**3GPP TSG RAN WG1 #102-e R1-20XXXXX**

**e-Meeting, August 17th - 28th, 2020**

**Agenda item:** 8.6.3

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

**Title:** FL summary #3 on Coverage Recovery and Capacity Impact for NR RedCap

**Document for:** Discussion/decision

# Introduction

This document captures the RAN1#102-e email discussion [102-e-NR-RedCap-03] under the AI 8.6.3 (Study on Support of Reduced Capability NR Devices: coverage recovery and capacity impact).

[102-e-NR-RedCap-03] Email discussiona/approval – Chao (Qualcomm)

* By 8/20 – high priority
* By 8/26 – medium
* By 8/28 – last check

FL summary #1 was provided in [R1-2007091](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/R1-2007091.zip), and the updated FL summary #2 was provided in [R1-2007153](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/R1-2007153.zip). The following agreements were made via email:

Agreements

For the channel(s) affected by complexity reduction, the following methodology can be used to determine the target performance for coverage recovery

* Step 1: Obtain the link budget performance of the channel based on link budget evaluation
* Step 2: Obtain the target performance requirement for RedCap UEs within a deployment scenario
  + FFS on the target performance requirement
* Step 3: Find the coverage recovery value for the channel if the link budget performance is worse than the target performance requirement

Agreements:

* Link budget evaluation for RedCap should include at least PDCCH/PDSCH and PUCCH/PUSCH

Agreements:

* For initial access related channels, at least Msg2, Msg3, Msg4 and PDCCH scheduling Msg2/4 are included for link budget evaluation
  + Other initial access related channels are not precluded

Agreements:

* The impact of small form factor is considered for all the uplink and downlink channels
  + A 3dB loss of antenna gain is included in link budget calculation for FR1
    - FFS on the application to both FDD and TDD bands or only FDD bands

The following agreements were made in an online (GTW) session:

**Agreements**: Down-selection on the following options for the target performance requirement for RedCap UEs in RAN1#103-e (aim for early in the e-meeting):

* Option 1: The target performance requirement for each channel is identified by a target MCL or MIL or MPL within a reasonable deployment
* Option 3: The target performance requirement for each channel is identified by the link budget of the bottleneck channel(s) for the reference NR UE within the same deployment scenario
  + Note: The “bottleneck channel(s)” are the physical channel(s) that have the lowest MCL or MIL or MPL
* The details for the target performance requirement are FFS

Agreements: For RedCap UE, adopt the following target data rates for link budget evaluation for FR1 Rural.

* 1 Mbps on DL and 100kbps in UL

Agreements: For RedCap UE, down-selection on the following target data rates for link budget evaluation for FR1 Urban.

* 2 Mbps on DL and 1Mbps in UL

Note: The 2Mbps target data rate in downlink is the scaled value of the 10Mbps in the CE SI by a factor of 0.2

Agreements: For RedCap UEs, the target data rates for link budget evaluation for FR2 are as follows:

* 25Mbps for BW 50MHz/100MHz on DL and 5Mbps in UL
  + Optionally, 12.5Mbps for BW 50MHz as the target data rate for DL, assuming the same DL PSD as that of BW 100MHz
  + Note: in case of 50MHz BW, the maximum supported DL data rate is half that of the 100MHz BW in DL

This version of the document contains the medium priority proposals to be discussed till 8/26.

# Evaluation methodology

## Issue #1: FFS on the bands for antenna gain loss

For the following agreement, the application of the 3dB antenna loss to FR1 bands has not been agreed. During the offline discussion, it was proposed to solve the FFS as early as possible since it may have an impact on the link budget analysis.

Agreements:

* The impact of small form factor is considered for all the uplink and downlink channels
  + A 3dB loss of antenna gain is included in link budget calculation for FR1
    - FFS on the application to both FDD and TDD bands or only FDD bands

Since the majority view is to apply the antenna gain loss to all the FR1 bands including both FDD and TDD, the following proposal is made.

**Moderator’s proposal**

* The antenna gain loss due to the small form factor is applied to all the FR1 bands

Please input your view on the moderator proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Fine with this proposal. |
| vivo | Agree the moderator proposal. |
| Intel | Fine with the FL proposal |
| DOCOMO | Agree with the proposal |

## Issue #2: scenario and frequency for link level evaluation

**Question 3: Should the link level coverage evaluation for the RedCap study consider only the scenario and frequency agreed in the RAN1-101e?**

Regarding **Question #3**, most responses seem to support the scenario and frequency agreed in RAN1-101-e meeting. Several responses also indicated the 4GHz Urban scenario should be also discussed although it has lower priority than 2.6GHz. One response pointed out that other scenario and frequency should not be precluded if company has interest to evaluate it.

Considering the above summary, the moderator proposes to close the discussion on the scenario and frequency for link level evaluation

## Issue #3: other common LLS parameters

**Question 7: For the common LLS parameters, can the RedCap study adopt the CE agreement on the number of gNB TX and RX chains, channel model, delay spread and antenna correlation? If not, what modifications are needed?**

Regarding **Question #7**, most responses seems to agree to align with the CE SI assumptions if applicable, and several responses indicate that there are a few additional assumptions not covered in the CE agreements and also some parameters such as the number of antennas and BW need to be adapted for the RedCap.

**Moderator’s proposal**

* For RedCap coverage evaluation, the Rel-17 CE SI agreements on gNB antenna configuration, channel model and delay spread are reused with the following revision and/or addition

|  |  |  |
| --- | --- | --- |
| **Parameters** | **FR1 values** | **FR2 values** |
| Channel model | TDL-C | TDL-A |
| Delay spread | 300ns | 30ns |
| UE velocity | 3 km/h | 3 km/h |
| Antenna correlation | Low | Low |
| # gNB Tx chains | 4 | 2 |
| # gNB Rx chains | 4 | 2 |

* For RedCap coverage evaluation, adopt the following table for the reference NR UE.

|  |  |  |
| --- | --- | --- |
| **Parameters** | **FR1 values** | **FR2 values** |
| # UE Tx chains | 1 | 1 |
| # UE Rx chains | Urban: 4 and Rural: 2 | 2 |
| UE BW | Urban: 100 MHz (273 PRBs)  Rural: 20 MHz (106 PRBs) | 100 MHz (66 PRBs) |

* For RedCap coverage evaluation, adopt the following table for the RedCap UE.

|  |  |  |
| --- | --- | --- |
| **Parameters** | **FR1 values** | **FR2 values** |
| # UE Tx chains | 1 | 1 |
| # UE Rx chains | 1 or 2 | 1 or 2 |
| UE BW | Urban: 20 MHz (51 PRBs)  Rural: 20 MHz (106 PRBs) | 50 MHz (32 PRBs) or  100 MHz (66 PRBs) |

Please input your view on the moderator’s proposal.

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Fine with this proposal |
| vivo | For gNB Tx and Rx chains in FR1, there are two options provided in CE SI (RAN1#101-e agrement), as follows  ~~[~~gNB modeling in LLS for TDL:   * Option 1: 2 or 4 gNB receive chains in LLS ~~(as starting point)~~. FFS: correlation   In Option 1, both 2 or 4 gNB receiver chains are considered. We suggest to align with that in CE, companies can report the number of Tx/Rx chains in evaluation. |
| Intel | Fine with this proposal |
| DOCOMO | While we still prefer to include 4GHz case in Issue #2, we can live with the conclusion from moderator.  In that sense, we can agree with the proposal. |

## Issue #4: channel specific LLS parameters

**Question 8: For the channel specific LLS parameters other than target data rates, can the RedCap study reuse the link-level simulation assumptions adopted by the Rel-17 CE SI? If not, what modifications are needed?**

Regarding **Question #8**, most responses seems to support reusing the CE agreements for the RedCap in general with some changes on the TBS, MCS, and MIMO layers. It is also noted that the evaluation of Msg2 is not supported in the Rel-17 CE SI, and therefore the moderator proposes to discuss and decide the evaluation assumptions for Msg2.

**Moderator’s proposal**

* For RedCap coverage evaluation, reuse the Rel-17 CE SI agreements on channel specific parameters with the following revision and/or addition
  + TBS/PRB/MCS of PDSCH/PUSCH for the RedCap UE are based on the agreed target data rates and reported by companies
  + Adopt the following table for Msg2

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Payload size | 9 bytes |
| PDSCH duration | 12 OS |
| DMRS configuration | Type I, 3 DMRS symbol, no multiplexing with data |
| Number of PRBs | 3 |
| Waveform | CP-OFDM |
| HARQ configuration | No retransmission |

Please input your view on the moderator’s proposal.

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | We suggest revising -  “TBS/PRB/MCS of PDSCH/PUSCH for the RedCap UE are based on the agreed target data rates and reported by companies”  to  “TBS/PRB/MCS of PDSCH/PUSCH for the RedCap UE are based on the agreed target data rates or message sizes and reported by companies”.  This revision is to cover Msg3 and Msg4. |
| vivo | We are fine with the FL proposal. |
| Intel | We are fine with the FL proposal. |
| DOCOMO | Agree with the proposal. Also fine with the update from Ericsson. |

## Issue #5: LB template and performance metric

**Question 9: For link budget template, should the RedCap study reuse/align the link budget template with the CE SI? If not, what modifications are needed?**

Regarding **Question #9**, most responses seems to be okay to reuse/align the link budget template with the CE SI although 8 responses have a preference on Option 1. One response also indicates the antenna array gain should be reflected also in the link budget when the array gains for all the DL channels are different and required to evaluate.

It is noted that the CE SI has made the following agreements on LB template, antenna array gain and performance metric. Therefore, the following proposal is made.

Agreements (for both FR1 & FR2):

* For the definition of antenna array gain, adopt option 1, i.e. Antenna array gain is included in the link budget template, where there are four antenna gain components
  + Note: the four components are illustrated below – the figure is for illustration purpose only
  + FFS which component(s) are NOT part of the definition of antenna array gain



Agreements:

* Adopt single link budget template for both FR1 and FR2 based on IMT-2020 self-evaluation with rows for MIL, MCL, MPL, and necessary revisions, including adding/removing/revising/simplifying some parameters
  + [For LLS based methodology, ]coverage bottleneck(s) identification is performed using at least [MCL and] MIL.
  + [MCL values can also be considered to compare channels with similar antenna (and antenna array) gain]

**Moderator’s proposal**

* For RedCap coverage analysis, the agreements in the Rel-17 CE SI regarding link budget template, antenna array gain and performance metrics are reused.

Please input your view on the moderator’s proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are fine with this proposal. |
| vivo | We checked the agreements made in this meeting, and the definition for MCL, MIL and MPL are given as follows. For MCL definition, the UE antenna gain is not included in the metric, and the coverage reduction due to UE antenna gain loss is not reflected in MCL metric. Therefore, MCL is not preferred in coverage analysis for RedCap, regardless of what the agreements made in CE SI.   * For TDL Option 1   + Definition of MCL     - Total transmit power - Receiver sensitivity + gNB antenna gain (component 2)   + Definition of MIL     - Total transmit power - Receiver sensitivity + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain   + Definition of MPL     - Further discussion offline the definition using below as a starting point:       * Total transmit power - Receiver sensitivity + gNB antenna array gain (component 2+3+4 for TDL option 1) + UE antenna gain - (8) Cable, connector, combiner, body losses (Tx side) - (20) Receiver implementation margin + (21a/b) H-ARQ gain - (25a/b) Shadow fading margin + (26) BS selection/macro-diversity gain - (27) Penetration margin + (28) Other gains – (12) Cable, connector, combiner, body losses (Rx side)   + Note: whether/how to use the above definitions is to be discussed |
| Intel | We are supportive to the FL proposal |
| DOCOMO | Agree with the proposal |

## Issue #6: SLS parameters

**Question 11: For evaluating the impact of network capacity and spectrum efficiency, can the RedCap study use the assumption in TR 38.802, Table A.2.1-1 as the starting point?**

Regarding **Question #11**, most responses seems to support to use the assumption in TR 38.802, Table A.2.1-1 as a starting point. One response indicates a preference to the methodology of ITU-2020 self-evaluation and use the assumption in TR 37.910. Several responses also pointed out that the scenario, traffic model and the percentage of RedCap UEs should be clarified also. One response proposes to de-prioritize the SLS for now.

**Question 12: Can the system level evaluation focus on the downlink capacity and down-prioritization of the uplink capacity?**

Regarding **Question #12**, most responses seems to be okay with prioritize the downlink, and 4 responses also pointed out that uplink capacity should also be evaluated to see potential impact from complexity reduction techniques and reduced antenna efficiency. One response proposes to de-prioritize the SLS for now.

In the moderator’s view, the assumption in TR 38.802, Table A.2.1-1 is also the baseline for the IMT-2020 self-evaluation, which includes a long list of parameters and some of them may not be relevant to the RedCap study. It is preferable to have a simple assumption for SLS evaluation with agreements only on key parameters such as scenario, ISD, traffic model, and percentage of RedCap UEs. Other parameters can be reported by companies.

Regarding the scenario, dense Urban for FR1 was proposed in all the four contribution [3, 4, 18, 32], and the rural scenario for FR1 is also proposed in the two contributions [4, 18]. For FR2, only one contribution proposed to consider indoor hotspot. Considering the simulation efforts, the moderator proposes to consider at least the dense Urban for FR1 and indoor hotspot for FR2.

Regarding the inter-BS distance for dense Urban, one contribution [3] has a preference to 500m, and one contribution has a preference on 200m. The moderator proposes to further discuss the value and make a down-selection if needed.

For traffic pattern, one contribution [4] proposes to consider full buffer while two contributions [3, 32] propose to consider the burst traffic for evaluation. Additionally, the contribution [32] proposes to consider the realistic traffic model, e.g. using FTP traffic model 3 for normal UEs and the IM traffic model for RedCap UEs, which has been agreed in power saving evaluation for RedCap. The moderator proposes to further discuss and make a down-selection if needed.

For the percentage of RedCap, a different ratio of 0, 25%, 50%, 75% and 100% is considered in [4], while it is assumed in [32] that up to 50% of total users in the system can be RedCap users. The moderator proposes to further discuss and make a down-selection if needed.

**Moderator’s proposal**

* For SLS based capacity evaluation, use the assumption in TR 38.802, Table A..2.1-1 as the baseline.
* For calibration purposes, the following settings can be used:

|  |  |  |
| --- | --- | --- |
| **Parameters** | **FR1 values** | **FR2 values** |
| Layout | Single layer Macro layer: Hex. Grid | Single layer  Indoor floor: (12BSs per 120m x 50m)  Candidate TRP numbers: 3, 6, 12 |
| Inter-BS distance | [200 or 500m] | 20m |
| Scenario and frequency | Dense Urban:  2.6 GHz (TDD) (primary choice)  4 GHz (TDD) (secondary choice) | Indoor: 28 GHz (TDD) |
| Frame structure for TDD | For 2.6 GHz:  DDDDDDDSUU (S: 6D:4G:4U)  For 4 GHz:  DDDSUDDSUU (S: 10D:2G:2U) | DDDSU (S: 10D:2G:2U) |
| Channel model | 3DUma | 5GCM office |
| UE distribution | 20% Outdoor in cars: 30km/h, 80% Indoor in houses: 3km/h | 100% Indoor: 3km/h |
| Traffic model | Option 1: Full buffer  Option 2: Burst traffic, e.g. FTP traffic model 3 for the reference NR UEs and the IM traffic model for RedCap UEs | |
| Traffic load | 10 users per cell for full buffer traffic model  25%, 50% and 80% loading (resource utilization) for burst traffic model | |
| Percentage of RedCap UEs among total number of UEs  Note: Other UEs are the reference NR UEs | [0], [25%], [50%], [75%], [100%] | |

Please input your view on the moderator’s proposal, including the revision/additional for any parameter.

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | It might be good to also include 700 MHz scenario so that the impact from UE antenna reduction, 2 Rx to 1 Rx, on spectral efficiency and capacity is studied.  Regarding channel models, we suggest using the ITU channel models according ITU M.2412.   * 700 MHz: RMa\_B * 2.6GHz/4GHz: UMa\_B * 28 GHz: InH\_B   It would be good to clarify that 10 users per cell include both RedCap and reference NR UEs.  Regarding “percentage of RedCap UEs among total number of UEs”, we think it is enough to evaluate [0], [25%], and [50%], as these settings already cover the most likely scenarios. |
| vivo | 1. For traffic model, we think down-selection should be made. Typically we use non-full buffer traffic model for system performance evaluation, for eMBB and RedCap UE, it is hard to imagine a case with full buffer traffic. Therefore we strongly prefer to adopt option 2.  One clarification for option 2 is that we can reuse the traffic mode from 38.840, copied below for reference.    Note that we have following agreement in 8.6.2, therefore it make much sense to keep consistent traffic model across different agenda items for RedCap.  Agreements:  For power saving evaluation of RedCap UEs:   * Reuse the Instant message traffic model from TR 38.840 as baseline. Other ~~Instant~~ traffic models based on FTP model 3 are not precluded and companies to report the mean inter-arrival time and packet size if other ~~instant~~ traffic models are assumed in evaluation. * FFS: ‘heartbeat’ traffic model   2. On the traffic load, we think “10 users per cell for full buffer traffic model” should be removed since the evaluation should use non-full buffer traffic. We may not need to specify very specific load ratio as it would be difficult to find a traffic arrival rate that perfectly matches the target load ration Suggest we define the low load range (e.g. <30%), medium load range (e.g. 30%~50%) to leave some flexibility. We may not need to evaluate high load scenario as typically it does not happen in an practical deployment as the system will become unstable and user experience cannot be satisfied.  3. For the percentage of RedCaP UEs, we are not sure what is the scenario with 100% redcap UEs in the cell?? even 75% may not make much sense to us. At least for wearable cases, 50% should be the upper bound which means every person has one smartphone and one wearable device. |
| DOCOMO | Regarding the traffic model, since non-full buffer traffic model is usually used for SLS, we prefer Option 2.  Regarding the percentage of RedCap UEs, up to 50% would be enough considering the coexistence with legacy UEs. |

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