**3GPP TSG RAN WG1 #103-e R1-200xxxx**

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

**Source: Moderator (NTT DOCOMO, INC.)**

**Title: [draft] Summary #2 on Framework and Principles for Reduced Capability**

**Agenda Item:** **8.6.4**

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

1. **Introduction**

This contribution summarizes the discussion points mentioned in the contributions submitted to AI8.6.4 regarding the framework and principles for RedCap.

1. **Discussion**
	1. **Definition of a limited set of one or more device types**

## How to define UE type for RedCap

In [6, 9, 14, 18], the framework how to indicate the capabilities of RedCap UE is discussed, e.g., existing UE feature/capability framework is assumed as the baseline. As the following agreement, especially highlighted by yellow, was made in RAN2#111-e meeting, FL thinks RAN1 can follow the RAN2 agreement and no additional discussion is necessary in RAN1.

Agreements:

1. At least for device type identification and access restriction (including initial access), the network needs to know whether the UE is redCap UE or not. FFS on whether based on explicit or implicit signalling.
2. The existing UE capabilities framework is used as baseline to indicate the capabilities of a RedCap UE (this does not imply anything on the reporting of the device type, if the need for a device type will be agreed)
3. The number of device types should be minimised, to reduce market fragmentation, and introduced only where essential to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs, (e.g. number of Tx/Rx antennas, maximum supportable BW, etc.). The exact composition of the set of L1 capabilities of the device type can be discussed by RAN1
4. Discuss in normative phase on whether to signal (and in case how) a Device type and its associated capabilities (the reduced set of capabilities) is captured in specifications, and whether device type is indicated as part of UE capability;

### **FL proposal#1:**

* **Defer to RAN2 on the framework how to** **indicate the capabilities of RedCap UE**
	+ **Note: RAN1 continues the discussion on the exact composition of the set of L1 capabilities of the RedCap UE type**

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In addition, [4] discusses the potential capability classification for RedCap UEs as below.

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| Case  | eMBB UEs | RedCap UEs |
| Case 1a | Case 1: Mandatory with/ without capability signaling | Mandatory without capability signaling with the same/different values with eMBB UEs |
| Case 1b | Mandatory with capability signaling with the same/different values with eMBB UEs |
| Case 1c | Optionally supports the feature |
| Case 1d | Does not support the feature  |
| Case 2a | Case 2: Optional with capability signaling | Optionally supports the feature |
| *Case 2b* | *Does not support the feature at all* |
| *Case 2c* | *Mandatory with/without capability signalling?* |

Similar discussion is held in RAN2 email discussion [Post111-e][913][REDCAP] and following proposals are captured in the latest draft report:

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| **Proposal 1: RedCap UE capabilities can be categorized as:*** **Min capabilities all RedCap UEs support (i.e. mandatory for RedCap UE) if identified;**
	+ **FFS on whether some features are mandatory with signaling for RedCap UE, i.e. IOT bit;**
	+ **It is up to RAN1 on the number of RedCap UE types and whether different RedCap type UEs may support different value for mandatory features;**
* **Optional capabilities (signaled explicitly)**

**Proposal 2: Following scenarios are considered when design the capability signaling for RedCap UE, but FFS on the details, e.g. what each category of features may include:**For the features that are mandatory for non-Redcap UEs, following scenarios are considered: Case1: The Redcap UE mandatorily supports the feature with the same value;Case2: The Redcap UE mandatorily supports the feature, but with different value (e.g. bandwidth value);Case3: The Redcap UE optionally supports the feature;Case4: The Redcap UE does not support the feature at all. For the features that are optional for non-Redcap UEs, following scenario is considered: Case1: The Redcap UE does not support the feature at all.Case 2: The RedCap UE supports the feature with different value;**Proposal 3: Following capability design principle is considered for RedCap UE, but details should be discussed in WI phase:*** **The UE capability requirements for a RedCap device type, that are different from those for non-RedCap UEs, are listed in the specifications. That is:**
	+ **Mandatory features for non-RedCap UE that are not supported for RedCap UE;**
	+ **Mandatory features for non-RedCap UE that are optional for RedCap UE;**
	+ **Mandatory features for non-RedCap UE that are supported for RedCap UE but with different value;**
	+ **Optional features for non-RedCap UE that are not supported for RedCap UE;**
	+ **Optional features for non-RedCap UE that are mandatorily supported for RedCap UE.**

**For a RedCap device type, define new signaling fields in UE Capability for the features that are mandatory w/o capability signaling for non-RedCap UEs but are optional for Redcap UEs, or mandatory with capability signaling for non-RedCap UEs but with different value for RedCap UEs.** |

Therefore, FL thinks that RAN1 can follow the RAN2 discussion and no additional discussion is necessary in this SI in RAN1. Note that the exact components/values for mandatory/optional capabilities for RedCap can be discussed in WI phase.

### **FL proposal#2:**

* **Defer to RAN2 on the signalling of capability classification for RedCap UEs from non-RedCap UEs**
	+ **Exact components/values are discussed in WI phase**

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As shown in the above RAN2 agreement, it is RAN1 task to discuss the exact composition of the set of L1 capabilities of the device type. For high-level, in [1, 3, 13, 14, 18, 19], it is discussed which reduced capabilities should be included in the definition of the RedCap UE types and following alternatives can be considered:

* Alt.1: All the reduced capabilities recommended at the end of the RedCap study: [1]
* Alt.2: Only include the reduced capabilities that the network needs to know during initial access: [1]
* Alt.3: All the recommended reduced capabilities as well as recommended power saving features: [1]
* Alt.4: Minimum (mandatory) capability set: [3, 13, 14, 18, 19]

As there are still divergent views regarding the number of UE types, FL thinks it is beneficial to have common understanding among companies regarding the above aspect and proposes the following:

### **FL proposal#3:**

* **Down select one of the followings to be included in the definition of the RedCap UE types**
	+ **Alt.1: All the reduced capabilities recommended at the end of the RedCap study**
	+ **Alt.2: Only include the reduced capabilities that the network needs to know during initial access**
	+ **Alt.3: All the recommended reduced capabilities as well as recommended power saving features**
	+ **Alt.4: Minimum (mandatory) capability set**

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Note: Companies are also encouraged to show the preferred alternative

In [3, 5, 7, 8, 9, 10, 13, 14, 15, 17, 19], the detail of the exact composition of the set of L1 capabilities of the device type is discussed and following are proposed for the capabilities:

* Maximum supported UE BW: [3, 5, 7, 8, 9, 10, 13, 14, 15, 17, 19]
* Number of Rx/Tx: [5, 7, 8, 9, 10, 13, 14, 15, 17, 19]
	+ and/or number of MIMO layers: [9, 10, 14, 15]
* FD/HD-FDD [3, 10, 14, 15, 19]
* Processing time capability [8, 15, 19]
* Maximum supported modulation order: [3, 9, 14, 19]
* Small form factor in FR1 [7]
* Power saving features [14, 15]
	+ Reduced PDCCH monitoring [14]
	+ Extended DRX for RRC Inactive and/or Idle [14]
	+ RRM relaxation for stationary devices [14]
* Coverage recovery features [14]
* Small data enhancement [15]
* BWP framework [15]
* Configured grant [15]

While concrete evaluation results and corresponding conclusions would be necessary to determine the exact composition, it seems at least the maximum supported UE BW and the number of Rx/Tx have much support and hence, following is proposed:

### **FL proposal#4:**

* **At least maximum supported UE BW and the number of Rx/Tx are included in the set of L1 capabilities of the device type for RedCap**
	+ **FFS others**

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## Number of UE types

In [1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22], how many UE types are defined for RedCap is discussed as follows:

* Only one device type per frequency band: [1, 2, 3, 13, 16 (for FR2), 17, 18, 19, 22]
* Two device types: [4, 5, 10, 11, 14 (for FR1), 21]
	+ low-end use cases (e.g., industrial sensors, economic video, and low-end wearable) and high-end use cases (e.g., high-end wearable and high-end video Surveillance): [4, 11, 12, 21]
	+ At least two if coverage enhancement capability is regarded as a component to be included in the definition of the RedCap UEs: [5]
	+ Type1 (reduced bandwidth, 1 Rx antenna, no DL MIMO support, and HD-FDD (where applicable)) and Type 2 (reduced bandwidth, 2 Rx antennas, and maximum of 2 DL MIMO layers), both for FR1 FDD, either one for others: [10]
* Should be discussed based on the conclusion of UE complexity reduction techniques: [6, 19]
* Focus on the numbers of device types necessary to be defined from RAN operational need [7]
* Further study how the reduced complexity features is associated with each use cases to meet the performance requirement: [15]

It is FL understanding that concrete evaluation results and corresponding conclusions would be necessary to decide the number of UE types, as pointed out by [6, 19], following is proposed at this stage

### **FL proposal#5:**

* **Decide the number of RedCap UE types after concluding UE complexity reduction features in this RAN1 meeting**

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* 1. **Others**

## Coexistence with legacy UE

In [3, 4, 8, 12, 20], coexistence with legacy UE is discussed including:

* Initial access (SSB/CORESET#0/SIB1/initial BWP/PRACH) and paging: [3, 4, 8, 12, 20]
* Efficient Beam-based operation in FR2: [20]
* Efficient resource usage in FR2: [20]
* How to mitigate the PRACH collision in FR2: [20]

As discussed in the last RAN1 meeting, coexistence issue regarding initial access and paging was also discussed in other AIs for RedCap. So this issue should be discussed in the corresponding AIs.

Regarding the 2nd to 4th points, as these issues have been proposed by only one company from the beginning of this SI but no other companies discussed these aspects in their contributions, following is proposed:

### **FL proposal#6:**

* **Studying following coexistence issues is deprioritized in Rel.17 RedCap SI**
	+ **Efficient Beam-based operation in FR2**
	+ **Efficient resource usage in FR2**
	+ **How to mitigate the PRACH collision in FR2**

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| **Company** | **Agree (Y/N)** | **Comments** |
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## Other comments

Comments that do not fit in any of the previous sections of this document but related to AI 8.6.4 can be provided in this section.

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| **Company** | **Comments** |
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* 1. **Topics to be discussed in other AIs**

Potential UE complexity reduction features

In [5], aspect related to potential UE complexity reduction features is discussed, but this should be discussed in AI 8.6.1.

Evaluation methodology

In [22], aspect related to the evaluation methodology is discussed, but this should be discussed in AIs 8.6.1/2/3.

Identification/access control of RedCap UE

In [4, 11, 12, 13, 16, 18, 20], aspect related to identification/access control of RedCap UE are discussed, but this should be discussed in AI 8.6.5.

1. **Conclusion**

To be updated

**Reference**

1. R1-2007532 Framework and principles for RedCap Ericsson
2. R1-2007537 Framework for RedCap UEs FUTUREWEI
3. R1-2007599 Framework and principles for reduced capability devices Huawei, HiSilicon
4. R1-2007671 Framework and Principles for Reduced Capability vivo, Guangdong Genius
5. R1-2007718 Views on Framework and Principles for Reduced Capability ZTE
6. R1-2007865 Framework and principles for reduced capability NR devices CATT
7. R1-2007950 Framework and principles for introduction of RedCap UEs Intel Corporation
8. R1-2008019 Discussion on design principles and definition for RedCap device type CMCC
9. R1-2008051 Consideration on the framework to support reduced capability NR devices LG Electronics
10. R1-2008071 Framework and Principles for Reduced Capability UE Nokia, Nokia Shanghai Bell
11. R1-2008087 Framework and Principles for Reduced Capability Xiaomi
12. R1-2008101 Discussion on Framework and Principles for Reduced Capability Spreadtrum Communications
13. R1-2008173 Framework and Principles for Reduced Capability Samsung
14. R1-2008263 Further considerations on reduced UE capability OPPO
15. R1-2008290 Discussion on Framework and Principles for Reduced Capability Panasonic
16. R1-2008296 Framework and Principles for RedCap Lenovo, Motorola Mobility
17. R1-2008473 Framework and principles for RedCap Apple
18. R1-2008513 On the framework for RedCap UEs MediaTek Inc.
19. R1-2008554 Discussion on framework and principles for RedCap NTT DOCOMO, INC.
20. R1-2008623 Standardization Framework and Design Principles for RedCap Devices Qualcomm Incorporated
21. R1-2008687 Framework and Principles for Reduced Capability InterDigital, Inc.
22. R1-2008741 Framework and principles for RedCap UE Sequans Communications