3GPP TSG RAN WG2 Meeting #115-e draft R2-2108891

**Electronic meeting, 16th-27th August 2021**

**Agenda item:** 8.12.2.1

**Source:** Intel Corporation

**Title:** Summary of [AT115-e][109][RedCap] Capabilities (Intel)

**Document for:**  Discussion and decision

# Introduction

This document is the summary of following offline discussion:

* [AT115-e][109][RedCap] Capabilites (Intel)

Initial scope: Continue the discussion on p5, p6, p8-p13, p16-p18 (p19-p20 can be discussed during the running CR drafting). In general discuss whether, for (some of) these proposals, we need to ask anything to RAN1. Also discuss p1 and p2 from [R2-2107677](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2107677%20Constraining%20of%20reduced%20capabilities.docx), i.e. need to send an LS to SA2/CT1

Intended outcome: Summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
		- List of proposals that require online discussions
		- List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Monday 2021-08-23 10:00 UTC

Initial deadline (for rapporteur's summary in R2-2108891): Monday 2021-08-23 16:00 UTC

Proposals marked "for agreement" in R2-2108891 not challenged until Tuesday 2021-08-24 0800 UTC will be declared as agreed via email by the session chair (for the rest the discussion will further continue online).

Status: Ongoing

# Discussion

Based on [12], RAN2 discussed the supported capabilities for RedCap UE and how to capture them into specification. Following agreements have been made:

Agreements:

1. The number of DRBs supported by RedCap UEs is less than legacy value (which is 16). There will be a single mandatory value (FFS if 4 or 8). FFS if it will be possible to have an optional capability
2. “RRC processing delay” is not relaxed for RedCap UE
3. PDCP/RLC AM 12 bits SN is mandatory for RedCap UE, and PDCP/RLC AM 18bits SN is optional supported by RedCap UE; FFS on how to capture this in specification
4. NE-DC, and (NG)EN-DC are not supported by RedCap UE; FFS on how to capture it in the specification
5. DAPS and CAPC related capabilities are not applicable for RedCap UE; [8/20] FFS on CHO. FFS on how to capture this in the specification;

Following proposals will be treated in this offline discussion based on the guidance from Chair:

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| **Proposal 5.** **[To agree] Leave the discussion on “small scalling factor values for RedCap UEs” to RAN1.****Proposal 6.** **[To discuss] Continue the discussion on how to reduce maximum DRBs supported by RedCap UEs.****Proposal 6.1.** **Option 1 (supported by 8 companies):** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCaps UEs without any optional capability signalling; FFS on what is the mandatory value, 4 or 8?**Proposal 6.2.** **Option 2 (supported by 4 companies):** Introduce optional capability to indicate the number of DRBs that the RedCap UE supports; FFS on what is the possible value 2, 4, 8, 16?**Proposal 6.3.** **Option 3 (supported by 11 companies):** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCap UE; FFS on what is the mandatory value, 4 or 8? In addition, introduce the optional capability to indicate the number of DRBs that the RedCap can additionally support. FFS on what is possible value 8 or 16, depends on the mandatory value;**Proposal 8.** **[To discuss]** whether whole L2 buffer reduction discussion should be left to RAN1, i.e. based on proposal 5, or RAN2 should still discuss it;**Proposal 9.** **[To agree] [19/21] ANR feature is optional for RedCap UE; FFS on how to capture this in specification;****Proposal 10.** **[To agree] [21/21] From RAN2 perspective, inter RAT mobility related capabilities are applicable for RedCap UE; No specification impact is foreseen;****Proposal 11.** **[To agree] [15/21] From RAN2 perspective, measurement related capabilities are applicable for RedCap UE; No specification impact is foreseen;****Proposal 12.** **[To agree] [13/20] From RAN2 perspective, URLLC related capabilities are applicable for RedCap UE except those impacted by CA/DC; No specification impact is foreseen;****Proposal 13.** **[To agree] [15/19] From RAN2 perspective, IAB related capabilities are not applicable for RedCap UE; FFS on specification impact;****Proposal 16.** **[To discuss]** [TP to TS 38.306]. **RAN2 to discuss how to capture Maximum BW:****Proposal 16.1.** **Option 2 9 companies****Proposal 16.1.1.** to add “For FR1 RedCap UE, the bit which indicates 20MHz shall be set to 1, and the bits which indicate 25, 30, 40, 50, 60 and 80MHz are ignored. For FR2 RedCap UE, the bit which indicates 100MHz shall be set to 1, and the third / rightmost bit is ignored.” and “channelBWs-DL-v1590 is not applicable to RedCap UE.” for field description of existing fields “channelBWs-DL” and “channelBWs-UL”**Proposal 16.1.2.** and add “This capability is not applicable to RedCap UE.” for field description of existing fields “channelBW-90mhz”;**Proposal 16.2.** **Option 3 7 companies** to create a new section in 38.306 to capture the maximum UE bandwidth for RedCap UE (considering the clarification wording in Proposal 15.1.1 as the baseline);**Proposal 17.** **[To agree] [20/21] Do not introduce capability signalling on the supported Rx number for RedCap UE since the number of Rx branches for RedCap is implicitly indicated by the corresponding capability parameter *maxNumberMIMO-LayersPDSCH* in the existing UE capability framework. FFS on specification impact.****Proposal 18.** **[To discuss] [TP to TS38.306] RAN2 to discuss how to capture the relationship between Rx and MIMO layers:****Proposal 18.1.** **Option 2** 14 companies to add “For RedCap UE, if signalled, only 2 MIMO layers can be reported.” for field description of existing fields “maxNumberMIMO-LayersPDSCH”;**Proposal 18.2.** **Option 3** 7 companies to create a new section in 38.306 to capture the relationship between Rx and MIMO layers; |

## Supported capabilities for RedCap UE

### L2 buffer reduction

The discussion in [12] is shown as below:

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| **Summary on the Discussion point 1.4 on L2 buffer size:** 17 companies provided inputs to this discussion point:* “L2 buffer size should be reduced” is supported by 11 companies (Qualcomm, Spreadtrum, Lenovo, OPPO, Squans, ZTE, LGE, China Telecom, China Unicom, vivo, Apple)
	+ Option 1: ”Value: introduce a scaling factor, which may take values of 0.25x, 0.5x, 0.75x, 1.0x, for the total L2 buffer size”. is supported by 3 companies (Qualcomm, LGE, Apple)
	+ Option 2: “keep L2 buffer size definition and equations in TS 38.306, Change the values of *scalingFactor* for RedCap (smaller scalingFactor), see discussion point 1.6” is supported by 2 companies (Spreadtrum, Lenovo)
	+ 6 companies would like to continue the discussion on the details; (vivo, China Unicom, China Telecom, ZTE, Sequans, OPPO)
* “No change” is supported by 6 companies (Intel, Huawei, Futurewei, Ericsson, Samsung, Nokia)

**Rapporteur**: Although quite some companies (11/17) would like to reduce the L2 buffer size, however it is unclear how to reduce it, e.g. option 1, option 2 or other options? Note as discussed in discussion point 1.6, option 2 scalingFactor is related to RAN1 and Rapporteur suggests to leave the discussion on option 2 to RAN1. **Summary on the Discussion point 1.6 on small scalling factor values for RedCap UEs:** 15 companies provided inputs to this discussion point:* “Introduce smaller value for “*scalingFactor*”” is supported by 9 companies (Spreadtrum, Lenovo, Sequans, ZTE, LGE, China Telecom, China Unicom, vivo, Apple)
	+ - “new Values: 0.75, 0.1.” is supported by 1 company (Spreadtrum,)
		- *scalingFactor* is mandatory for RedCap UE:
			* *Yes,* (Spreadtrum,)
			* *No, (ZTE, )*
			* *FFS (China Unicom)*
* “no” is supported by 5 companies (Intel, Qualcomm, Ericsson, Samsung, Nokia);
* Ericsson commented “this has been discussed in RAN1 already and this discussion is not in RAN2 scope.”

**Rapporteur**: The issue is related to discussion point 1.4 L2 buffer size reduction. Considering scaling factor was introduced by RAN1 to resolve the mismatch between RF and baseband capabilities, and RAN1 has discussed it. It would be good to avoid the duplicated discussion in different WGs for the same topic, especially there is no majority in RAN2 to take any decision. Rapporteur suggests to leave this discussion to RAN1.**Proposal 5.** **[To agree] Leave the discussion on “small scalling factor values for RedCap UEs” to RAN1.****Summary on the Phase 2- Discussion point 1.4 on L2 buffer size reduction.**21 companies provided inputs to this discussion point:* + **Option 1**: ”Value: introduce a scaling factor, which may take values of 0.25x, 0.5x, 0.75x, 1.0x, for the total L2 buffer size”.

The option is supported by 5 companies (Qualcomm, vivo, Sharp, Sequans, LGE )* + Option 2: “keep L2 buffer size definition and equations in TS 38.306, Change the values of *scalingFactor* for RedCap (smaller scalingFactor), see discussion point 1.6”

The option is supported by 8 companies (Apple, Spreadtrum, Lenovo, China Unicom, vivo, Sharp, China Telecom, LGE )* + **Option 3** no change, i.e. keep L2 buffer size definition and equations in TS 38.306

The option is supported by 9 companies (Intel, Huawei, Sierra Wireless, Futurewei, Samsung, Xiaomi, CATT, Ericsson, MediTek )* + **Option 4** Up to RAN1

The option is supported by companies (ZTE, OPPO)**Rapporteur**: There is no clear majority on L2 buffer size reduction. Further discussion is still needed. Considering companies who support L2 buffer size reduction are considering scalling factor solution, and rapporteur already proposed to leave the discussion up to RAN1 in proposal 5 (**[To agree] Leave the discussion on “small scalling factor values for RedCap UEs” to RAN1.**). Rapporteur would suggest to leave all related discussion to RAN1, and therefore no proposal here. Rapporteur received offline comments from Spreadtrum that the L2 buffer reduction should be discussed in RAN2 instead of leaving all discussions to RAN1. To reflect this comments, Rapporteur added proposal as**Proposal 8.** **[To discuss]** whether whole L2 buffer reduction discussion should be left to RAN1, i.e. based on proposal 5, or RAN2 should still discuss it; |

Same issue is discussing in RAN1 [13].

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| FL1 Question 1* *Please share your views on the following for handling of scaling factors for RedCap UEs:*
	+ ***Opt. 1:*** *Scaling factors for peak DL rates with existing values {0.4, 0.75, 0.8, 1} are available to RedCap UEs, with the same constraint on the minimum value of the product* $v\_{Layers}^{(j)}⋅Q\_{m}^{\left(j\right)}⋅f\_{}^{\left(j\right)}$*as applicable for single carrier NR SA operation.*
	+ ***Opt. 2:*** *Scaling factors for peak DL rates with existing values {0.4, 0.75, 0.8, 1} are available to RedCap UEs, with the removal of the constraint on the minimum value of the as applicable for single carrier NR SA operation.*
	+ ***Opt. 3:*** *Scaling factors for peak DL rates with existing values {0.4, 0.75, 0.8, 1} and new smaller values from one or more of: {0.1, 0.2} are available to RedCap UEs, with the removal of the constraint on the minimum value of the product* $v\_{Layers}^{(j)}⋅Q\_{m}^{\left(j\right)}⋅f\_{}^{\left(j\right)}$*as applicable for single carrier NR SA operation.*
	+ ***Opt. 4:*** *Scaling factors for peak DL rates are NOT available to RedCap UEs.*
	+ *Other options are not precluded.*

**Summary of views:**Company preferences:* **Opt. 1:** DCM (1st preference), Sierra W. (2nd preference), Intel **(3)**
* **Opt. 2:** DCM (2nd preference), Ericsson (w/ “relaxation” in addition to “removal” of the existing constraint) **(2)**
* **Opt. 3:** SPRD, vivo, CMCC (subject to RAN2 decision), Xiaomi, ZTE/Sanechips, Apple **(6)**
* **Opt. 4:** QC, LG, Nordic, HW-HiSi, Nokia/NSB, FTW, Sierra W., IDCC, Intel (2nd preference) **(9)**
* **Up to RAN2:** Lenovo, CMCC (w/ Option 3 being their preference), vivo (w/ Option 3 being their preference) **(3)**
* **No opinion** expressed on identified Options: CATT **(1)**

Considering the situation above, and taking into account the justifications provided by companies, it does not appear that there is agreement in RAN1 on need to support scaling factor for DL peak rate for RedCap UEs. Proposed Observation 1* *There is no consensus in RAN1 on the need to introduce new smaller values of scaling factor for DL peak rate for RedCap UEs.*
* *There is no consensus in RAN1 on the need to remove or relax the Rel-15 constraint on minimum value of the product* $v\_{Layers}^{(j)}⋅Q\_{m}^{\left(j\right)}⋅f\_{}^{\left(j\right)}$ *for single carrier SA operation.*
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There is no majority in both RAN1 and RAN2 discussion.

Rapporteur would like to check companies’ view again to see whether RAN2 can have consensus on this issue:

* + **Option 1**: ”Value: introduce a scaling factor, which may take values of 0.25x, 0.5x, 0.75x, 1.0x, for the total L2 buffer size”.
	+ **Option 2.1:** Scaling factors for peak DL rates with existing values {0.4, 0.75, 0.8, 1} are available to RedCap UEs, with the removal of the constraint on the minimum value of the as applicable for single carrier NR SA operation.
	+ **Option 2.2**: Scaling factors for peak DL rates with existing values {0.4, 0.75, 0.8, 1} and new smaller values from one or more of: {0.1, 0.2} are available to RedCap UEs, with the removal of the constraint on the minimum value of the product $v\_{Layers}^{(j)}⋅Q\_{m}^{\left(j\right)}⋅f\_{}^{\left(j\right)}$as applicable for single carrier NR SA operation.
	+ **Option 3** no change, i.e. keep L2 buffer size definition and equations in TS 38.306
	+ **Option 4** Up to RAN1

**Discussion point 2.1.1 on L2 buffer size reduction: Companies are invited to provide view on which option is preferred from RAN2 perspective.**

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| **Company’s name** | **Option 1,****Option 2.1,****Option 2.2 Option 3****Option 4** | **Comments, if any** |
| Intel | Option 3 | We agree the current supported max bit rate is higher than requirements for some use cases. However RAN1 did not agree to further reduce the bit rate. If we use scaling factor solution, that means the TBS will be reduced which has been discussed in RAN1 and has not been agreed. To our understanding, for the use case, e.g. 2/4M bit rate, if the UE only supports such scenario, then from UE implementation, the UE can reduce the L2 buffer size since the data rate will never be higher than 2/4 M. But we do not need to specify this.  |
| Sierra Wireless | Option 3 | No need to change the L2 buffer size definition. |
| Huawei, HiSilicon | Option 3 | Scaling factor is out of RAN2 scope. |
| Spreadtrum | Option 2.x(either 2.1 or 2.2 is fine.) | First, we have to clarify that during RAN1#106, no any agreement or conclusion on this topic were made so far, and RAN1 vice Chair Xiaodong recommended online to discuss this topic in RAN2. Second, based on Rapporteur summary on the several past RAN2 email discussions, we think it is time have more constructive discussion that we can  make decision on L2 buffer size reduction and down-selection the candidate solutions. At last, we don’t think the UE implementation method as intel mentioned can work well. If this method works, we cannot prevent those fake NR UEs with very low L2 buffer size sneaking into market.  |

### Max DRB number

The discussion situation is

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| **Summary on the Phase 2-Discussion point 1.1 on reduction of maximum DRBs supported by RedCap UEs:** 20 companies provided inputs to this discussion point:* **Option 1:** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCaps UEs without any optional capability signalling; FFS on what is the mandatory value, 4 or 8?

The option is supported by 8 companies (Intel, Huawei, Sierra Wireless, Futurewei, Samsung, Sharp, CATT, Ericsson )“Maximum mandatory value = 8” is supported by 5 companies (Intel, Huawei, Sierra Wireless, Futurewei, Samsung, )* **Option 2:** Introduce optional capability to indicate the number of DRBs that the RedCap UE supports; FFS on what is the possible value 2, 4, 8, 16?

The option is supported by 4 companies (Apple, Spreadtrum, Sequans, MediaTek)* **Option 3:** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCap UE; FFS on what is the mandatory value, 4 or 8? In addition, introduce the optional capability to indicate the number of DRBs that the RedCap can additionally support. FFS on what is possible value 8 or 16, depends on the mandatory value;

The option is supported by 11 companies (ZTE, OPPO, Qualcomm, Lenovo, vivo, Sharp, Xiaomi, Sequans, ChinaTelecom, LGE, MediaTek, )“Maximum mandatory value = 8” is supported by 2 companies (ZTE, OPPO)“Maximum mandatory value = 4” is supported by 4 companies (Qualcomm, Futurewei, vivo, Sequans)Regarding the benefit of option 1:* Intel mentioned “It would be good to keep the principle the same as non-RedCap UE. ”
* Huawei mentioned “Single mandatory value will make the gNB implementation much simpler.

Regarding the benefit of option 2:* Spreadtrum mentioned “considering R17 RedCap will support three use cases, which have very different requirements.”

Regarding the benefit of option 3:* Qualcomm mentioned “We think Option 3 is the most flexible one among the three, which can accommodate RedCap UEs with a wider range of capabilities.”

**Rapporteur**: There is no clear majority on how to reduce maximum DRBs supported by RedCap UEs. Further discussion is still needed:* **Option 1 (supported by 8 companies):** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCaps UEs without any optional capability signalling; FFS on what is the mandatory value, 4 or 8?
* **Option 2 (supported by 4 companies):** Introduce optional capability to indicate the number of DRBs that the RedCap UE supports; FFS on what is the possible value 2, 4, 8, 16?
* **Option 3 (supported by 11 companies):** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCap UE; FFS on what is the mandatory value, 4 or 8? In addition, introduce the optional capability to indicate the number of DRBs that the RedCap can additionally support. FFS on what is possible value 8 or 16, depends on the mandatory value;

**Proposal 6.** **[To discuss] Continue the discussion on how to reduce maximum DRBs supported by RedCap UEs.****Proposal 6.1.** **Option 1 (supported by 8 companies):** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCaps UEs without any optional capability signalling; FFS on what is the mandatory value, 4 or 8?**Proposal 6.2.** **Option 2 (supported by 4 companies):** Introduce optional capability to indicate the number of DRBs that the RedCap UE supports; FFS on what is the possible value 2, 4, 8, 16?**Proposal 6.3.** **Option 3 (supported by 11 companies):** On “the number of DRBs that a UE shall support”, a single mandatory value is specified for all RedCap UE; FFS on what is the mandatory value, 4 or 8? In addition, introduce the optional capability to indicate the number of DRBs that the RedCap can additionally support. FFS on what is possible value 8 or 16, depends on the mandatory value; |

RAN2 has agreed

1. The number of DRBs supported by RedCap UEs is less than legacy value (which is 16). There will be a single mandatory value (FFS if 4 or 8). FFS if it will be possible to have an optional capability

The open issue is which value should be mandatory, 4 or 8, and whether to support optional capability, e.g. more than 8.

**Discussion point 2.1.2-1 on max DRB number: Companies are invited to provide view on which value should be mandatory support by RedCap UE between 4 or 8**

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| **Company’s name** | **4 or 8** | **Comments, if any** |
| Intel | 8 | We think 8 should be ok.  |
| Sierra Wireless | 8 |  |
| Huawei, HiSilicon | 8 | 4 is not acceptable to us, which is not able to meet the requirement for some RedCap UE.The intention is to reduce some UE complexity. Changing from 16 to 8 is sufficient, while changing from 16 to 4 will be overkill to lose some feasibility to support more services. |
| Spreadtrum | 8 |  |

**Discussion point 2.1.2-2 on max DRB number: Companies are invited to provide view on whether to introduce the optional capability to indicate the number of DRBs that the RedCap can additionally support?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | No | It would be good to keep the same principle as the non-RedCap UE. We do not see any motivation to define it optional, especially considering that the fixed mandatory value should be sufficient. |
| Huawei, HiSilicon | No | Agree with Intel. |
| Spreadtrum  | No  | If 8 is selected in Discussion point 2.1.2-1, no optional capability is needed.  |
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### Support of ANR

ANR is mandatory with capability signalling. The discussion in email discussion 105 was for RedCap UE whether it should be optional instead of mandatory with capability signalling.

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| **Summary on the Phase 2-Discussion point 2.1: Should ANR feature be optional for RedCap UE (instead of mandatory with capability signalling as for non-RedCap)?**21 companies provided inputs to this discussion point:* **ANR is optional for RedCap UE** is supported by 19 companies (Intel, ZTE, Apple, Huawei, OPPO, Spreadtrum, Qualcomm, Sierra Wireless, Futurewei, Samsung, Lenovo, KDDI, vivo, Sharp, Xiaomi, CATT, Sequans, ChinaTelecom, MediaTek)
* **ANR is mandatory for RedCap UE** is supported by 2 companies (Ericsson, LGE)

;**Rapporteur**: There is clear majority on this 19/21. **Proposal 9.** **[To agree] [19/21] ANR feature is optional for RedCap UE; FFS on how to capture this in specification;** |

Considering there was clear majority in previous email discussion, Rapporteur would like to check whether above proposal 9 is agreeable?

**Discussion point 2.1.3 on ANR: Companies are invited to provide view on whether proposal “ANR feature is optional for RedCap UE; FFS on how to capture this in specification;” is agreeable?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | Yes | We do not see the need to support RedCap only cell. The operator can use non-RedCap UE to get sufficient information on ANR.  |
| Sierra Wireless | Yes |  |
| Huawei, HiSilicon | Yes | There will be always non-RedCap UE to support ANR, since there is no RedCap only cell. ANR feature causes significant complexity for RedCap, which is not essential in the typical deployment. |
| Spreadtrum | Yes |  |
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### Support of inter RAT mobility related capabilities

The discussion in email discussion 105 on Inter RAT mobility related capabilities is:

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| **Summary on the Phase 2-Discussion point 2.2: Should inter-RAT mobility related capabilities be applicable to RedCap UEs, e.g. to LTE/UTRAN?**21 companies provided inputs to this discussion point, and all of them agreed that **Inter RAT mobility related capabilities are applicable for RedCap UE** ZTE clarified their intention is “However, we are not sure the current RAN4 requirement (for non-RedCap UE) can be applicable to RedCap UEs or not? E.g. handover delay requirement defined in TS 38.133. So it is better to check with RAN4.”. Apple suggests to send LS to RAN4. However vivo commented that it is under RAN4 scope and RAN4 should be able to check this by themselves. **Rapporteur**: There is clear majority on this 21/21. **Proposal 10.** **[To agree] [21/21] From RAN2 perspective, inter RAT mobility related capabilities are applicable for RedCap UE; No specification impact is foreseen;** |

Considering there is clear majority in previous email discussion, Rapporteur would like to check whether above proposal 10 is agreeable?

**Discussion point 2.1.4 on inter RAT mobility related capabilities: Companies are invited to provide view on whether proposal “From RAN2 perspective, inter RAT mobility related capabilities are applicable for RedCap UE; No specification impact is foreseen;” is agreeable?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | Yes | Anyway, it is an optional feature. If it is complex to some RedCap UEs, then those RedCap UEs will not support it. But do not see the reason why we need to forbid the RedCap UE to support this.  |
| Sierra Wireless | Yes |  |
| Huawei, HiSilicon | Yes | If opponents’ concern is we don’t need explicit agreement for optional features, maybe the proposal can be reformulated as:”RAN2 understands/assumes inter RAT mobility related capabilities are applicable for RedCap UE”, and not to mention whether there is spec impact. |
| Spreadtrum | Yes |  |
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### Support of measurement related capabilities

The discussion in email discussion 105 on measurement related capabilities is:

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| **Summary on the Phase 2-Discussion point 2.3: - For measurement related capabilities, maxNumberCSI-RS-RRM-RS-SINR, the current value range is {n4, n8, n16, n32, n64, n96}; Should the larger values (n64, n96) be applicable to RedCap UEs?**21 companies provided inputs to this discussion point.* measurement related capabilities are applicable for RedCap UE is supported by 15 companies (Intel, Apple, Huawei, OPPO, Qualcomm, Futurewei, Samsung, vivo, Sharp, CATT, Ericsson, Sequans, China Telecom, LGE, MediaTek )
* 7 companies think that it should be discussed in RAN1 (Apple, Huawei, Spreadtrum, Lenovo, Sharp, Xiaomi, MediaTek)
* 1 company would like to reduce the large value (ZTE)

**Rapporteur**: There is clear majority on this 15/21. Only 1 company proposed the change in RAN2. Rapporteur considers from RAN2 perspective we do not see the motivation to reduce the value. The change should be from RAN1 if any.**Proposal 11.** **[To agree] [15/21] From RAN2 perspective, measurement related capabilities are applicable for RedCap UE; No specification impact is foreseen;** |

Considering there is large majority in previous email discussion, Rapporteur would like to check whether above proposal 11 is agreeable?

**Discussion point 2.1.5 on measurement related capabilities: Companies are invited to provide view on whether proposal “From RAN2 perspective, measurement related capabilities are applicable for RedCap UE; No specification impact is foreseen;” is agreeable?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | Yes | Anyway, it is an optional feature. If it is complex to some RedCap UEs, then those RedCap UEs will not support it. But do not see the reason why we need to forbid the RedCap UE to support this.  |
| Huawei, HiSilicon | Yes | See comments on Discussion point 2.1.4. |
| Spreadtrum |  | We need to check with RAN1 if any agreement is achieved.  |
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### Support of URLLC related capabilities

The discussion in email discussion 105 on URLLC related capabilities is:

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| **Summary on the Phase 2-Discussion point 2.4: For Rel-16 features, should URLLC be applicable for RedCap UE?** 20 companies provided inputs to this discussion point.* URLLC related capabilities are applicable for RedCap UE is supported by 13 companies (Intel, ZTE, Apple, Huawei, Spreadtrum, Qualcomm, Futurewei, Samsung, Lenovo, vivo, Sharp, CATT, ChinaTelecom)
* 5 companies think that it should be discussed in RAN1/4 (Apple, ZTE, OPPO, Xiaomi, CATT, )
* 1 company (KDDI) does not think the RedCap UE needs to support URLLC.
* Ericsson commented that there is no single “URLLC capability” and PDCP duplication cannot be supported since CA/DC is not applied for RedCap UE.

**Rapporteur**: Considering only 1 company clearly objected the feature for RedCap UE. Rapporteur considers from RAN2 perspective we do not see the motivation to forbid the support of URLLC feature for RedCap UE except feature impacted by CA/DC. The change should be from RAN1 if any.Note, the PDCP duplication should be covered by proposal 19 “All UE capabilities related to CA and MR-DC are not applicable for RedCap UE.”.**Proposal 12.** **[To agree] [13/20] From RAN2 perspective, URLLC related capabilities are applicable for RedCap UE except those impacted by CA/DC; No specification impact is foreseen;** |

Considering that there is large majority in previous email discussion, Rapporteur would like to check whether above proposal 12 is agreeable?

**Discussion point 2.1.6 on , URLLC related capabilities: Companies are invited to provide view on whether proposal “From RAN2 perspective, URLLC related capabilities are applicable for RedCap UE except those impacted by CA/DC; No specification impact is foreseen;” is agreeable?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | Yes | Anyway, it is optional feature. If it is complex to some RedCap UEs, then these RedCap Ues will not support it. But do not see the reason why we need to forbid the RedCap UE to support this. However, we agree that the impact due to reduced BW/Rx should be checked by RAN1/4. |
| Huawei, HiSilicon | Yes | See comments on Discussion point 2.1.4. |
| Spreadtrum | Yes |  |
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### Support of IAB related capabilities

The discussion in email discussion 105 on IAB related capabilities is:

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| **Summary on the Phase 2-Discussion point 2.6: For Rel-16 features, should IAB be applicable for RedCap UE?** 19 companies provided inputs to this discussion point.* IAB related capabilities are applicable for RedCap UE is supported by 3 companies (Intel, Lenovo, vivo)
* IAB related capabilities are not applicable for RedCap UE is supported by 15 companies (ZTE, Huawei, OPPO, Spreadtrum, Qualcomm, Futurewei, Samsung, KDDI, Sharp, Xiaomi, CATT, Ericsson, Sequans, LGE, MediaTek)
* 2 companies (Ericsson, MediaTek) do not see the impact on RAN2 specification although the use case does not make sense.

**Rapporteur**: Most companies do not see the use case to support IAB, i.e. use RedCap device to deploy IAB-MT (gNB-DU). However some companies also commented that there should not be any RAN2 specification impact.**Proposal 13.** **[To agree] [15/19] From RAN2 perspective, IAB related capabilities are not applicable for RedCap UE; FFS on specification impact;** |

Considering that there is large majority in previous email discussion, Rapporteur would like to check whether above proposal 13 is agreeable?

**Discussion point 2.1.7 on IAB related capabilities: Companies are invited to provide view on whether proposal “From RAN2 perspective, IAB related capabilities are not applicable for RedCap UE; FFS on specification impact;” is agreeable?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | Yes | Anyway, it is optional feature. If it is complex to some RedCap UEs, then these RedCap Ues will not support it. But do not see the reason why we need to forbid the RedCap UE to support this. However, we agree that the impact due to reduced BW/Rx should be checked by RAN1/4. |
| Huawei, HiSilicon | Yes |  |
| Spreadtrum | Yes | It is too complex to as IAB node for Redcap UE. |
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## Capture RedCap specific capabilities in the specification

### How to capture Maximum BW

The discussion in the email discussion 105 is

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| **Summary on the 3.2.1 Phase 2-Discussion point 3.1: How to capture Maximum BW;**20 companies provided inputs to this discussion point. There are 3 options:* **Option 1**: 3 companies (Intel, Apple, KDDI): to add “For RedCap UE, the maximum supported bandwidth in FR1 is 20Mhz, and the maximum supported bandwidth in FR2 is 100Mhz.” for field description of existing fields “***channelBWs-DL***” and “***supportedBandwidthDL***”;
* **Option 2:** 9 companies (ZTE, OPPO, Spreadtrum, Lenovo, vivo, Sharp, Xiaomi, Ericsson, LGE ) to add “For FR1 RedCap UE, the bit which indicates 20MHz shall be set to 1, and the bits which indicate 25, 30, 40, 50, 60 and 80MHz are ignored. For FR2 RedCap UE, the bit which indicates 100MHz shall be set to 1, and the third / rightmost bit is ignored.” and “channelBWs-DL-v1590 is not applicable to RedCap UE.” for field description of existing fields “channelBWs-DL” and “channelBWs-UL”

 and add “This capability is not applicable to RedCap UE.” for field description of existing fields “channelBW-90mhz”;* **Option 3:** 7 companies (Qualcomm, Futurewei, Huawei, Samsung, CATT, Sequans, MediaTek): to create a new section in 38.306 to capture the maximum UE bandwidth for RedCap UE ;

**Rapporteur**: Considering most companies support option 2 or option 3, Rapporteur would suggest to continue the discussion among these two options. **Proposal 16.** **[To discuss]** [TP to TS 38.306]. **RAN2 to discuss how to capture Maximum BW:****Proposal 16.1.** **Option 2 9 companies****Proposal 16.1.1.** to add “For FR1 RedCap UE, the bit which indicates 20MHz shall be set to 1, and the bits which indicate 25, 30, 40, 50, 60 and 80MHz are ignored. For FR2 RedCap UE, the bit which indicates 100MHz shall be set to 1, and the third / rightmost bit is ignored.” and “channelBWs-DL-v1590 is not applicable to RedCap UE.” for field description of existing fields “channelBWs-DL” and “channelBWs-UL”**Proposal 16.1.2.** and add “This capability is not applicable to RedCap UE.” for field description of existing fields “channelBW-90mhz”;**Proposal 16.2.** **Option 3 7 companies** to create a new section in 38.306 to capture the maximum UE bandwidth for RedCap UE (considering the clarification wording in Proposal 15.1.1 as the baseline); |

**Discussion point 2.2.1 on Maximum BW: Companies are invited to provide view on which option is preferred focusing on Option 2 vs option 3?**

* **Option 2)** to add “For FR1 RedCap UE, the bit which indicates 20MHz shall be set to 1, and the bits which indicate 25, 30, 40, 50, 60 and 80MHz are ignored. For FR2 RedCap UE, the bit which indicates 100MHz shall be set to 1, and the third / rightmost bit is ignored.” and “channelBWs-DL-v1590 is not applicable to RedCap UE.” for field description of existing fields “channelBWs-DL” and “channelBWs-UL” and add “This capability is not applicable to RedCap UE.” for field description of existing fields “channelBW-90mhz”;
* **Option 3)** to create a new section in 38.306 to capture the maximum UE bandwidth for RedCap UE (considering the clarification wording in Proposal 15.1.1 as the baseline);

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| **Company’s name** | **Option 2 or option 3** | **Comments, if any** |
| Intel | Option 2 | Both options can work. However we have slightly preference for option 2 i.e. to capture the restriction in the existing field description if available. |
| Huawei, HiSilicon | Prefer option 3.Propose WF | Our preference is option 3, but:The compromised way seems to capture both option 2/3: first we clarify the wording in option 2 in the existing filed description. In addition, we also capture one sentence in the RedCap specific section “For RedCap UE, the maximum bandwidth on FR1 is 20 MHz, and the maximum bandwidth on FR2 is 100 MHz.” |
| Spreadtrum | Option 2 |  |
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### How to capture Rx limitation

The discussion in the email discussion 105 is

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| **Summary on the Phase 2-Discussion point 3.2-1: need to introduce capability signalling on the supported Rx number for RedCap UE?**21 companies provided inputs to this discussion point. * ZTE mentioned that there is no need to introduce separate capability to indicate the supported Rx number for RedCap UE since RAN1 has made following agreement:

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| Agreement:For UE capability signalling, the number of Rx branches for RedCap is implicitly indicated by the corresponding capability parameter *maxNumberMIMO-LayersPDSCH* in the existing UE capability framework.* Detailed signalling is up to RAN2
 |

20 companies supported ZTE’s view, i.e. not to introduce capability signalling on the supported Rx number for RedCap UE.* Vivo commented that there are three cases for the mapping between number of Rx branches and ]
* ‘maxNumberMIMO-Layers: 1rx with 1layer, 2rx with 1layer, and 2rx with 2layers. While the WID excludes the case of 2rx with 1layer. we need to explicitly capture the conclusion in the specification.

**Proposal 17.** **[To agree] [20/21] Do not introduce capability signalling on the supported Rx number for RedCap UE since the number of Rx branches for RedCap is implicitly indicated by the corresponding capability parameter *maxNumberMIMO-LayersPDSCH* in the existing UE capability framework. FFS on specification impact.** |

Considering there was clear majority in previous email discussion, Rapporteur would like to check whether above proposal 17 is agreeable?

**Discussion point 2.2.2 on , how to capture Rx limitation: Companies are invited to provide view on whether proposal “Do not introduce capability signalling on the supported Rx number for RedCap UE since the number of Rx branches for RedCap is implicitly indicated by the corresponding capability parameter maxNumberMIMO-LayersPDSCH in the existing UE capability framework. FFS on specification impact.;” is agreeable?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | Yes | We can follow RAN1 agreements.  |
| Huawei, HiSilicon | Yes, but | Fine with the proposal.One minor wording clarification:Suggest to delete “in the existing UE capability framework”, since we may need to add “*oneLayer*” for *maxNumberMIMO-LayersPDSCH* IE to indicate the 1RX case. |
| Spreadtrum | Yes |  |
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### How to limitation on MIMO

The discussion in the email discussion 105 is

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| **Summary on the 3.2.3 Phase 2-Discussion point 3.3: How to capture MIMO layer;**21 companies provided inputs to this discussion point. There are 3 options suggested by companies’ inputs:* **Option 1:** 4 companies (Intel, Futurewei, Sharp, LGE): to add “RedCap UE supports 1 DL MIMO layer if 1 Rx branch is supported, and 2 DL MIMO layers if 2 Rx branches are supported. ” for field description of existing fields “***maxNumberMIMO-LayersPDSCH***”;
* **Option 2**: 14 companies (ZTE, Apple, OPPO, Spreadtrum, Qualcomm, Samsung, Sierra Wireless, Lenovo, KDDI, vivo, Xiaomi, CATT, ChinaTelecom, MediaTek) to add “For RedCap UE, if signalled, only 2 MIMO layers can be reported.” for field description of existing fields “***maxNumberMIMO-LayersPDSCH***”;
* **Option 3:** 7 companies (Qualcomm, Samsung, Huawei, CATT, Ericsson, Squans, MediaTek): to create a new section in 38.306 to capture the relationship between Rx and MIMO layers;

Companies commented that we should wait for RAN1 on UL MIMO. **Rapporteur**: Considering most companies support option 2 or option 3, Rapporteur would suggest continuing the discussion among these two options. **Proposal 18.** **[To discuss] [TP to TS38.306] RAN2 to discuss how to capture the relationship between Rx and MIMO layers:****Proposal 18.1.** **Option 2** 14 companies to add “For RedCap UE, if signalled, only 2 MIMO layers can be reported.” for field description of existing fields “maxNumberMIMO-LayersPDSCH”;**Proposal 18.2.** **Option 3** 7 companies to create a new section in 38.306 to capture the relationship between Rx and MIMO layers; |

Based on the discussion in email discussion 105, seems companies assume

*1. For 1 Rx RedCap UE, DL MIMO is not supported, and then this can be indicated via the absence of maxNumberMIMO-LayersPDSCH (already covered by the last sentence of field description: “If absent, the UE does not support MIMO on this carrier.”).*

*2. For 2 Rx RedCap UE, the UE can only report “twoLayers” for maxNumberMIMO-LayersPDSCH, so “fourLayers, eightLayers” values are not applicable to RedCap UEs.*

However based on the WID:

* + *Maximum number of DL MIMO layers:*
		- *For a RedCap UE with 1 Rx branch, 1 DL MIMO layer is supported.*
		- *For a RedCap UE with 2 Rx branches, 2 DL MIMO layers are supported.*

So, the statement from company “For 1 Rx RedCap UE, DL MIMO is not supported” is not aligned with the WID description since “not support DL MIMO” is not same as “support 1 DL MIMO layer”. Therefore option 1 is still valid.

**Discussion point 2.2.3 on how to capture MIMO limitation: Companies are invited to provide view on which option is preferred? Option 1, 2, 3?**

* **Option 1:** to add “RedCap UE supports 1 DL MIMO layer if 1 Rx branch is supported, and 2 DL MIMO layers if 2 Rx branches are supported.” for field description of existing fields “***maxNumberMIMO-LayersPDSCH***”;
* **Option 2**: to add “For RedCap UE, if signalled, only 2 MIMO layers can be reported.” for field description of existing fields “***maxNumberMIMO-LayersPDSCH***”;
* **Option 3:** to create a new section in 38.306 to capture the relationship between Rx and MIMO layers;

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| **Company’s name** | **Option 1, 2, 3?** | **Comments, if any** |
| Intel | Option 1 | Both option 1 and 3 can work. We slightly prefer option 1 considering there is existing field.  |
| Huawei, HiSilicon | Option 1 | On the clarification wording, “RedCap UE supports 1 DL MIMO layer if 1 Rx branch is supported” is aligned with the WID “For a RedCap UE with 1 Rx branch, 1 DL MIMO layer is supported.”, rather than option 2.Agree with rapporteur that ““not support DL MIMO” is not same as “support 1 DL MIMO layer”, as indicated by the ASN.1.MIMO-LayersDL ::=   ENUMERATED {twoLayers, fourLayers, eightLayers}MIMO-LayersUL ::=   ENUMERATED {oneLayer, twoLayers, fourLayers}Regarding whether to capture in existing filed or new section, slightly prefer option 3, but no strong view. |
| Spreadtrum | Option 2 |  |
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## LS to RAN1, RAN4

Some companies think RAN1/4 should check the features (URLLC, measurement, V2X, IAB, positioning) from their perspective, Rapporteur would like to check whether LS is needed to them.

**Discussion point 2.3-1 on LS to RAN1 and RAN4: Companies are invited to provide view on whether RAN2 needs to send LS to RAN1/4, ask them to check features, URLLC, measurement, V2X, IAB, positioning ? If yes, please indicate which feature should be included in the LS.**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | No | It is also under RAN1 and RAN4 scope, they can check by themselves.  |
| Huawei, HiSilicon | See comments | This may depends on whether RAN2 will have formal agreement on those features, see the discussion point 2.1.5/6/7. If no agreement at all, we cannot inform anything to R4. |
| Spreadtrum | Yes | RAN2 has discussed the application on Redcap UE of some features, for example, V2X, and positioning, but has not achieved any consensus considering the potential other groups impacts, so we suggest to send LS to check with them, including the possible RAN2 agreements.  |
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In addition, Rapporteur would like to check whether RAN2 needs to send LS to RAN1, RAN4 for other purpose?

**Discussion point 2.3-2 on LS to RAN1 and RAN4: Companies are invited to provide view on whether RAN2 needs to send LS to RAN1/4 for other purpose? Please indicate the content if the answer is yes.**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
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## Constrain the use of RedCap

The background is RAN2 discussed the issue at RAN2#114, However RAN2 did not discuss the proposal due to lack of the time. Considering the option 2 is tightly related to SA2, CT1, it would be good to consult SA2/CT1 on this.

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| **Summary on the Discussion point 9 on -Option 2: Subscription validation (Note: SA2, CT1 confirmation is needed), i.e. RedCap UE identifies itself during its RRC connection establishment procedure; RAN then informs core network, which then decides whether to accept or reject UE’s registration/connection request.** **During the RRC connection setup, the UE indicates that it is a RedCap UE to the core network, e.g.** **- UE includes this indication in NAS signalling message to core network; or** **- UE informs this indication during its RRC connection establishment procedure to RAN; RAN then informs core network of the UE’s RedCap type in the Initial UE Context message to core network.****The network validates UE’s indication against its subscription plan, which includes information such as the set of services allowed for the UE. Network then decides whether to accept or reject UE’s registration request. For example, network may reject UE if UE indicates RedCap, but its subscription does not include any RedCap-specific services.** 19 companies provided inputs to this discussion point:* 11 companies (OPPO, Ericsson, MediaTek, Sequans, Lenovo, LGE, Samsung, Huawei, HiSilicon, Nokia, DENSO) do not see the need to support“Option 2: Subscription validation” (from RAN2 perspective); .
* 5 companies (ZTE, Apple, Qualcomm, Intel, BT) support option2.
* 11 companies (ZTE, Ericsson, Apple, Qualcomm, Sequans, Intel, LGE, Samsung, BT, DENSO, vivo) would be ok to send LS to consult SA2/CT1 on subscription solution, i.e. whether core network should know the UE is a RedCap UE..

**Rapporteur**: The proposal is to discuss in the meeting on whether LS to SA2/CT1 is needed. **Proposal 9 [To discuss] [11]** **S**end LS to SA2/CT1 to check subscription solution, whether core network should know the UE is a RedCap UE. |

Following two proposals are proposed in [14]

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| Proposal 1: Send LS to SA2/CT1 to check subscription solution, whether core network should know the UE is a RedCap UE.Proposal 2: Agree the content of LS to SA2 and CT1 on subscription solution as below.*During Rel-17 SI support of reduced capability NR devices, Subscription validation solution was raised as an option for constraining of reduced capabilities as:**Option 2: Subscription validation (Note: SA2, CT1 confirmation is needed), i.e. RedCap UE identifies itself during its RRC connection establishment procedure; RAN then informs core network, which then decides whether to accept or reject UE’s registration/connection request.* *During the RRC connection setup, the UE indicates that it is a RedCap UE to the core network, e.g.* *- UE includes this indication in NAS signalling message to core network; or* *- UE informs this indication during its RRC connection establishment procedure to RAN; RAN then informs core network of the UE’s RedCap type in the Initial UE Context message to core network.**The network validates UE’s indication against its subscription plan, which includes information such as the set of services allowed for the UE. Network then decides whether to accept or reject UE’s registration request. For example, network may reject UE if UE indicates RedCap, but its subscription does not include any RedCap-specific services.* *However RAN2 has no consensus on whether it is needed from RAN2 perspective. Considering it is tightly related to SA2 and CT1, RAN2 kindly ask SA2 and CT1’s input on:**Q.1) whether core network should know the UE is a RedCap UE or not**Q.2) If answer to Q.1) is yes, what solution is preferred?* |

**Discussion point 2.4-1 on LS to SA2, CT1: Companies are invited to provide view on whether RAN2 needs to send LS to SA2/CT1** **to check subscription solution?**

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| **Company’s name** | **Yes/No** | **Comments, if any** |
| Intel | Yes | We see the need to trigger the discussion in SA2, CT1 since RedCap is not in their scope.  |
| Huawei, HiSilicon | No | We understand the last meeting agreement as the discussion should be initiated by SA2/CT1, rather than RAN2.

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| It is up to the network how to prevent RedCap UEs from using radio capabilities not intended for RedCap UEs (no specification impact is foreseen at least in RAN2. FFS whether something is needed from SA2/CT1) |

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| Spreadtrum | Yes |  |
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**Discussion point 2.4-2 on LS to SA2, CT1: if answer of 2.4-1 is yes, Companies are invited to provide view on what question RAN2 should ask? E.g. the content in proposal 2?**

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| **Company’s name** | **Question, content** |
| Intel | At least we need to check “whether core network should know that the UE is a RedCap UE”. We can use the content in proposal 2 as baseline for further discussion.  |
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# Summary report and proposals

Aiming to help with the meeting discussion/progress, the proposals are categorized starting with:

* [To agree] when there is large support and hence proposed for easy agreement.
* [To discuss] when there is substantial level of support and agreement may be possible.
* [FFS] when there is low support or companies propose new solutions or options to possibly consider further e.g. if there is sufficient support (understanding that these topic have not been discussed by all companies when providing their views in the different discussion points).

The proposals also start with a number: for the format [x], ‘x’ represents the number of supportive companies (i.e. these solutions are marked as FFS as the proposed solutions were not discussed by all companies) and, for the format [x/y], ‘x’ represents the number of supportive companies, and (y-x) the number of companies with different view.

The observations captured are the following:

**Observation 1.** xxxx.

The proposals captured are the following:

The following list shows the proposals above organized based on the suggested priority aiming to help during its meeting discussion:

**Proposals for easy agreement**

**Proposals for discussion (1st priority) or to be captured as FFS**

**Proposals for discussion (2nd priority) or to be captured as FFS**

xxx

# Annex: companies’ point of contact

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| --- | --- | --- |
| **Company** | **Point of contact** | **Email address** |
| Intel Corporation | Yi Guo | Yi.guo@intel.com |
| Huawei, HiSilicon | Yulong Shi | shiyulong5@huawei.com |
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# Reference

1. R2-2106462 Summary 8.12.2.1 - Definition of RedCap UE and reduced capabilities (Intel)
2. R2-2106521 [offline 105] Definition of RedCap UE and reduced capabilities (Intel) Intel
3. R2-2106528 [offline 105] Definition of RedCap UE and reduced capabilities - second round Intel
4. TR 38.875
5. RP-210918, “Revised WID on support of reduced capability NR devices”
6. R2-2102017 Summary of offline 107 - [REDCAP] L2 capabilties and UE types Huawei
7. R2-2105234 Definition of RedCap UE and first look on capability signaling Ericsson
8. R2-2105634 Definition of RedCap UE type and reduced capabilities Huawei, HiSilicon
9. R2-2104927 RedCap UE capability and constraining of reduced capabilities Intel Corporation
10. TS 38.306 g40
11. TS 38.331 g41
12. R2-2107676 Email discussion report on [105][RedCap] Capabilities (Intel) Intel Corporation
13. R1-2108316 FL summary #1 on other aspects of UE complexity reduction for RedCap Moderator (Intel Corporation)
14. [R2-2107677](file:///C%3A%5CData%5C3GPP%5CExtracts%5CR2-2107677%20Constraining%20of%20reduced%20capabilities.docx) Constraining network access for UE with reduced capabilities Intel Corporation