**3GPP TSG RAN Meeting #96 R1-221163**

**Budapest, Hungary, 6th – 9th June 2022**

**Agenda Item:**  **9.4.1.6**

**Source: Ericsson**

**Title:** **Summary of WI on support of reduced capability (RedCap) NR devices**

**WI code(s): NR\_redcap-Core**

**leading WG: RAN1**

**Release: Rel-17**

### 1 Introduction

This Rel-17 work item introduces support for UE complexity reduction techniques and UE power saving techniques suitable for IoT use cases such as industrial wireless sensors, video surveillance, and wearables, with requirements on low UE complexity and/or low UE power consumption and with relatively relaxed data rate requirements. Following an initial study [1], this work item [2] specified support for a reduced capability (RedCap) UE type and two UE power saving techniques: Extended DRX in RRC idle/inactive state, and RRM measurement relaxation for neighbour cells.

### 2 Description

The following key functionalities are introduced as part of this work item:

**Reduced capability (RedCap) UE type**

The new reduced capability (RedCap) UE type enables reduced UE complexity through various UE complexity reduction techniques. A RedCap UE supports a maximum UE Rx/Tx bandwidth of 20 MHz in FR1 and 100 MHz in FR2 (whereas a normal NR UE supports at least 100 MHz in FR1 and 200 MHz in FR2). A RedCap UE cannot support larger Rx/Tx UE bandwidths than 20 MHz in FR1 and 100 MHz in FR2, and it cannot support features related to carrier aggregation (CA), dual connectivity (DC), more than 2 UE Rx/Tx antenna branches, or more than 2 DL/UL MIMO layers.

A RedCap UE can furthermore have a reduced antenna configuration and a reduced number of DL MIMO layers:

* For FR1, a RedCap UE supports 1 or 2 UE Rx branches and 1 or 2 DL MIMO layers. The supported number of DL MIMO layers is the same as the implemented number of Rx branches, and as a result, 2-Rx RedCap UEs have twice as high DL peak rate as 1-Rx RedCap UEs. The UE indicates to gNB how many branches/layers it supports. The gNB can allow or disallow access from 1-Rx and 2-Rx RedCap UEs separately per cell.
* For FR2, a RedCap UE can either support a legacy UE power class such as PC3 or the new lower UE power class PC7 (with a reduced-complexity reference UE Rx/Tx antenna configuration with either 1 panel with 4 elements or 2 panels with 2 elements each, corresponding to half the number of array elements compared to a legacy PC3 UE). Furthermore, the UE indicates support for 1 or 2 DL MIMO layers (independent of the antenna configuration).

A RedCap UE in FDD mode can report per band whether it implements half-duplex FDD (HD-FDD) or full-duplex FDD (FD-FDD) support. In HD-FDD operation, the UE is not required to transmit and receive at the same time. The network indicates in SIB1 whether the cell supports HD-FDD RedCap UEs.

A RedCap UE can be implemented with or without support for DL 256QAM in FR1. Compared to 64QAM (which is mandatory for RedCap UEs), 256QAM support increases the peak data rate by ~33%. Support for UL 256QAM in FR1 and DL/UL 256QAM in FR2 is also optional for RedCap UEs, but this is true even for legacy NR UEs.

Some higher layer features are optional for RedCap UEs: RedCap UEs can optionally support 16 DRBs (as normal NR UEs) but only have mandatory support of 8 DRBs. RedCap UEs can optionally support 18-bit PDCP/RLC sequence numbers (as normal NR UEs) but only have mandatory support for 12-bit sequence numbers. RedCap UEs have optional (but not mandatory) support for automatic neighbour relation (ANR) functionality.

Due to the reduced UE bandwidth, there are some modifications of the bandwidth part (BWP) operation. Separate initial DL/UL BWPs can be configured for random access for RedCap UEs, which may be required if one or both of the ordinary initial DL/UL BWPs in the cell are configured with a bandwidth which is wider than the maximum RedCap UE bandwidth (i.e., wider than 20 MHz in FR1 or wider than 100 MHz in FR2). A separate initial DL BWP can, but does not need to, contain SSB/CORESET#0/SIB. A DL BWP used in connected mode needs to contain (cell-defining or non-cell-defining) SSB but not necessarily CORESET#0/SIB.

The UE provides an early indication already during random access that it is a RedCap UE. If RedCap-specific PRACH resources are configured in the cell, the early indication is provided implicitly already by Msg1. In any case, an indication will be provided in Msg3 (or MsgA in case of 2-step RACH) in the form of a RedCap-specific LCID value for CCCH.

To minimize UL resource fragmentation for other UEs, the network can choose to disable frequency hopping for the PUCCH transmission carrying HARQ-ACK feedback for Msg4 (similar to how PUCCH frequency hopping can be disabled in connected mode).

**Extended DRX in RRC idle/inactive state**

Extended DRX cycles are introduced for RRC idle state (up to 10485.76 seconds, i.e., roughly 3 hours) and RRC inactive state (up to 10.24 seconds) as an optional feature for both RedCap and non-RedCap UEs. For use cases with relatively relaxed requirements on DL reachability/latency, the network may configure an extended DRX cycle, which may reduce the UE power consumption substantially during periods with large enough packet inter-arrival time.

**RRM measurement relaxation for neighbour cells**

RRM measurement relaxation for neighbour cells is introduced as an optional feature for RedCap UEs that can be enabled by the network. In RRC idle/inactive states, to help reduce UE power consumption, the UE is allowed to further relax neighbour-cell RRM measurements (compared to existing Rel-16 relaxation functionality) when an RSRP/RSRQ-based stationarity criterion is met for a period of time, or when both the stationarity criterion and a not-at-cell-edge criterion are met. In RRC connected state, the network may configure the RSRP/RSRQ-based stationarity criterion and in that case the UE shall report when the criterion is met or no longer met (and how to use the reporting information is up to the network implementation).

### 3 References

[1] [TR 38.875 V17.0.0](https://www.3gpp.org/ftp/Specs/archive/38_series/38.875/38875-h00.zip), “Study on support of reduced capability NR devices”

[2] [RP-220966](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_95e/Docs/RP-220966.zip), “Revised WID on support of reduced capability NR devices”

[3] [RP-221162](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_96/Docs/RP-221162.zip), “Status report for support of reduced capability NR devices”