**3GPP TSG RAN Meeting #102 R1-23xxxx**

**Edinburgh, Scotland, 11th – 15th December 2023**

<guidance: replace the blue text and remove the red guidance information before submission to the TSG meeting;
introduction and description should usually be ~1 page long (not counting figures/tables etc.);

TSG RAN: This template is applicable to all Core part WIs that are not spectrum related and that are 100% complete.
TSG CT/SA: In case this summary covers more than one WI, then please clarify which WIs are covered.

Remember that this summary has to be technically correct otherwise you will have to revise it.>

**Agenda Item:**  **9.3.1.7**

**Source: Ericsson**

**Title:** **Summary of WI on enhanced support of reduced capability NR devices**

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

**Leading WG: RAN1**

**Release: Rel-18**

### 1 Introduction

<guidance:
- summarize in one sentence what was achieved with this WI and how;

- remember that only what ended up in the specs is of interest;

- clarify what is the relation of this WI to other WIs (e.g. is this an enhancement of a former WI? Is there a related WI?) and what was the status before this WI

- clarify why this WI/enhancement was needed/which problem(s) does it solve but stay realistic!>

This Rel-18 work item [1, 2] introduces enhancements of Rel-17 RedCap functionality [3] by introducing features for further UE complexity reduction (through UE peak data rate reduction and UE baseband bandwidth reduction) and further UE power saving (through enhanced eDRX in RRC Inactive state) to expand the market for RedCap use cases with low-tier eRedCap devices similar to LTE UE category 1/1bis, between existing 3GPP LPWA (NB-IoT/LTE-MTC) devices and Rel-17 RedCap devices.

### 2 Description

<guidance:

- summarize the key functionalities of this WI, e.g. in a bullet list and what is their purpose;

- remember that only what ended up in the specs shall be covered here;

- this it not intended to be a copy and paste from the specifications, the WID or status report;

- the reader shall understand how the key functionalities are working without running too far into details;

- use figures, tables, references to illlustrate and facilitate the understanding;

- remember that you do not write the WI summary for people who contributed to this WI so make sure that you use terminology and abbreviations that can be understood by any engineer or make sure you explain them;

- make the following test: give this summary to a colleague who was not at all involved in this topic and let this colleague explain in her/his own words how your WI works after reading the summary>

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

**Further UE complexity reduction (through UE peak data rate reduction and UE baseband bandwidth reduction)**

The Rel-17 RedCap work item [3] introduced a reduced capability (RedCap) UE type which implements one or more UE complexity reduction techniques (reduced maximum UE Rx/Tx bandwidth, reduced number of UE Rx antennas, etc.) to enable NR to efficiently serve midrange IoT use cases (wearables, industrial wireless sensors, video surveillance, etc.).

Rel-18 introduces an **eRedCap UE type** allowing for further complexity reduction using the following techniques [1]:

- UE peak data rate reduction in FR1

- UE baseband bandwidth reduction in FR1

The work item [1] was preceded by a study item documented in [4], where the UE peak data rate reduction is referred to as Option PR1, and the UE baseband bandwidth reduction is referred to as Options BW3/PR3 for PUSCH/PDSCH.

The **UE peak data rate reduction** restricts the peak rate in DL and UL to 10 Mbps. For every eRedCap UE, the peak rate target is 10 Mbps in UL and DL regardless of what other features the UE may support.

- The UE peak data rate reduction is supported with or without UE baseband bandwidth reduction. The initial access procedure for UE peak data rate reduction without UE baseband bandwidth reduction is the same as for UE peak data rate reduction with UE baseband bandwidth reduction.

The **UE baseband bandwidth reduction** restricts the maximum number of PRBs for PDSCH/PUSCH that the UE needs to process per slot. This maximum number of PRBs corresponds to about 5 MHz, or more precisely 25 PRBs for 15 kHz SCS and 12 PRBs for 30 kHz SCS (referred to as ‘25/12 PRBs’ below).

- The restriction on the number of PRBs only affects PDSCH/PUSCH, no other signals/channels.

- For PUSCH, up to 25/12 PRBs can be allocated contiguously within a BWP of up to 20 MHz.

- For unicast PDSCH, up to 25/12 PRBs can be allocated contiguously or distributed within a BWP of up to 20 MHz.

- For broadcast (SIB/paging/Msg2) PDSCH, the number of allocated PRBs is not restricted, i.e., any number of PRBs can be allocated within 20 MHz, but it is assumed that the UE is allowed to serialize its processing of these PRBs if they exceed 25/12 PRBs, so that the UE baseband parts process no more than 25/12 PRBs per slot, meaning that it may take more than one slot for the UE to demodulate and decode the whole PDSCH. For SIB and paging, this is not expected to be a problem. However, to give the UE enough time to process Msg2 PDSCH, it was agreed to specify a relaxed Msg2-Msg3 timeline, which is described below.

- There are some relaxations of the requirements on simultaneous reception of two PDSCHs.

As mentioned above, if a gNB wants to schedule a Msg2 PDSCH with more than 25/12 PRBs, then an eRedCap UE may need a **relaxed Msg2-Msg3 timeline**. This means that the minimum time between Msg2 and Msg3 is increased by 1 slot. A similar relaxation applies in case of 2-step RACH. The relaxed Msg2-Msg3 timeline was motivated by the UE baseband bandwidth reduction, but it has been agreed that it applies to all eRedCap UEs regardless of whether they support UE baseband bandwidth reduction or not.

Similar **early indications** have been specified for eRedCap UEs as for Rel-17 RedCap UEs (in the Uu and F1 interfaces). This means that an eRedCap UE always indicates in Msg3 PUSCH (or MsgA PUSCH in case of 2-step RACH) using special LCID that it is an eRedCap UE, and that it also indicates this in Msg1 PRACH if gNB has configured eRedCap-specific PRACH resources.

Similar **access barring** bits have been specified for eRedCap UEs as for Rel-17 RedCap UEs (in the Uu, Xn, and F1 interfaces). This means that gNB can indicate separately for 1-Rx eRedCap UEs and 2-Rx eRedCap UEs whether they are allowed to access the cell or not.

**Further UE power saving (through enhanced eDRX in RRC Inactive state)**

The Rel-17 RedCap work item [3] introduced extended DRX cycles for RRC Idle state (up to 10485.76 seconds, i.e., ~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 downlink 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.

Rel-18 takes a step further by introducing support for **enhanced eDRX cycle length in RRC Inactive state** beyond 10.24 seconds, up to the same eDRX cycle length as for RRC Idle state (up to 10485.76 seconds, i.e., ~3 hours), making the RRC Inactive state more power-efficient. The RAN/SA work items [1, 5] were started after a study [6] had assessed that this would be feasible.

For eDRX cycles longer than 10.24 seconds, new procedures between RAN and CN have been defined to enable/disable buffering of data and signalling in the CN, based on the RAN configured eDRX cycle and paging time window (PTW). A new RAN paging request is defined from CN to RAN to page the UE in RRC Inactive state based on the long eDRX cycle information. Regarding PTW, different PTW lengths can be configured for RRC Idle state and RRC Inactive state, respectively (in the range 1.28 to 40.96 seconds). The configured eDRX cycle length for RRC Inactive state is upper bounded by the configured eDRX cycle length for RRC Idle state.

### 3 References

<guidance: It is recommended to add some references where the interested reader can find further documentation, e.g.

- last approved WID

- TR (if any)

- last status report (if any)

- CRs

NOTE: Please provide references that can be found easily, e.g. indicating Tdoc numbers.>

[1] [RP-23xxxx](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_102/Docs/RP-23xxxx.zip), “Revised WID on Enhanced support of reduced capability NR devices”

[2] [RP-23xxxx](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_102/Docs/RP-23xxxx.zip), “Status report for Enhanced support of reduced capability NR devices”

[3] [RP-221163](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_96/Docs/RP-221163.zip), “Summary of WI on support of reduced capability (RedCap) NR devices”

[4] [TR 38.865 V18.0.0](https://www.3gpp.org/ftp/Specs/archive/38_series/38.865/38865-i00.zip), “Study on further NR RedCap UE complexity reduction”

[5] [SP-220803](https://www.3gpp.org/ftp/tsg_sa/TSG_SA/TSGS_97E_Electronic_2022-09/Docs/SP-220803.zip), “New WID: 5GS support of NR RedCap UE with long eDRX for RRC\_INACTIVE State”

[6] [TR 23.700-68 V18.1.0](https://www.3gpp.org/ftp/Specs/archive/23_series/23.700-68/23700-68-i10.zip), “Study on support of reduced capability NR devices; Phase 2”

[5] CRs