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

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

**Agenda item:** 8.6.3

**Source:** Moderator (Qualcomm Inc.)

**Title:** FL summary #9 on Coverage Recovery and Capacity Impact for RedCap

**Document for:** Discussion and Decision

# Introduction

This contribution summarizes the contributions submitted to AI 8.6.3 (Study on NR reduced capability devices – coverage recovery and capacity impact).

This document captures the following RAN1#103e RedCap email discussion.

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| [103-e-NR-RedCap-04] Email discussion for coverage recovery and capacity impact– Chao (Qualcomm)* + Recovery: email extension till 11/17, focusing on “TR clause 9.1: TP for coverage recovery observation for FR2 indoor scenario”
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In this round of the email discussion, please check the proposals/questions tagged ‘FL9’ (search for ‘FL9’).

# Coverage Recovery

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| Agreements:* For FR2 indoor scenario, the representative value is derived based on results for max TRP 12 dBm. The aggregated value for UL channels has then been obtained by considering
	+ Results presented by companies assuming max TRP 12 dBm; and
	+ Results presented by companies assuming max TRP 23 dBm, where corresponding MIL values have been reduced by 11 dB, and each company is counted only once (no double value is considered, if any).

Agreements:* Capture the following observations for FR2 coverage recovery to the TR 38.875
	+ For FR2, there is no assumption of reduced antenna efficiency for RedCap UE and the MIL of the UL channels is the same as the reference NR UE and coverage recovery for UL channels is not needed.
	+ [For RedCap UE with 100 MHz BW and 1Rx, although there is performance loss from reducing the number of Rx branches to 1, the MIL(s) of all the DL channels is better that that of the bottleneck channel for the reference NR UE and coverage recovery for DL channels is not needed. ]
	+ For RedCap UE with 50MHz BW and 1Rx, coverage recovery may be needed for PDSCH when the same target data rate as the reference NR UE is assumed, and the amount of coverage recovery to be considered is approximately [2-3 dB]
		- The tradeoff between data rate and coverage can be considered and the amount of coverage recovery may depend on this choice.
	+ The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the target for coverage recovery
		- E.g. coverage recovery may not be needed for FR2 indoor scenario when the target is based on an MPL value from a target ISD of 20m
		- ~~E.g. a large amount of coverage recovery may be needed for the initial access channels if the target is to achieve the same coverage for the initial access channels between RedCap UE and the reference NR UE~~
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**[FL8] Proposal 3.4-2:**

* Observations for FR2 coverage recovery can be drawn separately for max TRP 12 dBm and max TRP 23 dBm

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| **Company** | **Y/N** | **Comments** |
| vivo | N | We prefer to use the same way as in CE, i.e. based on TRP 12dBm, otherwise, it may be inconsistent between different items.  |
| Samsung  | Y | Separate observations seem reasonable. |
| Futurewei | N | Prefer to have one assumption on max TRP |
| Intel | Y | The main reason to go with single observation based on 12dBm is to align with CE. However, RedCap is quite different from CE. - For CE, it is to enhance the coverage of UE using maximum 12dBm TX power, while the coverage of UE with 23dBm max TX power is maintained (i.e. at least not worse for reference UE). - On the contrary, if we only consider RedCap UE with max 12dBm Tx power, it means such UE can be enhanced to be no worse than reference UE. However, a RedCap UE with max 23dBm TX power is still worse than reference UE. Such a problem should be avoided.  |
| Ericsson | Y | We are fine either way. |
| Qualcomm | Y |  |
| Nokia, NSB |  | We have no strong view here and are fine either way. |
| MediaTek | Y |  |
| Huawei, HiSilicon | N | Prefer to align with CovEnh SI. |

Based on the received responses for **[FL8] Proposal 3.4-2**, there is no consensus to support separate observations for max TRP 12 dBm and 23 dBm. From FL’s understanding, the max TRP value will also affect the reference NR UE since we use the same Tx power for both RedCap and the reference NR UE. We will observe a different bottleneck channel for the reference NR UE with max 12 dBm and 23 dBm TX power and the corresponding MIL value for coverage recovery target is also different. That is, the current observation that the DL channels of the RedCap UE is not coverage limited as compared to the bottleneck channel of the reference NR UE is due to max 12 dBm Tx power used for the reference NR UE. However, we have not captured such information clearly in the observations.

Considering that we have agreed to use max TRP 12 dBm, the FL’ suggestion is to adopt the TP for max TRP 12dBm but update the observation to clarify the max TRP assumption used for the reference NR UE.

**[FL9] Proposal:**

* Adopted the updated TP in section 3.4 of R1-2009722 as baseline text for TR clause 9.1
* Adopt the following update to observations for FR2 indoor coverage recovery

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| * Capture the following observations for FR2 coverage recovery to the TR 38.875
	+ For FR2, there is no assumption of reduced antenna efficiency for RedCap UE and the MIL of the UL channels is the same as the reference NR UE and coverage recovery for UL channels is not needed.
	+ ~~[~~For RedCap UE with 100 MHz BW and 1Rx in FR2 indoor scenario, although there is performance loss from reducing the number of Rx branches to 1, the MIL(s) of all the DL channels is better that that of the bottleneck channel for the reference NR UE, for which max TRP 12dBm is assumed, and coverage recovery for DL channels is thus not needed.~~]~~
	+ For RedCap UE with 50MHz BW and 1Rx, coverage recovery may be needed for PDSCH when the same target data rate as the reference NR UE is assumed, and the amount of coverage recovery to be considered is approximately [2-3 dB]
		- The tradeoff between data rate and coverage can be considered and the amount of coverage recovery may depend on this choice.
	+ The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the target for coverage recovery and/or max TRP for the reference NR UE
		- E.g. coverage recovery may not be needed for FR2 indoor scenario when the target is based on an MPL value from a target ISD of 20m
		- ~~E.g. a large amount of coverage recovery may be needed for the initial access channels if the target is to achieve the same coverage for the initial access channels between RedCap UE and the reference NR UE~~
		- E.g. coverage recovery for DL channels may be needed for RedCap UE with 100 MHz BW and 1Rx when max TRP 23 dBm is assumed for the reference NR UE
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**If not, what modification is needed?**

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| **Company** | **Y/N** | **Comments** |
| vivo | Y |  |
| Samsung | Y |  |
| Intel | Y | We still prefer to have separate observations on UE with max TRP 23dBm. In our understanding, the previous agreement on observation of max TRP 12dBm does not exclude another observation on max TRP 23dBm.However, since the remaining time for discussion is rather limited, we can accept [FL9] Proposal for progress. Some suggestion for update- It is better to clarify that the third bullet is based on max TRP 12dBm too. - for the last sentence, we think it is better to delete ‘for the reference NR UE’, since both reference UE and RedCap UE use 23dBm in the example. * E.g. coverage recovery for DL channels may be needed for RedCap UE with 100 MHz BW and 1Rx when max TRP 23 dBm is assumed ~~for the reference NR UE~~
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| LG | Y |  |
| ZTE | Y | We are also fine with Intel’s revision.  |
| Nokia, NSB | Y |  |
| Futurewei |  | Considering that we have agreed to use max TRP 12 dBm in RedCap we prefer to remove the last bullet as it may result in unnecessary coverage enhancements due to it being based on the 23 dBm. However, we can accept the following for the sake of progress, which states the exact channels that require compensation according to the FL summary table in our study. * + - E.g. coverage recovery for some DL channels may be needed for RedCap UE with 100 MHz BW and 1Rx when max TRP 23 dBm is assumed for the reference NR UE (~1dB for Msg 2/4, ~3dB for PDSCH)
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| MediaTek | Y |  |
| InterDigital | Y |  |
| Ericsson | Y | We are fine with the FL9 proposal. But one minor suggestion for clarify. It might be good to revise the last sub-bullet to“E.g. coverage recovery for DL channels may be needed for RedCap UE with 100 MHz or 50 MHz BW and 1Rx when max TRP 23 dBm is assumed for the reference NR UE”The current formulation may give an impression that only the 100 MHz BW option may need coverage recovery for DL channels, but not the 50 MHz option.  |
| Qualcomm | Y | We still think that observations for both UE max TRP of 12 dBm and 23 dBm are required, however, for the sake of progress and the limited time to complete the SI, we can accept the updated FL’s text proposal.We however suggest the following addition to the last sub-bullet:E.g. coverage recovery for some DL channels may be needed for RedCap UE with 100 MHz BW (e.g. Msg2/4, PDSCH) or 50 MHz BW (e.g. Msg2/4, PDSCH, PDCCH) and 1Rx when max TRP 23 dBm is assumed for the reference NR UE |
| FL | It seems most of responses are fine with the FL’s proposal. The only concern is on the last sub-bullet and it was proposed to state exact channels that require compensation and also include the 50MHz case.There could be two alternatives for the revision of the last sub-bullet. The second alternative has more details on the amount of coverage recovery, which is from the FL summary based on mixed results of 12 dBm and 23 dBm. From FL’s perspective, there is no much difference between the two alternatives and the first alternative is slightly preferred.Alt. 1: E.g. coverage recovery for some DL channels may be needed for RedCap UE with 100 MHz BW (e.g. Msg2/4, PDSCH) or 50 MHz BW (e.g. Msg2/4, PDSCH, PDCCH) and 1Rx when max TRP 23 dBm is assumed for the reference NR UEAlt. 2: E.g. coverage recovery for some DL channels may be needed for RedCap UE with 100 MHz BW or 50 MHz BW and 1Rx when max TRP 23 dBm is assumed for the reference NR UE (e.g. ~1dB for Msg 2/4, ~3dB for PDSCH for 100 MHz BW and 1Rx) Regarding the comment to remove the “reference NR UE” in the last bullet, FL thinks the example can be applied to both RedCap with max TRP 12 dBm and 23 dB. If we remove the reference NR UE, it may be mis-understood that 23 dBm TRP is only for RedCap UE. Also, for the third bullet, the observation can be applied to both 12 and 23 dBm. Therefore, the FL’s suggestion is to keep the current wording. |
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# References

1. R1-2008865 Coverage recovery and capacity impact for RedCap Ericsson
2. R1-2007536 Coverage recovery for RedCap FUTUREWEI
3. R1-2008813 Functionality for coverage recovery, Huawei, HiSilicon
4. R1-2007670 Discussion on coverage recovery, capacity and spectrum efficiency impact, vivo, Guangdong Genius
5. R1-2007717 Discussion on coverage recovery for RedCap UE ZTE
6. R1-2007864 Coverage recovery for reduced capability NR devices CATT
7. R1-2007889 Coverage recovery and capacity impact TCL Communication Ltd.
8. R1-2007949 On coverage recovery for RedCap UEs Intel Corporation
9. R1-2009217 Coverage Recovery and Capacity Impact Panasonic Corporation
10. R1-2008018 Discussion on coverage recovery for RedCap UEs CMCC
11. R1-2008050 Discussion on the coverage recovery of reduced capability NR devices LG Electronics
12. R1-2008070 Functionality for coverage recovery Nokia, Nokia Shanghai Bell
13. R1-2008086 Discussion on coverage recovery for reduced capability device Xiaomi
14. R1-2008102 Discussion on coverage recovery and capacity impact Spreadtrum Communications
15. R1-2008172 Coverage recovery for low capability device Samsung
16. R1-2008262 Discussion on coverage recovery issues and evaluation OPPO
17. R1-2009173 Coverage recovery for RedCap Lenovo, Motorola Mobility
18. R1-2008367 Coverage recovery for Redcap devices Sony
19. R1-2008396 Coverage recovery for reduced capability UEs Sharp
20. R1-2008472 Functionality for Coverage Recovery for RedCap Apple
21. R1-2008512 Discussion on coverage recovery for NR RedCap UEs MediaTek Inc.
22. R1-2008518 On coverage recovery for reduced capability UEs Convida Wireless
23. R1-2008553 Discussion on coverage recovery for RedCap NTT DOCOMO, INC.
24. R1-2009310 Coverage Recovery for RedCap Devices Qualcomm Incorporated
25. R1-2008686 Coverage recovery for reduced capability NR devices InterDigital, Inc.
26. R1-2008728 Discussion on Coverage Recovery for RedCap UE WILUS Inc.
27. R1-2008740 Coverage recovery for RedCap UE Sequans Communications

# Appendix