3GPP TSG-RAN WG1 Meeting #102-e Tdoc R1-20xxxxx

e-Meeting, August 17th – 28th, 2020

**Agenda Item: 8.6**

**Title: FL summary for RedCap evaluation templates**

**Source: Moderator (Ericsson, Apple, Qualcomm)**

**Document for: Discussion, Decision**

# 1 Introduction

This is the FL summary for Phase 1 in the following RAN1#102-e post-meeting email discussion:

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| [102-e-Post-NR-RedCap-01] Email discussion/approval – Johan (Ericsson)/Hong (Apple)/Chao (Qualcomm)Phase 1 (9/10-9/29): template for evaluations, including:* cost reduction estimates
* power saving estimates
* coverage recovery and capacity impact simulation results

Phase 2 (9/30-10/21)* Initial collection of the above evaluation results
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The discussion document and draft templates are stored in this working directory:

<https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/>

# 2 Template for cost reduction evaluation

The first draft template is provided in [RedCapCostTemplate-v000.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCostTemplate/RedCapCostTemplate-v000.xlsx). The template for cost reduction evaluation has three tabs for **FR1 FDD**, **FR1 TDD** and **FR2 TDD**, respectively. On each tab, the details can be collapsed or expanded using the little buttons with numbers or plus/minus signs on them, highlighted in the figure below.



The individual cost reduction techniques are listed on the upper part of each tab and the combinations of multiple cost reduction techniques are listed further down on each tab. The combinations of multiple cost reduction techniques are preceded by the key word **Combination**. If all possible combinations were listed, there would be very many combinations to evaluate. Instead of listing all possible combinations, a small number of combinations is selected, where the intention is that the selected combinations are relevant, representative and can give insights into what cost reduction that can be expected also for many of the combinations that are not included in the list.

The cost breakdowns for the **Reference** devices are given in Column B on each tab, although the tilde (~) signs are excluded to facilitate mathematical operations on the data. Contributing companies can enter their cost estimates in one of the following columns (Column C and onwards). For simplicity, but somewhat differently compared to the approach used in some of the tables in TR 36.888, all numbers are ***cost estimates rather than cost reduction estimates***.

For example, looking at the figure above where the Reference cost for FFT/IFFT is 4% of the baseband (BB) cost, if a cost reduction technique would be estimated to result in 25% cost reduction in FFT/IFFT, then ***the cost estimate to enter on that row in the company’s column would not be 25% but instead be 75% of 4%, i.e. 3%***. This lower cost will then be reflected in the totals “BB: Total” and “RF+BB: Total”.

Below, the first question concerns collection of results for individual cost reduction techniques, and the second questions concerns combinations of multiple cost reduction techniques.

**Question 2-1: Can the spreadsheet be used to collect the cost reduction evaluation results for the *individual* cost reduction techniques? If not, what other aspects need to be added?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Fine with the template. Beyond the techniques that have been listed in the template, we wonder should companies be encouraged to provide analysis on other potential cost reduction techniques, e.g. reduced number of HARQ processes, and if so how to capture them into the table?  |
| Ericsson | Yes |
| Samsung | Yes. |

**Question 2-2: Can the spreadsheet be used to collect the cost reduction evaluation results for the *combinations* of multiple cost reduction techniques? If not, what other aspects need to be added?**

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Yes. Regarding combinations of techniques, we can start with those currently listed.  |
| Samsung | We suggest to focus on cost break down of each separated techniques firstly, to conclude the cost saving for each technique. And then discuss the potential combinations and the cost saving later, which can exclude some techniques with limited cost saving and reduce the combinations.  |
|  |  |

# 3 Template for power saving evaluation

The first draft template is provided in [RedCapPowerTemplate-v000.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapPowerTemplate/RedCapPowerTemplate-v000.xlsx). In current TR 38.840, TDD was assumed for power saving evaluation in FR1/FR2. It can be reused for Redcap study item to simplify the power reduction evaluation for reduced number of blind decoding and CCEs. Regarding the performance metrics, at least power saving gain and the corresponding PDCCH block rate should be evaluated. With these considerations in mind, three tabs were created in template as follows:

* **Tab-3:** Power saving gain – FR1, TDD, 1 RX
* **Tab-4:** Power saving gain – FR1, TDD, 2 RX
* **Tab-5:** Power saving gain – FR2, TDD, 1 RX
* **Tab-6:** Power saving gain – FR2, TDD, 2 RX
* **Tab-7:** PDCCH blocking rate evaluations

For the Tab-7, i.e. PDCCH blocking rate, “approximately” was added in front of “25%” and “50%”. The reason is that since the BD limit for FR1 (30 kHz SCS) is 36, 25% reduction in BDs is 27. However, if the UE is monitoring only 2 DCI sizes, then we will not be able to get 27 (no. of BDs = no. of DCI sizes \* total no. of PDCCH candidates for all ALs). Similarly, “approximately” is added in front of “50%” for the case where three or four DCI format sizes are monitored by UE.

Still on Tab-7, there are a few optional assumptions e.g. 3-symbols CORESET configuration, 2 slots delay toleration. The template was organized as follows to collect results:

* The first table in Tab-7 is for the combination of the non-optional assumptions, where there is no need to describe anything in the ’Comments’ column
* The second table is for all combinations that include some optional assumptions, where companies need to describe what settings they have used in the Comments column.

**Question 3-1: Can the power saving gain tabs in the template (i.e. Tab-3/4/5/6/7) be used to collect the evaluation results? If not, what other aspects need to be added?**

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| **Company** | **Comments** |
| vivo | Yes, the template can be used for collection evaluation results. But we wonder what TDD DL/UL configuration is expected to be used for power evaluation? Should we use the same assumption as for Capacity evaluation, i.e. the following

|  |  |  |
| --- | --- | --- |
| 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) |

 |
| Ericsson | Yes. However, the power consumption models for PUCCH/PUSCH need to be added. Our proposal is to reuse TR38.840 models as below.

|  |  |  |
| --- | --- | --- |
| Power State | Characteristics | Relative Power |
| FR1 | FR2  |
| UL | Long PUCCH or PUSCH.  | 250 (0 dBm)700 (23 dBm) | 350 |

In our view, the time percentage values for different power states for different traffic models are needed for performing the power saving evaluations. The time percentages are needed to compute the contribution of each state to the overall power consumption. Since there are no agreements on the time percentages, we suggest companies declare the values. So, we suggest adding an additional tab to capture the time percentage values. |
| Samsung | Yes. For Tab-4 and Tab- 6, we suggest to consider system bandwidth of 100MHz only as we don’t have power model of system bandwidth of 50MHz.  |

**Question 3-2: Can the PDCCH blocking rate tab in the template be used to collect the evaluation results? If not, what other aspects need to be added?**

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| **Company** | **Comments** |
| vivo | Yes, the template can be used in general. We would like to clarify that “Number of users (e.g., 10)” is the number of simultaneously scheduled UEs in a slot. This is the key factor for the PDCCH blocking evaluation, we think companies should provide justification to the “number of users” they selected by SLS evaluation, e.g. what deployment scenario, traffic model, resource utilization, etc, so that observation of blocking issues can be drawn based on realistic assumptions. |
| Ericsson | Yes |
| Samsung | Yes. For the assumption about number of users in Tab-7, we suggest to consider multiple values, e.g. 1 to 10, instead of a single value, e.g. 10. Companies can provide multiple PDCCH blocking rates corresponding to a range of values for the number of users. |

In the RAN1#102-e meeting, PDCCH blocking rate evaluation was discussed and consensus was reached on a few parameters including SCS/BW, CORESET duration, delay toleration. However, company views were still not converged on some important parameters e.g. aggregation level distributions and number of candidates for each AL. It therefore was agreed to leave for company report. However, the assumption should not be too broad to make the results incomparable. To produce comparable evaluation results, it was further recommended by feature leader to limit the AL distribution of [1,2,4,8,16] as one of the following:

* **Configuration 1:** [0.5, 0.4, 0.05, 0.03, 0.02], assuming majority of the UEs are in is good coverage
* **Configuration 2:** [0.1, 0.2, 0.4, 0.2, 0.1]: Majority of the UEs are in medium coverage
* **Configuration 3:** [0.05, 0.05, 0.2, 0.3, 0.4]: Majority of the UEs are in poor coverage
* **Configuration 4:** [0.2, 0.2, 0.2, 0.2, 0.2]: Uniform distribution

**Question 3-3: Can we limit the AL distributions to be one of the four configurations listed above? If not, what other configurations need to be added? It should be noted that it is important to minimize the configurations to ensure the comparable results.**

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| --- | --- |
| **Company** | **Comments** |
| vivo | This is highly dependent on the simulation assumptions, including SINR distribution, DCI payload size, etc. We observed there can be cases with even better AL distribution than configuration #1. If there is a strong need to align the AL distribution, we would like to add the following configuration to represent such casesConfiguration #5: [0.7, 0.2, 0.05, 0.03, 0.02] |
| Ericsson | Yes. It would be good to be able to align results between companies. Thus, we would suggest we all evaluate Configuration 4 for alignment purpose. Then, additional configurations on the list can be evaluated based on each company’s preference. |
| Samsung | Yes.  |

# 4 Template for coverage recovery evaluation

The first draft template is provided in [RedCapCoverageTemplate-Urban2.6GHz-v000.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCoverageTemplate/RedCapCoverageTemplate-Urban2.6GHz-v000.xlsx). The first two tabs (one for the reference UE and the other for RedCap UE) describe where the assumptions come from and the following tabs are used to collect results for the concerned channel and message. On the tabs for collecting results, the first column contains the reference UE case, followed by one or two columns for the RedCap case. One spreadsheet only concerns one scenario, and there would be four spreadsheets for the concerned 4 scenarios, e.g. Urban-2.6GHz, Urban-4GHz, Rural-700MHz and Indoor-28GHz. Currently, only the spreadsheet for Urban-2.6GHz is provided. If it is considered useful, additional spreadsheets would be created for the other three scenarios,

**Question 4-1: Can the spreadsheets be used to collect the coverage recovery evaluation results? If not, what other aspects need to be added?**

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| --- | --- |
| **Company** | **Comments** |
| vivo | Generally fine with the spreadsheets. However, since there are still some of the evaluation assumptions not stable in CE SI, which are discussing in [102-e-Post-NR-CovEnh-01]. Following aspects may need to be further updated to align with the templates to be provided by CE SI, summarized as follows.1, The definition on MIL may be changed to include (12) /connector/combiner/body losses (Rx side) in [102-e-Post-NR-CovEnh-01], we suggest to align with the template provided in CE SI.2, Besides, in [102-e-Post-NR-CovEnh-01], the UE antenna array gain components are still discussing, which is more complicated for FR2, we suggest to align with the agreements made in CE SI after new agreements are made, especially for FR2. |
| Ericsson | Yes. We agree with Vivo that updates on link budget template may be considered later on, motivated by future CE SI agreements. |
| Samsung | Yes in principle. We also prefer the updated spreadsheet in order to reflect outcomes from on-going email discussions in CE SI. |

In the RAN1#102-e meeting, it was agreed to reuse the link budget template agreed in the Rel-17 CE SI for coverage recovery evaluation. The link budget template for the Rel-17 CE SI is based on IMT-2020 self-evaluation with necessary revisions including adding/removing/revising/simplifying some parameters. However, the update of the link budget template has not started in the Rel-17 CE SI, and thus it is not desirable to await the agreement in the CE SI before proceeding with coverage analysis for RedCap.

In the template for coverage recovery evaluation, an adapted version of the IMT-2020 self-evaluation template is used, where items related to the “Maximum range” have been deleted. In addition, four rows (i.e. row(40a), (40b), (41a) and (41b)) are added for supporting the calculation of the “Maximum coupling loss”.

**Question 4-2: Can the proposed link budget template be used to perform the coverage analysis? If not, what modifications are needed?**

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| --- | --- |
| **Company** | **Comments** |
| vivo | For antenna gain and array gain, in CE antenna gain component 3 and component 4 are merged to one row, according to agreements made in RAN1#102e, and components 2 is separated from component 3. While in the proposed link budget template, the component 2 and component 3 are merged in one row, i.e. (5), and component 4 is in another row, i.e., (4). we suggest to align with the agreements made in CE SI.Agreements:Further clarify the agreement on antenna gain and antenna gain components including antenna gain correction factors as follows:* For both TDL option 1 (table A below) and TDL option 2 & CDL (table B below)
	+ The gain of antenna gain component 1 is included in LLS results
	+ The gain of antenna gain component 2 is included in link budget template
		- The gain is expressed by 10 \* log 10( N/k ) - Δ1
		- For TDL option 2 & CDL, the gain is 0 dB
	+ The gain of antenna gain component 3 is included in link budget template
	+ The gain of antenna gain component 4 is included in link budget template
		- The gain of antenna gain components 3 and 4 is expressed by Antenna Element Gain + 10 \* log 10( M/N ) -Δ2
		- For Tx, One row is used represent the gain of antenna gain component 3 + 4, i.e. row No. (4)
		- For Rx, One row is used represent the gain of antenna gain component 3 + 4, i.e. row No. (11)
		- Note: more appropriate name or explanation will be added to row No.(4) and (11). Details can be discussed when the link budget template is updated.
 |
| Ericsson | Yes. Although SSB and PRACH are not explicitly included in the link budget evaluation agreements, they are not excluded either. Although we do not expect these channels to become the coverage bottleneck, we will provide evaluation results for these channels for completeness.Regarding Vivo’s comment on antenna gain components, we see the main point is that antenna gain component 3 should be included in lines (4) and (11), rather than in lines (5) and (11b) based on the CE SI agreement. I guess this revision will not change the final link budget results. We are fine with either the FL proposal or Vivo’s suggestion. |
| Samsung | We are OK with Vivo's suggestion. In principle, we think it would be good to align assumptions between RedCap and CE including antenna gain/array gain except Redcap specific ones. |

In the proposed link budget template, some parameters have been assigned with specific values which are based on the CE SI agreements. It is assumed that company is not required to change the values for these parameters. The parameters that company can declare the values are highlight with orange color.

**Question 4-3: Are the proposed values for the fixed parameters acceptable? If not, please provide the parameters that are needed to be changed and the proposed values?**

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| --- | --- |
| **Company** | **Comments** |
| vivo | For interference density at receiver, we suggest to use the parameter provided by IMT-2020 as a baseline, and companies can report the value, instead of fixed to ‘-999’dBm.For (1bis) Number of transmit antenna ports and (10bis) Number of receive antenna ports at gNB, 2 or 4 can be up to companies report based on the agreements in RAN1#102e, instead of fixed to 4.For the following parameters, although the exact values can be reported by companies, we suggest to revise some values to align with the values that are considered as starting point in IMT-2020 or agreed in CE SI, in the initial templates for guidance.According to the Notes in the template, the value for shadow fading margin and penetration margin used in IMT-2020 can be considered as a starting point. However, the value provided in the template, i.e. (24), (25a), (25b) and (27), is not aligned with the values used in IMT-2020. We suggest to make the IMT-2020 value as the default value in the template, while companies can report a different value. The values used in IMT-2020(Channel Model A) are provided as follows.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **DL Control** | **DL Data** | **UL Control** | **UL Data** |
| (24) Lognormal shadow fading std deviation (dB) | ~~6.00~~ 7.00 | ~~6.00~~ 7.00  | ~~6.00~~ 7.00  | ~~6.00~~ 7.00  |
| (25a) Shadow fading margin for control channel (function of the cell area reliability and (24)) (dB) | ~~8.00~~ 7.56 | - | ~~8.00~~ 7.56 | - |
| (25b) Shadow fading margin for data channel (function of the cell area reliability and (24)) (dB)  | - | ~~5.00~~4.48  | - | ~~5.00~~4.48  |
| (26) BS selection/macro-diversity gain (dB) | 0.00  | 0.00  | 0.00  | 0.00  |
| (27) Penetration margin (dB) | ~~15.00~~ 26.25 | ~~15.00~~ 26.25 | ~~15.00~~ 26.25 | ~~15.00~~ 26.25  |
| (28) Other gains (dB) (if any please specify) | 0.00  | 0.00  | 0.00  | 0.00  |

For MSG3, the number of PRBs is 2 based on agreements in RAN1#101, we suggest to use 2RBs instead of 30RBs as the default value in the template.  |
| Ericsson | Yes.Regarding the number of gNB Tx/Rx chains, our suggestion is that we use 4 for 2.6 GHz, and 2 for 700 MHz so that we can easily compare results.We are fine with Vivo’s proposed values for lines (24), (25a), (25b) and (27). |
| Samsung  | We agree with Vivo that the values in IMT-2020 or agreed in CE SI should be considered as starting point in the template. |

For post processing, there could be the following two alternatives.

* **Alt. 1:** Take the average or midpoint for the parameters that the company declare the values and then plug the average value into a link budget.
* **Alt. 2:** Take the average or midpoint for the calculated MIL/MCL/MPL without repeating the link budget calculation.

Alt. 1 may require a common assumption for link level evaluation, e.g. number of Tx chains, #PRBs, etc, while Alt. 2 is more flexible to support different link level evaluation assumptions, but the problem with Alt. 2 is that only the values of the MIL/MCL/MPL can be copied and paste into the TR instead of the whole link budget table.

**Question 4-4: For post processing, can we down-select from the above two alternatives? If not, please provide the other alternative for consideration. If yes, please provide your view on which alternative is preferred.**

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| --- | --- |
| **Company** | **Comments** |
| vivo | Neither Alt.1 or Alt.2The MIL/MPL is calculated by quite a lot of parameters, such as antenna/array gain, MCS and PRB, number of repetitions, etc. The average or midpoint for parameters and MIL/MCL/MPL is only applicable when all the parameters are aligned among companies.Hence, we suggest to capture the parameters and MIL/MCL/MPL provided by each company in to TR. And the bottleneck channel can also be reported by individual companies rather than deterimed based on average or midpoint of the MCL/MIL/MPL. |
| Ericsson | Perhaps this does not need to be settled now. We can discuss post processing alternatives when we have collected all the results. |
| Samsung | Vivo’s suggestion seems reasonable. However, no need to down-select one, right now. |

# 5 Template for capacity impact evaluation

The first draft template is provided in [RedCapCapacityTemplate-v000.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCapacityTemplate/RedCapCapacityTemplate-v000.xlsx). Six tabs are created for collecting the results for the concerned scenarios each with two tabs for UL and DL, respectively. On each tab, there are 8 tables, where four are used for the non-full buffer traffic and the other four are used for the optional full buffer traffic for different ratios of RedCap UEs in the network.

For the non-full buffer traffic, the performance metric is based on 5% and 50% UPT, and company is required to report the value of resource utilization (RU) for low and medium loading. An SE row is also included in the non-full-buffer table, where we use the “bits/RE” as the performance metric. Note that “bits/RE” has been used as a SE metric in previous 3GPP SI (see e.g. TR 38.802).

For the full buffer traffic, the performance metric is based on the cell average SE.

**Question 5-1: Can the spreadsheet be used to collect the capacity impact evaluation results? If not, what other aspects need to be added?**

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| --- | --- |
| **Company** | **Comments** |
| vivo | We have following question and comments to the current table. 1. We think it would be reasonable to collect the results (e.g. UPT, SE) separately for reference UEs and the RedCap UEs, since the aim is to look at the performance impact to reference UE due to the presence of RedCap UEs in the cell. We wonder if this is also the understanding from moderator, and if so, the table would need to be updated.
2. We think it may be difficult to perfectly match the exact loading ratio, e.g. 30%, or 50%, so company report on their load ration would be needed.
3. And we do not think taking Avg. or Med. among different companies are very meaningful, the most important information is how much capacity difference for the system with different percentage of RedCap UEs (including the case without RedCap UEs)
 |
| Ericsson | The template is good. But a few comments from our side.1. Should the loading level be determined based on the limiting link (either DL or UL)? For example, if the UL is the limiting link (i.e. it has higher RU than the DL), we then load the network to the medium loading level so that the UL reaches 50% RU. We then report the actual RUs for DL and UL, respectively, in the tables.
2. We assume the UPT statistics include both the eMBB and RedCap UEs. But in this case, the drop in UPT as the percentage of RedCap UEs in the network increases might be simply due to more RedCap UEs being included in the 5% UPT due to its lower UPT performance resulting from BW/antenna/efficiency reduction. This reduction is not the same as capacity reduction. So it might be good to report eMBB UPT statistics additionally, which is directly coupled to eMBB capacity reduction.
3. It is not clear what RedCap complexity reduction combination is considered. We propose as a start we can assume the most ambitious cost reduction combination, e.g. 20 MHz, 1 layer, 1 Rx, DL 64QAM, and UL 16QAM in FR1 FDD.
4. According to the SID, we need to evaluate the network capacity and spectral efficiency impact from coverage recovery. There are no agreements on what coverage recovery solutions can be considered for RedCap UEs. We suggest that companies can declare which coverage recovery solutions are assumed in SLS.
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|  |  |