need to be discussed to improve the power consumption for SIB update when only Redcap-specific SIB information is updated in the shared SIB1. Contribution [32] proposed to introduce a new SIB1 (e.g., SIB1-R) used by REDCAP UEs. Several advantages of separate SIB1 for Redcap were listed in [32] including SIB1 size limitation and SIB1 transmission optimization for Redcap UEs. Regarding the separate SIB1 scheduling, it was stated in [32] that DCI format 1\_0 with CRC scrambled by SI-RNTI can be used to schedule both legacy SIB1 and new SIB1-R by using some reserved bits in DCI to differentiate between these two SIBs.

* <1st Round Comments>

**Medium Priority Proposal 5-1:**

* **Alt.1: Reuse the existing SIB1 and incorporate the new system information for RedCap.**
* **Alt.2: Introduce a new SIB1 (e.g., SIB1-R) used by REDCAP UEs**
* **Alt.3: Whether to introduce new SIB1 for Redcap UE is left up to RAN2.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| LG | Alt 2 or 3 | In 38.214, it is specified that the UE is not expected to receive a PDSCH assigned by a PDCCH with CRC scrambled by SI-RNTI with a TBS exceeding 2976 bits. Considering that RAN2 previously discussed this limitation of SIB1 for Rel-15 specification and RAN1 may introduce new RedCap specific parameters for UEs in RRC\_IDLE/INACTIVE, we think that it is beneficial to introduce a new SIB1 used by RedCap UEs. We think that analysis of new RedCap specific parameters (e.g. new RACH configurations for early indication and a new initial BWP configuration) and the roughly expected size of new parameters is a prerequisite for introduction of a new SIB1. Thus, RAN1 could first inform RAN2 about roughly estimated size of new RedCap specific parameters. Then, RAN2 could make final decision on whether a new SIB1 is needed or not. |
| Ericsson | Alt. 1 or 3 | If some PHY related issue is found out by RAN1 then RAN2 should be made aware, but unless there is some clear issue in reusing SIB1, we should not design new procedures. |
|  |  |  |

* P1 [7]: Relative criterion that the comparison on maximum channel bandwidth for a UE can support and the cell is operating (i.e. by locationAndBandwidth) should be used by the UE to determine whether it is a RedCap UE or not.

## Issue 7: Measurements for Redcap with reduced number of Rx branches

One contribution [8] suggest discussing measurement related issues caused by reduced numbrer of Rx branches with the following proposals:

* P1 [8]: A relaxed RSRP thresholds is used for RedCap UEs to select SSB for performing random access.
* P2 [8]: Other measurement related thresholds are configured specifically for RedCap UEs with reduced Rx branches number.
* <1st Round Comments>

**Medium Priority Question 5-2: Which of P1/P2 can be agreed for Redcap measurement? If none, please provide brief justification.**

* **P1 [8]: A relaxed RSRP thresholds is used for RedCap UEs to select SSB for performing random access.**
* **P2 [8]: Other measurement related thresholds are configured specifically for RedCap UEs with reduced Rx branches number.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| OPPO | Y, P1 and P2 | As we stated in our contribution, the reduced Rx branches number of RedCap UE causes some measurement related issues, if related thresholds are not relaxed for RedCap UE. Although it is mainly a RAN2 issue, RAN2 may not discuss the relaxed threshold without RAN1’s observation and information. We suggest to identify this issue in RAN1, and inform RAN2 for detailed RRC parameters standardization.  |
| LG | N | The benefit of P1 is not clear to us. P2 could be left for RAN2 and/or RAN4. |
| Ericsson | N | These proposals can be treated in RAN2 and RAN4. |

**SSB/CORESET#0 and initial UL/DL Configuration**

Contribution [25] discussed various aspects for Redcap device, including system information configuration (e.g., PUCCH resource), BWP Configuration (e.g., CORESET#0/SSB in a separate initial DL BWP and associated CSS for Redcap device) and L2 buffer size reduction. These topics have been handled in other Redcap agendas already (e.g., AI 8.6.1.1 and AI 8.6.1.3) and it is reasonable to continue discussing over there to avoid duplicated efforts.

**RA-RNTI Overlapping handling**

One contribution [27] provides different solutions to address the RA-RNTI collision issue. However, the following was agreed in RAN1 106-e meeting to leave this problem for RAN2 [2]:

|  |
| --- |
| **Conclusion:*** Whether there is RA-RNTI overlapping issue and how to address RA-RNTI overlapping issue in the early indication of RedCap UEs in Msg1 in Rel-17 is up to RAN2.
 |

# 6. Conclusion

# Annex: Companies’ point of contact

**FL1 Question: Please consider entering contact info below for the points of contact for this email discussion.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Point of contact** | **Email address** |
| Qualcomm | Jing Lei | leijing@qti.qualcomm.com |
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| Xiaomi | Qin MU | muqin@xiaomi.com |
| Ericsson | Johan Bergman | johan.bergman@ericsson.com |
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# References

1. RP-211574 Revised WID on support of reduced capability NR devices Ericsson
2. R1-2108271, RAN1 agreements for Rel-17 NR RedCap Rapporteur (Ericsson)
3. [R1-2108755](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2108755.zip) RAN1 aspects of RedCap UE type and identification Huawei, HiSilicon
4. [R1-2108803](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2108803.zip) Discussion on the Capabilities of RedCap UEs FUTUREWEI
5. [R1-2108823](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2108823.zip) RAN1 aspects for RAN2-led features for RedCap Ericsson
6. [R1-2108915](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2108915.zip) Discussion on early indication for Redcap UE Spreadtrum Communications
7. [R1-2108983](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2108983.zip) Higher layer support for RedCap vivo, Guangdong Genius
8. [R1-2109084](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109084.zip) Mechanism in higher&PHY layer for Reduced Capability NR Devices OPPO
9. [R1-2109233](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109233.zip) Discussion on higher layer support of RedCap CATT
10. [R1-2109254](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109254.zip) Discussion on RAN1 aspects for RAN2-led features for RedCap China Telecom
11. [R1-2109290](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109290.zip) Discussion on RAN1 aspects for RAN2-led features for RedCap CMCC
12. R1-2109312 Higher layer support of Reduced Capability NR Devices Nokia, Nokia Shanghai Bell
13. [R1-2109327](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109327.zip) RAN1 aspects for RAN2-led features for RedCap Lenovo, Motorola Mobility
14. [R1-2109335](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109335.zip) Higher layer support of Reduced Capability NR devices ZTE, Sanechips
15. [R1-2109420](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109420.zip) Discussion on the remaining issues of higher layer related topics for RedCap Xiaomi
16. [R1-2109499](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109499.zip) RAN1 aspects for RAN2-led features for RedCap Samsung
17. [R1-2109620](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109620.zip) On RAN1 aspects for RAN2-led objectives for RedCap Intel Corporation
18. [R1-2109687](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109687.zip) Discussion on RAN1 aspects for RAN2-led features for RedCap NTT DOCOMO, INC.
19. [R1-2109726](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109726.zip) Design consideration for Higher layer support of RedCap Sierra Wireless. S.A.
20. [R1-2109761](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109761.zip) Discussion on RedCap Type definition NEC
21. [R1-2109854](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109854.zip) RAN1 aspects for RAN2-led features for RedCap Panasonic Corporation
22. [R1-2109950](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109950.zip) Remaining RAN1 aspects of RAN2-led RedCap features InterDigital, Inc.
23. [R1-2109978](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109978.zip) RAN1 aspects for RAN2-led features for RedCap LG Electronics
24. [R1-2109998](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109998.zip) RAN1 aspects for RAN2-led features for RedCap Sharp
25. [R1-2110196](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2110196.zip) Cross-Layer Design Considerations for RedCap Device Qualcomm Incorporated
26. [R1-2110282](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2110282.zip) On RAN1 aspects of RAN2-led RedCap features Nordic Semiconductor ASA
27. [R1-2110326](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2110326.zip) Discussion on higher layer support of Redcap UE WILUS Inc.
28. [R1-2109234](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109234.zip) Views on remaining issues of RedCap CATT
29. [R1-2109328](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109328.zip) 2-step RACH for RedCap Lenovo, Motorola Mobility
30. [R1-2109336](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109336.zip) Consideration on PRACH resource configuration for RedCap and CovEnh ZTE, Sanechips
31. [R1-2109421](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109421.zip) Discussion on the transmission of system information for RedCap Xiaomi
32. [R1-2109979](file:///C%3A%5CUsers%5Chonghe%5CDocs%5CR1-2109979.zip) Discussion on other aspects of RedCap LG Electronics

1. [R2-2106472](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_114-e/Docs/R2-2106472.zip), “Report from Break-out session on R17 NTN and REDCAP”, Vice Chairman (ZTE Corporation), 3GPP TSG RAN2 #114-e, May 2021