

The vivo logo is positioned in the top left corner of the slide. The background of the entire slide is a dark blue, abstract image with glowing, fiber-like patterns radiating from a central point, resembling a microscopic view of neural tissue or a complex network.

3GPP TSG RAN Meeting #90e

RP-202637

Electronic Meeting, Dec 7-11, 2020

Views on WID scope for Rel-17 RedCap

Source: vivo

Document for: Discussion & Decision

Agenda Item: 9.1.1

Background

- The Rel-17 “Study on support of reduced capability NR devices” can be considered as completed from RAN1 perspective (TR endorsed in R1-2009850), while the RAN2 study regarding the following objectives is still ongoing until 2021/3
- A follow-up work item to include RAN1 led objectives is expected to be approved in RAN#90e
- In this contribution, vivo’s view on WID scope for Rel-17 RedCap is given

Study UE power saving and battery lifetime enhancement for reduced capability UEs in applicable use cases (e.g. delay tolerant) [RAN2, RAN1]:

- Reduced PDCCH monitoring by smaller numbers of blind decodes and CCE limits [RAN1].
- Extended DRX for RRC Inactive and/or Idle [RAN2]
- RRM relaxation for stationary devices [RAN2]

Study standardization framework and principles for how to define and constrain such reduced capabilities – considering definition of a limited set of one or more device types and considering how to ensure those device types are only used for the intended use cases [RAN2, RAN1].

Study functionality that will allow devices with reduced capabilities to be explicitly identifiable to networks and network operators, and allow operators to restrict their access, if desired [RAN2, RAN1].

High level views

- The RedCap WID to be approved in RAN#90e should only include RAN1 centric objectives, which includes the following aspects
 - UE complexity reduction
 - PDCCH monitoring reduction
 - Coverage recovery
- Study on RAN2 centric items should be continued in 2021Q1 and the related WID objectives are to be included in RAN#91e, which may include the following aspects
 - Additional power saving features, i.e. eDRX, RRM relaxation
 - Standard framework for UE type(s) and/or capability definition
 - Device type identification and access restriction, if desired

Proposal 1: Only RAN1 centric objectives can be included in the Redcap WID to be approved in RAN#90e.

Views on UE complexity reduction features

- BW reduction

Study item recommendation

- *Maximum UE bandwidth:*
 - *Maximum bandwidth of an FR1 RedCap UE during and after initial access is 20 MHz*
 - *Whether an FR1 RedCap UE can optionally support a maximum bandwidth larger than 20 MHz after initial access can be discussed during the WI phase or at RAN plenary.*
 - *Maximum bandwidth of an FR2 RedCap UE during and after initial access is 100 MHz*

High priority scope

- Support of 20MHz UE BW for initial access in FR1
 - Support of larger UE BW after initial access to be discussed further in WI phase
- Support of 100MHz UE BW during and after initial access in FR2

Views on UE complexity reduction features

- UE Rx reduction

Study item recommendation

- *Number of Rx branches:*
 - *For FR1 FDD or FR2 bands where a non-RedCap UE is required to be equipped with a minimum of 2 Rx branches, the minimum number of Rx branches supported by specification for a RedCap UE is 1. The specification also supports of 2 Rx branches for a RedCap UE.*
 - *For FR1 TDD bands where a non-RedCap UE is required to be equipped with a minimum of 4 Rx branches, the minimum number of Rx branches supported by specification for a RedCap UE is N, where N is to be down-selected during the WI phase or at RAN plenary between the following alternatives:*
 - *Alt 1: N=2*
 - *Alt 2: N=1, where N=2 is also supported*
- *Number of DL MIMO layers:*
 - *For a RedCap UE with 1 Rx branch, the maximum number of DL MIMO layers is 1.*
 - *For a RedCap UE with 2 Rx branches, the maximum number of DL MIMO layers is M, where M is to be down-selected during the WI phase or at RAN plenary between the following options (where different options may be selected for FR1 FDD, FR1 TDD, and FR2, respectively):*
 - *Option 1: M=1, where M=2 is also supported*
 - *Option 2: M=2*

Views on UE complexity reduction features

- RAN1 could not reach consensus on Whether to support 1Rx for FR1 TDD bands
- Supporting 1Rx is crucial to enable wearable use cases with form factor limitations.
 - Most of LTE based smart watches in the market are equipped with 1Rx due to implementation challenges, although the LTE specification does not support 1Rx. In addition to 4G, supporting 5G in smart watches will be even more challenging for RF design
 - To support 1Rx UE in specification will ensure the UE performance and consistency and provide an possibility for network/operator to identify the RedCap device (1Rx or 2Rx) according to the capability reporting.
- The performance impact due to introduction of 1Rx RedCap UEs in the network has been carefully studied
- The following were observed from all three companies following RAN1 agreed traffic model (FTP model 3 for eMBB and IM model for RedCap) and scheduling BW assumption (100MHz for eMBB and 20MHz for RedCap)

For burst traffic evaluation with IM traffic model for RedCap users:

- *3 sources (Ericsson, Vivo, Qualcomm) observed that the RedCap users have minor or no impact on spectral efficiency and capacity, and little impact to the performance of co-existing eMBB users in the system*
 - *It is further noted that the 1 Rx RedCap users do not make an appreciable change on the user throughput performance of the eMBB users compared to the 2 Rx RedCap users*
- No coverage issue in FR1 for 1Rx UE for 4GHz with typical gNB PSD (33dBm/MHz) and any other FR1 TDD bands
 - For smart wearables, the compact device form factor will result in high Rx antenna correlations at the UE sides, thus large throughput degradation compared to the ideal antenna assumption (low correlation ensured by sufficient antenna spacing)
 - This aspect is missing in RAN1 performance study so far, see “RP-202642 Performance issues with supporting 2Rx for wearables in FR1” for more details

Views on UE complexity reduction features

- UE Rx reduction

High priority scope

- For FR1 FDD, the minimum number of Rx branches and DL MIMO layer supported by specification for a RedCap UE is 1
 - For FR1 TDD, the minimum number of Rx branches and DL MIMO layer supported by specification for a RedCap UE is 1
 - For FR2, the minimum number of Rx branches and DL MIMO layer supported by specification for a RedCap UE is 1
 - For RedCap UEs capable of 2Rx branches, to discuss further in the WI phase about the minimum number of supported DL MIMO layer, i.e. 1 or 2 layers.
- Other complexity reduction features

High priority scope

- Support relaxation of modulation in FR1 DL (256QAM -> 64QAM) (as recommended in the SI)

Low priority scope

- Relaxed UE processing time in terms of N_1 and N_2 by specification for a RedCap UE.
- HD-FDD operation type A support for an FR1 FDD RedCap UE.

Views on UE power saving features

- Power saving is very important for most of Redcap use cases
- PDCCH monitoring reduction has been studied during SI phase, it was proved to be feasible to reduce UE power consumption with insignificant system performance impact, i.e. small blocking rate increase

High priority scope

- Specify PDCCH monitoring reduction scheme(s) to obtain smaller BD numbers, with target for minimized increment of PDCCH blocking rate.
 - eDRX and RRM relaxation are expected to be added in RAN#91e

PDCCH blocking rate vector format:

Each observation below for PDCCH blocking rate impact based on the evaluation results in [3] is formulated using the vector format: $\langle N, A\%, [z1\%, x1\%, y1\%], [z2\%, x2\%, y2\%] \rangle$, which represents the following: With N simultaneously scheduled UEs in a slot and $z1\%$ reduction in maximum PDCCH blind decoding, the PDCCH blocking rate is increased approximately $x1\%$ from $A\%$, which corresponds to $y1\%$ increase relative to $A\%$. With N simultaneously scheduled UEs in a slot and $z2\%$ reduction in maximum PDCCH blind decoding, the PDCCH blocking rate is increased approximately $x2\%$ from $A\%$, which corresponds to $y2\%$ increase relative to $A\%$.

PDCCH blocking rate for FR1:

Evaluation results of PDCCH blocking rate were reported for FR1 with AL distribution configuration 'A1' in Table 6.2-5 and the baseline evaluation parameters in Table 6.2-4. Based on Table B.1-1, the observations from these evaluation results are summarized as follows:

10 sources (Vivo, Ericsson, Qualcomm, Nokia, Huawei/HiSilicon, InterDigital, Intel, ZTE, Samsung, Futurewei) reported the following evaluation results:

- $\langle 2, 1.63\%, [25\%, 0.39\%, 23.9\%], [50\%, 0.77\%, 47.11\%] \rangle$
- $\langle 3, 2.70\%, [25\%, 0.71\%, 30.85\%], [50\%, 1.28\%, 47.26\%] \rangle$
- $\langle 4, 3.22\%, [25\%, 0.99\%, 30.85\%], [50\%, 4.35\%, 135.32\%] \rangle$
- $\langle 5, 4.07\%, [25\%, 1.98\%, 48.68\%], [50\%, 6.81\%, 167.16\%] \rangle$

Views on coverage recovery features

- Based on the agreed methodology, following has been observed for RedCap UEs
 - In FR1 UL: coverage gap for PUSCH and MSG3 observed, no coverage gap for other channels
 - In FR1 DL:
 - Moderate coverage gap for PDCCH CSS (1dB) and MSG 4 (2~3dB) observed only in 4GHz, 1Rx UE and reduced gNB PSD (24dBm/MHz)
 - No coverage gap observed in 4GHz with 1Rx UE and normal gNB PSD (33dBm/MHz)
 - No coverage gap observed in any other FR1 bands
 - In FR2 DL&UL: No coverage issue identified
- High priority scope
 - For PUSCH and MSG 3, to leverage the solutions in coverage enhancement WI for a common solution across UE types.
 - No explicit objective in RedCap WID
- Low priority scope
 - For PDCCH CSS and MSG4, if agreed
 - Prefer to also leverage the solutions in coverage enhancement WI for a common solution across UE types
 - No explicit objective in RedCap WID
- No need
 - Msg 2 PDSCH (existing TBS scaling method is sufficient)
 - No issue identified: SSB, PRACH, PUCCH, PDSCH, etc

Proposals

- **Proposal 1:** Only RAN1 centric objectives can be included in the Redcap WID to be approved in RAN#90e.
- **Proposal 2:** For UE BW reduction
 - Support of 20MHz UE BW for initial access in FR1
 - Support of larger UE BW after initial access to be discussed further in WI phase
 - Support of 100MHz UE BW during and after initial access in FR2
- **Proposal 3:** For UE Rx reduction
 - For FR1 FDD, the minimum number of Rx branches and DL MIMO layer supported by specification for a RedCap UE is 1
 - For FR1 TDD, the minimum number of Rx branches and DL MIMO layer supported by specification for a RedCap UE is 1
 - For FR2, the minimum number of Rx branches and DL MIMO layer supported by specification for a RedCap UE is 1
 - For RedCap UEs capable of 2Rx branches, to discuss further in the WI phase about the minimum number of supported DL MIMO layer, i.e. 1 or 2 layers.
- **Proposal 4:** Support relaxation of modulation in FR1 DL (256QAM -> 64QAM)
- **Proposal 5:** Specify PDCCH monitoring reduction scheme(s) to obtain smaller BD numbers, with target for minimized increment of-PDCCH blocking rate.
- **Proposal 6:** for coverage recovery
 - For PUSCH and MSG 3, to leverage the solutions in coverage enhancement WI for a common solution across different UE types.
 - No explicit objective in RedCap WID
 - For PDCCH CSS and MSG4, if agreed for coverage recovery
 - Prefer to also leverage the solutions in coverage enhancement WI for a common solution across different UE types
 - No explicit objective in RedCap WID

THANK YOU.

谢谢。