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

e-Meeting, August 17th – 28th, 2020

**Agenda Item: 8.6**

**Title: FL summary #2 for RedCap evaluation templates**

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

**Document for: Discussion, Decision**

# 1 Introduction

This is FL summary #2 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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Initial FL proposals and company responses are documented in FL summary #1 (FLS1) in R1-2007476 ([Docs](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2007476.zip), [Inbox](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/R1-2007476.zip)).

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 updated draft template is provided in [RedCapCostTemplate-v001.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCostTemplate/RedCapCostTemplate-v001.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 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”.

One response in the first round of the email discussion (see FLS1) commented that the estimates similarly to the tables in TR 36.888 should express the cost reduction rather than the resulting cost, which would make the reduction more visible. As mentioned above, the FL recommendation is to express the estimates as resulting cost rather than the cost reduction. The reason is that when the table expresses the resulting cost, it becomes more immediately clear from the table where the main cost factors can be found. In the example above, the 25% cost reduction in the FFT/IFFT will be expressed with the resulting cost 3% rather than with an eye-catching relatively high number 25% which will take the reader some time to assess the real value of and perhaps even risk misleading the reader.

The first draft template covered both individual cost reduction techniques and combinations of cost reduction techniques. Based on the responses (see FLS1), the combinations have been removed from the template. Thus, the collection of estimates will first focus on the individual cost reduction techniques and estimates for combinations can be considered in a later stage. Once some level of common understanding has been reached regarding the individual techniques, it will hopefully be easier to select which combinations to evaluate.

A couple of responses comment on the relation between “*Reduced number of DL MIMO layers*” and “*Reduced number of Rx antennas*”. The FL recommendation is that both techniques are evaluated as independently as possible, meaning that there is no assumption that the number of DL MIMO layers is reduced when the number of Rx antennas is reduced or vice versa. This may seem somewhat unintuitive, but it should simplify the estimation for various combinations of number of DL MIMO layers and number of Rx antennas, especially for FR1 TDD where several different combinations can be envisioned. The cost reduction for a combination of number of DL MIMO layers and number of Rx antennas may then be the sum of the cost reduction for the number of DL MIMO layers and the cost reduction for the number Rx antennas. The alternative to this approach would probably have been to list more variants of the individual techniques.

Several responses (see FLS1) propose to include additional individual techniques in the template. The FL recommendation is to only include techniques that have normal priority, i.e. techniques that have not been given a lower priority by RAN1. For this reason, HD-FDD operation type B has been removed from the template, since RAN1#101-e agreed to “*Study HD-FDD operation Type A and Type B (as defined in LTE) in RAN1, where study of Type A is prioritized*”. Some responses propose to include reduced number of HARQ processes among the listed techniques, but there is currently no RAN1 agreement that it should be studied. One response proposes to include other FR1 UE bandwidths than 20 MHz, e.g. 40 MHz, but since RAN1 has not made concrete agreements regarding what other bandwidths to study (if any), they are not included in the template. One response proposes to include CSI computation relaxation, but RAN1#102-e has already agreed that “*Study of relaxed UE processing time related to CSI computation is not prioritized in the RedCap study item*”.

So, the template only includes techniques that have been agreed to study, but companies are of course free to provide results for additional techniques in their contributions to RAN1#103-e, for example by attaching a spreadsheet modified to their liking to the contribution. Then RAN1#103-e can decide whether to include the results or not in the TR.

One response in the first round of the email discussion (see FLS1) proposed to capture whether the techniques have additional savings for multi-band devices (i.e. whether the savings accumulate over multiple bands). RAN1#101-e noted that “*The study will consider impacts on the cost/complexity reduction from support of multiple RF bands within FR1 or FR2*”, and RAN1#102-e agreed that “*In potential cost evaluations for a UE, it is assumed that the multi-band support affects the RF cost but not the baseband cost significantly*” and that “*In the TR, at least include a qualitative statement; relevant numerical results can also be considered*”. In line with this, a Yes/No question “*Do RF savings accumulate across supported bands? (Y/N)*” has been included for each technique in the template.

**Question 2-1a: 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** |
| FUTUREWEI | Yes. Some aspects are not our preference (for example, showing cost reductions per component as in 888 allows for better identification and discussion on aberrant results) but can accept. Other aspects, including combinations, that are not included can be in discussed in company papers and could show up after later discussion. No strong feeling on the RF Y/N, if the majority prefer not to include that is fine also. |
| Ericsson | Yes |
| vivo | We are fine with the updated template.  |
| CATT | Yes |
| Huawei, HiSilicon | Thanks for taking various comments into account. We are generally Ok with the update according to FL considerations and explanations, while with clarifications as expressed below for companies to have a common understanding on the template when providing input. Regarding the *DL MIMO layer vs. number of Rx*, as explained by FL they can be individual/independent especially for cost reduction analysis. It is not accurate to strictly couple these two. Clearly there is also different interest of chipset vendors and device vendors. Since we are providing analysis for breakdown differentiated by RF and BB, there should be a way to reflect the cost reduction independently between RF and BB w.r.t. the MIMO layers reduction (which is a sum effect of Rx in RF and MIMO layers in BB) thus we support FL update. In this sense, our assumption for Row-43 is that the number of MIMO layers is 2 (or the BB part for supporting 2 MIMO layers is not reduced for companies to input), while only # of Rx in RF is reduced to 1.This is somewhat relates to the issue of RF:BB ratio after applying the cost reduction techniques. Though there is no response on how to deal with it, we assume this is the case that has to be (while a resulting ratio that is close to the ratio for reference UE may still be desirable, for comparable reason for example). |
| MediaTek | Yes |
| Qualcomm | The updated template looks good.Regarding the comments of Huawei on Row-43, we think some clarification is needed for the possible use case of “supporting 2 MIMO layers with 1 RX antenna.” |
| ZTE,Sanechips | We are OK with the template itself but we have an editorial comment: We prefer to call these spreadsheet ‘cost reduction estimation result’ since they only capture cost reduction estimation, while other evaluation result not included . |

# 3 Template for power saving evaluation

The first draft template was 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.

**Summary of 1st round replies on Q3-1:**

On Q3-1, all responses except one (i.e. 12 out of 13 companies) explicitly support to use the power saving Tab-3/4/5/6 to collect the evaluation results with some further modifications:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index**  | **Tab(s)** | **Proposal**  | **Proposed by**  | **Other company inputs** |
| 1 | Tab-1 | Clarify TDD UL/DL configuration for power evaluation. Proposed to use the configuration agreed for capacity improvement.  | Vivo | No: OPPO (leave companies to report) |
| 2 | Tab-1 | Align the DCI format size with 40 bits | Intel |  |
| 3 | Tab-1 | Add a note to a baseline traffic model tab that companies to report the assumption of DRX being used or not.  | Intel |  |
| 4 | Tab-2 | Adding PUCCH/PUSCH power consumption | Ericsson | OPPO/ZTE (Partially yes, no need to add PUSCH) |
| 5 | Tab-2 | Modifying the ‘PDCCH+PDSCH’ power consumption model as follows: P(X) = (1-*a*)PPDCCH+PDSCH+*a*\*PPDCCH+PDSCH\*X | ZTE |  |
| 6 | Tab-2 | Align the ordering of ALs of PDCCH for a given number of blind decoding  | ZTE |  |
| 7 | Tab-2 | Add the following to the power consumption model table: ‘companies to report the power consumption modelling for 3-symbols CORESET Configuration and reduced number of non-overlapped CCEs’ | Intel |  |
| 8 | Tab-2 | Add a note to clarify that the same baseline and evaluation assumptions regarding the number of DCI sizes per PDCCH candidates, number of candidates per each AL and AL distribution should be assumed for the PDCCH blocking rates in Tab-7 and the power saving results in Tab-3/4/5/6. | Huawei |  |
| 9 | Tab-2 | Add a note to clarify how the BD is reduced in the comment column when providing power saving gain results in Tab-3/4/5/6 | Huawei |  |
| 10 | Tab-3/4/5/6 | Add additional tab to capture time percentage values for different power states for different traffic model.  | Ericsson | OPPO (Intermediate values) |
| 11 | Tab-3/4/5/6 | Add absolute numbers for power consumption in power unit for each case in Tab-3/4/5/6 | Huawei |  |
| 12 | Tab-4/6 | Remove 50MHz BW for FR2 in Tab-4/6 | Samsung | Yes: Spreadtrum |

**Question 3-1a: Which of the listed proposals (P1, P2, …, P12) can be captured into the current template for power saving evaluation? If proposal(s) can be added with proper modification, please also provide details.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| FUTUREWEI | 4 and 9 should be considered. We are also supportive of 12 since we don’t anticipate drastically different trends for 50 and 100MHz.For power consumption, we prefer no change in the formula and are not supportive of 5. 10 and 11 are not needed since what matters in the end is the power consumption.For the other proposals, we are neutral. |
| Ericsson | P4: Supportive. In our view, it is important to capture P4 in the power saving template. This is necessary for power saving evaluation. The values provided in TR 38.840 are provided below:

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

P12: Not supportive. Although like Futurewei we do not expect to see very different trends for 50 and 100MHz, we think it is good to confirm that based on evaluation results. We can reuse the FR1 power scaling used in TR 38.840 for FR2, i.e., Scaling of X MHz = 0.4 + 0.6 \* (X - 20) / 80, with X=50 MHz.P3, P5, P11: Not supportive.Finally, in order to complement Proposal 3-3, it would be also good to align between companies on number of DCI sizes to monitor and number of candidates for each AL (for the reference and the RedCap cases) as well (in Tab-7). We have the following suggestion:* FR1:
	+ Number of DCI sizes to monitor: 2
	+ Number of candidates for each AL for the reference case: [6, 5, 4, 2,1]
	+ Number of candidates for each AL (~27% BD reduction): [5, 3, 3, 1, 1]
	+ Number of candidates for each AL (50% BD reduction): [3, 2, 2, 1, 1]
* FR2:
	+ Number of DCI sizes to monitor: 2
	+ Number of candidates for each AL for the reference case: [4, 3, 1, 1, 1]
	+ Number of candidates for each AL (~30% BD reduction): [2, 2, 1, 1, 1]
	+ Number of candidates for each AL (50% BD reduction): [1, 1, 1, 1, 1]
 |
| vivo | We think it would be good to clarify the following aspects so that the results from companies can be better understood and comparable.

|  |  |  |
| --- | --- | --- |
| **Index**  | **Tab(s)** | **Proposal**  |
| 1 | Tab-1 | Clarify TDD UL/DL configuration for power evaluation. Proposed to use the configuration agreed for capacity improvement.  |
| 2 | Tab-1 | Align the DCI format size with 40 bits (excluding CRC) |
| 3 | Tab-1 | Add a note to a baseline traffic model tab that companies to report the assumption of DRX being used or not.  |
| 8 | Tab-2 | Add a note to clarify that the same baseline and evaluation assumptions regarding the number of DCI sizes per PDCCH candidates, number of candidates per each AL and AL distribution should be assumed for the PDCCH blocking rates in Tab-7 and the power saving results in Tab-3/4/5/6. |
| 9 | Tab-2 | Add a note to clarify how the BD is reduced in the comment column when providing power saving gain results in Tab-3/4/5/6 |

 |
| CATT | P1: Leaving companies to report should be OK. Anyway, typical 1~2 kinds of TDD DL/UL configurations will be chosen by companies naturally.P4: Not necessary. For PDCCH, no matter being actually scheduled or not, a UE has to monitor the DL grant, and thus easy to acquire accurate power consumption result. For PUSCH, it is up to scheduling and out of scope. For PUCCH, assuming a PUCCH will always be triggered by a PDSCH, the power consumption of PUCCH is reflected by PDSCH to a certain degree.Neutral to other proposals. But we should keep in mind that the template should be kept as simple and focusing as possible, considering the limited time. |
| Huawei, HiSilicon | 1. P1: no need to agree a common assumption. It’s OK to let companies to report.
2. P2: We are also fine to align the DCI format size as we replied previously. One question for P2 is whether the DCI size includes CRC or not. In our view, it can be clarified that the DCI size is assumed to be 64 bits including CRC.
3. P3: DRX settings were agreed already in RAN1#102. It should be assumed as baseline for the corresponding traffic.
4. P4: we prefer to use similar way as that in Rel-16 power saving evaluation. No need to model the PUSCH in the evaluation, but it is open for companies to model the power of PUSCH and report it in the comments column.
5. P5: For PDCCH+PDSCH slot, the power consumption due to the PDSCH processing is the dominant part. Therefore, further modeling of PDCCH BD reduction for PDCCH+PDSCH slots is not needed.
6. P6: it is UE implementation, which should not be restricted in our evaluation.
7. P7: There is already a table in the Tab 3/4/5/6. We don’t think it is needed to list another optional assumption in power model tab. Companies can report the power model used for 3 symbol CORESET case in the “Comments” column.
8. P8: We support it.
9. P9: We support it.
10. P10/P11: we think the intention of P10 and P11 is the same. We are OK for P10 to provide the time slots distribution to calibrate companies’ results.

P12: we support the proposal from Samsung and Spreadtrum. It is not clear that whether 50MHz BW is supported for FR2 or not. |
| MediaTek | We are supportive to include Proposals 10, 11, and 12. In addition, we see the following revision to the quoted power scaling for reduced BD in Tab-2 is also necessary. In Rel-16, the formula is based on the assumption that, if UE spend little time for BD, it suffices to receive only control symbols (as PDCCH-only monitoring with cross-slot scheduling). If cross-slot scheduling is applied, there should be no additional power saving since UE still need to receive all control symbols whenever there is any candidate to decode. Therefore, removing “cross-slot scheduling case” for reduced BD is needed to avoid unrealistic combination of power saving schemes. “- P(α) = max (Micro-sleep, α ∙ Pt + (1 – α) ∙ 0.7Pt))- Pt is the PDCCH-only power for same slot ~~and cross-slot~~ scheduling case~~s~~.” |
| Qualcomm | A few comments on our side:P1: Companies can report the configuration they use for evaluation.P4: PUCCH power can be considered for HARQ-ACK report and CSI report, whether PUSCH power is considered depends on the traffic.P5: PDSCH power should be the dominant part. There is no strong need to change Rel-16 model which does not consider power gain for reduced PDCCH monitoring in PDSCH-PDCCH power. P6: Decoding order of ALs should be left to UE implementation given NR search space is not a nested structure and PDCCH candidates of ALs are not independent.P8: It is not clear how the number of DCI sizes per PDCCH candidates, number of candidates per each AL and AL distribution directly affect power evaluation. It should be sufficient to only use the same BD number in blocking rate evaluation and in power evaluation. P10: This is intermediate result. It can be optionally provided by companies.P11: This is intermediate result. It can be optionally provided by companies.For FR2, we are fine to include P1, P2, P3, P4, P10 and P12 |
| ZTE,Sanechips | 1. We are supportive of P5. The PDCCH candidates reduction has an impact on the PDCCH part. The impact is not only from PDCCH-only case, but also from PDCCH+PDSCH case. With the BD reduction, UE can start the processing of PDSCH faster in PDCCH+PDSCH, which helps UE finish PDSCH processing faster and go to sleep faster. Therefore, appropriate model for the PDCCH part in PDCCH+PDSCH case should be used to obtain the overall, reasonable and accurate evaluation results.2. We are supportive of P6. Actually, this proposal has the same motivation with P9 b. That is to make the candidates reduction clear and obtain the comparable evaluation results. In the power saving template, it is noted that there are two aspects to realize UE BD reduction: **BD reduction and BD limit reduction**, which are different.For the BD reduction, we have the similar opinion with Ericsson regarding the number of DCI sizes to monitor and number of candidates for each AL. In this case, the percentage of BD reduction has the same or similar impact on each AL. Therefore, with the 27% BD reduction, the number of candidates for each AL is changed to [5, 3, 3, 1, 1] from [6, 5, 4, 2,1].For the BD limit reduction, the percentage of BD limit reduction does not mean it has the same or similar impact on each AL. For example, without limit reduction, the number of candidates for each AL is assumed as [8,6,4,2,2] and the BD limit is set as 22. When the BD limit is reduced by 50%, the number of candidates for each AL can be set as [3,3,1,2,2] instead of [4,3,2,1,1]. That means for AL=16 and 8, the candidates are reduced by 0%. For AL=2 and 4, 50% and for AL=1, 62.5%. Therefore, when the BD limit is reduced, some AL can be provided without reducing the candidates, which is what we described as ‘ordering of ALs’. In order to provide comprehensive and accurate evaluation results, both the same impact and different impact on each AL should be considered. Based on this analysis, we have the following suggestion **BD limit reduction**:* FR1:
	+ Number of DCI sizes to monitor: 2
	+ Number of candidates for each AL for the reference case: [8, 6, 4, 2,2]
	+ Number of candidates for each AL (~27% BD reduction): [5, 4, 3, 2,2]
	+ Number of candidates for each AL (50% BD reduction): [3, 3, 1, 2, 2]
* FR2:
	+ Number of DCI sizes to monitor: 2
	+ Number of candidates for each AL for the reference case: [4, 2, 2, 1, 1]
	+ Number of candidates for each AL (~30% BD reduction): [2, 1, 2, 1, 1]
	+ Number of candidates for each AL (50% BD reduction): [1, 1, 1, 1, 1]

As for the **BD reduction**, we are OK with Ericsson’s proposal.3. We are supportive of P12. We discussed the relative power and made the modifications for 20M bandwidth. For 50M bandwidth, for power saving issue, we do not see the necessity to add the 50M (besides 100M) and spend the additional efforts to determine the relative power (similar with 20M) , due to the limited time.4. We think P4 is not preferred. Actually, the PUSCH model for RedCap UE has not been discussed. How to support the PUCCH, e.g. long PUCCH or short PUCCH, is also not determined. The uplink transmission is not the focus. Therefore, for simplicity, it is not preferred.  |

**Summary of 1st round replies on Q3-2:**

On Q3-2, all responses except one (13 out of 14 companies) support to use the Tab-7 for PDCCH blocking rate evaluation result collection. One company is ok with Tab-7 except some clarifications on the example numbers in bracket, e.g. number of users and the assumption of CORESET bandwidth.

Some modifications on Tab-7 were briefly summarized in table below for further discussions:

|  |  |  |  |
| --- | --- | --- | --- |
| **Index**  | **Tab(s)** | **Proposal**  | **Proposed by**  |
| 1 | Tab-7 | Adding note to clarify the “Number of users (e.g., 10)”  | Vivo: Clarify that it is the number of simultaneously scheduled UEs in a slot and company reports how the value is obtained, e.g. deployment scenario, traffic model, resource utilizationOPPO: Clarify either “number of simultaneously scheduled UEs in a slot” or “the system schedules the band with x user and the scheduling of user is based on the traffic models”Samsung/Futurewei: A range of values e.g. 1-10 and left it for company report. ZTE: Not use SLS here. |
| 2 | Tab-7 | Create separate Tab for 1Rx and 2 Rx case due to different AL distributions.  | Huawei |
| 3 | Tab-7 | Correct the candidate number of AL16 in the column ‘E’ of first table from ‘2’ to ‘1’ | Huawei |

It should be noted that P2 was discussed later in Q3-3a, due to the dependency on the outcome of the following Q3-3 discussions, e.g. which aggregation level distributions can be agreed for evaluation. If nothing was agreed for aggregation level distribution (i.e. Q3-3), separate 1 Rx/2 Rx Tabs maybe not necessary since companies can provide results with reporting the number of Rx and the corresponding aggregation level distributions even with a single Tab.

**Proposal 3-2: For PDCCH blocking rate evaluation, use Tab-7 in template to collect evaluation results with following modification(s):**

* **Revise “Number of users (e.g. 10)” to be “Number of users (e.g. 1 to 10)”**
* **Add a note in Tab-7 to clarify that “Number of users” represents the number of UEs that need to be scheduled simultaneously in a slot and company can provide different PDCCH blocking rates corresponding to a range of ‘number of users’ on different rows in Tab-7**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI | Y | For the second bullet point, we don’t really see the need for the “company can provide different PDCCH blocking rates” |
| Ericsson | Partially Y | Since the PDCCH blocking rate depends on the number of UEs, it would be useful to provide results for a limited set of UEs in the template. We suggest considering e.g., 2, 5 and 10 UEs. Also, there is no need to evaluate a single UE case (i.e., number of UEs should be at least 2 for blocking rate evaluations). |
| vivo |  | We are fine to take a range of value (e.g. 1 to 10) for evaluation, however, as we commented in the first round discussion, the upper bound is artificially selected without careful justification. In order to draw meaningful observations. we think companies should justify the value they pick for the evaluation. For example, if 10 is used, justification should be provided about what deployment scenario or load situation where it is observed that 10 users are simultaneously scheduled in a cell.Otherwise, we have concern on capturing the results and drawing conclusions based on artificial assumptions.  |
| CATT | Y |  |
| Huawei, HiSilicon | Y | Yes. We are fine with the change, but we think the results for 10UEs case needs to be reported and other cases can be optionally reported:At least 10 UEs is reported. Other values are optional |
| MediaTek | Y | We are fine with the number UEs. We are fine to have a set of this range (e.g. 2, 4, 6, 8, 10) in order to reduce the number of evaluations. |
| Qualcomm | Y |  |
| ZTE,Sanechips | Yes | We suggest 10 and 6 can be used.  |

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

**Summary of 1st round replies on Q3-3:**

On Q3-3, all responses agree to limit AL distribution to align results for making the conclusion in TP. Companies positions can be categorized as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| **Configuration index** | **Supporting companies** | **Number of supporting companies**  | **Concerns** |
| 1 | Ericsson, Qualcomm, CATT, Huawei | 4 |  |
| 2 | Ericsson, Futurewei, CATT, MediaTek | 4 |  |
| 3  | Ericsson, Qualcomm, MediaTek  | 3 | Intel (Not realistic and only happen in case of poor network planning) |
| 4 | Ericsson | 1 | Futurewei (artificial), Qualcomm, Intel |
| 5 (Revised Config.1) | Vivo: [0.7, 0.2, 0.05, 0.03, 0.02] | 1 |  |
| 6 (Revised Config.1) | OPPO: [0.4, 0.5, 0.05, 0.03, 0.02] | 1 |  |
| 7 (Revised Config.1) | Huawei: [0.3, 0.5, ~~0.05~~, 0.10, ~~0.03,~~ 0.06, ~~0.02,~~ 0.04] (for 1Rx case) | 1 |  |
| 8 (Revised Config.1) | Intel: [0.5, 0.4, 0.07, 0.02, 0.01]. | 1 |  |

Most responses prefer to categorize different cases into cases e.g. good/medium/poor coverage, which represents different UEs SINR distribution in network. Configure 2 are preferred by all of responses and seems agreeable as one of configurations. Companies views on Configuration 1 are still diverse with several modifications (i.e. Configuration 5/6/8) brought up to the table.

In addition, one company proposed to clarify the configuration 1-4 above is assumed with 2 Rx. Correspondingly, it was also proposed to consider configuration 7 above for PDCCH blocking rate evaluation.

**Question 3-3a: Can we clarify that the configuration 1-4 is applied for 2 Rx case? If yes, can we agree to use configuration 7 above for 1 Rx case for power saving evaluation as proposed by Huawei? Please provide some justification for each input.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| FUTUREWEI | We are supportive of the approach of having one poor, one medium and one good coverage configuration. Thus, configuration 1-3 are fine with us (OK to add 4 as well) for 2 RX. We do not see the need to modify configuration 1 (in particular, configurations like 5 are too AL-1 heavy and should not be considered for evaluation)Okay to consider a different distribution for 1 RX. Note that 7, as proposed only adds up to 90% |
| Ericsson | No. In general, 1 Rx UEs will skew the distribution towards higher ALs. However, it is not evident to us that configuration 1-4 necessarily represent the distribution for the 2 Rx case. These configurations can also represent 1 Rx case depending on, for example, the cell-size, the UE distribution, etc. Also, note that configuration 4 has been included only for calibration purposes, and it may represent neither the 1 Rx case nor the 2 Rx case.In our view, there it is not necessary to clarify the Rx case since the considered configurations reflect the coverage condition which itself is a function of system parameters (e.g., number of antennas, cell-size, UE distribution, etc.,).  |
| vivo | 1. Yes, the configuration 1-4 are based on 2Rx
2. Based on our evaluation, the AL distribution for 1Rx case (dense urban, 20MHz@2.6GHz, 40bits payload excluding CRC) is around [0.4, 0.35, 0.15, 0.06, 0.04], we suggest to take this distribution. The proposed configuration 7 seems not correct as the sum of the numbers does not equal to 1.
 |
| CATT | In our view, though 1 Rx case may tend to applied higher AL, a unified AL distribution (e.g. Configuration 1 or 2) for both 2 Rx and 1 Rx case can still be enough, as for calibration and comparison purpose. According to our observation, for AL distributions calculated by geometry, the 2 Rx case and 1 Rx case still have some common characteristics, e.g. very low proportion for AL16. |
| Huawei, HiSilicon | Yes. Yes. Actually, our proposal on configuration 7 of 1Rx reception is the corresponding configuration of the configuration 1 of 2 Rx reception assuming other assumptions are the same. We agree that besides the number of Rx, other parameters, e.g. the cell size, may impact the AL distribution. However, assuming all other assumptions are the same, we should model the difference on PDCCH blockage due to 2Rx and 1Rx reception, which shall impact the power consumption and should be used as the input for the power consumption evaluations in Tab 3/4/5/6. Otherwise, it does not make sense to provide both the results for 1Rx in Tab3 and 2Rx for Tab4, because they are not comparable.  |
| MediaTek | NO.It is sufficient to have Configuration 2 and 3 for evaluations, and there is no need to differentiate between 1Rx and 2Rx.  |
| Qualcomm | For the first question, yes, the model is for 2Rx. For the second question, no need to have different set of AL distributions for 1Rx. |
| ZTE,Sanechips | Company can use configuration 1-3 for both 2RX and 1RX ( as indicated by each company). 1RX can be chosen from poor or medium coverage case, so there is no need to use separate configuration. |

Note that, the configuration is counted on a per cell basis, instead of per UE AL distribution. In addition, it is great if we can adopt at least configuration that all interested companies can simulate it. Other configuration can be left company to select and report.

**Proposal 3-3: PDCCH aggregation level distribution configuration 1 and 2 listed above are used to evaluate power saving benefit of PDCCH monitoring. Other configurations are optional.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree (Y/N)** | **Comments** |
| FUTUREWEI |  | Our preference is for good/medium/bad coverage scenario, but could live with the proposal for the sake of progress |
| Ericsson | Y |  |
| vivo | N | If we should make a selection, we suggest to take configuration 1 as it is closer to the reality (although still far from perfect). We failed to see how configuration 2 can be justified with agreed deployment scenarios and assumptions.  |
| CATT | Y | Also OK if we can pick only one configuration out from Configuration 1 and 2.  |
| Huawei, HiSilicon | Y | OK. |
| MediaTek | No | No related power scaling agreements to AL distribution.If Proposal 3-3 is meant for “evaluating the PDCCH blocking probability” rather than “evaluating power saving benefit”, then Configuration 2 and 3 should be used. |
| Qualcomm | No | It is necessary to keep configuration 3. |
| ZTE,Sanechips | Y |  |

# 4 Template for coverage recovery evaluation

The updated draft templates are provided in:

* Rural 700 MHz: [RedCapCoverageTemplate-Rural700MHz-v001.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCoverageTemplate/RedCapCoverageTemplate-Rural700MHz-v001.xlsx)
* Urban 2.6 GHz: [RedCapCoverageTemplate-Urban2.6GHz-v001.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCoverageTemplate/RedCapCoverageTemplate-Urban2.6GHz-v001.xlsx)
* Urban 4 GHz: [RedCapCoverageTemplate-Urban4GHz-v001.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCoverageTemplate/RedCapCoverageTemplate-Urban4GHz-v001.xlsx)
* Indoor 28 GHz: [RedCapCoverageTemplate-Indoor28GHz-v001.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCoverageTemplate/RedCapCoverageTemplate-Indoor28GHz-v001.xlsx)

On each of the templates, 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 that will be captured to the TR. On the tabs for collecting results, the first column contains the reference UE case, followed by one or two columns for the RedCap case. Currently, only examples are provided for reference.

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

Based on the responses in the first round of the email discussion (see FLS1), the link budget template has been updated with change marks to align with the agreement in the CE SI including the agreement on UE antenna gain for FR2. Regarding antenna gain modeling, the antenna gain component 3 and component 4 are merged into one row, i.e. row (4) for transmitter and row (11) for receiver. The antenna gain component 2 is in anther separate row, i.e. row (5) for transmitter and row (11bis) for receiver. For the calculation of antenna gain component 3 and component 4, company is required to report the antenna gain correction factor, i.e. Δ2 for gNB and Δ3 for UE. In some cases, the antenna gain correction factor can be void, e.g. Δ3 fixed to zero for FR1, and thus no reporting is needed. It is noted that Δ1 is not included in the link budget template, and the gain of antenna gain component 2 is reported. The reason is that the gain of antenna gain component 2 can be zero in some cases. The report of the antenna gain component 2 instead of Δ1 makes the calculation simple.

Regarding rows (24), (25a), (25b) and (27), the notes have been updated with the CE SI agreement. As commented in one response, the row (27) penetration margin is dependent on the scenario “O-to-I” or “O-to-O”, and therefore the FL recommendation is to declare also the scenario when reporting the value. Currently for FR1, the values used in IMT-2020 (channel model A) for the O-to-I scenario is provided here as a reference, and for FR2, zero values are used due to no reference in the IMT-2020 self-evaluation.

For FR2, based on the CE SI agreement, single panel with total 8 antenna elements, i.e. (M, N, P) = (2,2,2) is used for LLS. However, there is no discussion on the number of antenna elements for RedCap UE. The FL recommendation is to reuse the same array structure for RedCap. In case of single Tx or Rx chain, only the antenna elements in one polarization is used, i.e. 4 instead of 8. Companies are invited to provide their views on this issue.

**Question 4-1a: For Urban 2.6GHz, can the spreadsheet be used to collect coverage recovery evaluation results? If not, what other aspects need to be added, and/or what parameter values need to be changed?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| FUTUREWEI | OK to use. |
| Ericsson | Yes |
| vivo | Yes |
| CATT | Yes |
| Huawei, HiSilicon | Yes only if the following changes are accepted* For (5), please remove “could vary across different physical channel” from the note which is not in line with agreements. In order to avoid arbitrary reported values, please follow the agreements to revise the note as “For TDL option 1, company declares a value according to 10 log( (2a)/(2b)) - delta1 where delta1 is an adjustment/correction factor.”. Similarly, it is also applied to (11bis). Regarding the recommended values for DL control and DL data, it is unclear why delta1 is as large as 4 dB to DL control, please remove the recommended value 8dB. If the intention is to differentiate broadcast channel from unicast channel by delta1, suggest to add a note for them.
* For (10bis), as per CovEnh agreements, please add note “For FR1 downlink, it is supposed to be equal to (10)”
 |
| MediaTek | Yes |
| Qualcomm | We are fine with the spreadsheet. For outdoor UE, we assume the in-car penetration loss will be modeled in the same way as Table A.2.2-1 of TR 38.802, i.e.- In case of outdoor (30km/h), penetration loss in-car is 9 dB (LN, σ = 5 dB). |
| ZTE,Sanechips | ok |

**Question 4-2a: For Urban 4GHz, can the spreadsheet be used to collect coverage recovery evaluation results? If not, what other aspects need to be added, and/or what parameter values need to be changed?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| FUTUREWEI | OK to use. |
| Ericsson | Yes |
| vivo | Yes |
| CATT | Yes |
| Huawei, HiSilicon | Yes only with changes suggested in Q4-1a. |
| MediaTek | Yes |
| Qualcomm | We are fine with the spreadsheet. For outdoor UE, we assume the in-car penetration loss will be modeled in the same way as Table A.2.2-1 of TR 38.802, i.e.- In case of outdoor (30km/h), penetration loss in-car is 9 dB (LN, σ = 5 dB). |
| ZTE,Sanechips | Since this scenario is the second choice in the agreement we suggest to make this optional |

**Question 4-3a: For Rural 700GHz, can the spreadsheet be used to collect coverage recovery evaluation results? If not, what other aspects need to be added, and/or what parameter values need to be changed?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| FUTUREWEI | OK to use. GHz🡪 MHz. |
| Ericsson | Yes |
| vivo | Yes |
| CATT | Yes |
| Huawei, HiSilicon | Yes only with changes suggested in Q4-1a.In addition to Rural scenario, FDD band in Urban, such as 700MHz and 2.1GHz, should not be excluded in study item. It is appreciated if it could be clarified how simulation results for Urban 700MHz are provided/collected and whether the same table can be reused. |
| MediaTek | Yes |
| Qualcomm | We are fine with the spreadsheet. |
| ZTE,Sanechips | Yes |

**Question 4-4a: For Indoor 28GHz, can the spreadsheet be used to collect coverage recovery evaluation results? If not, what other aspects need to be added, and/or what parameter values need to be changed?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| FUTUREWEI | OK to use |
| Ericsson | Yes |
| vivo | For (5) at gNB transmitter and 11(bis) at gNB receiver, i.e. the antenna gain component 2, is fixed to 0 in the template. However, Δ1, which may include the broadcast and unicast BF gain difference, is supposed to be reflected in component 2, by current template such BF gain difference cannot be modelled. Therefore, we suggest to revise these two rows also be highlighted with orange color and companies can report and revise these values (handled the same way as templates for other scenarios) |
| CATT | Yes |
| Huawei, HiSilicon | Yes with the following suggestionThe values of receiver noise figure (NF) in row #(13) are for FR1. For FR2, the values should be updated according to ITU-R M.2412-0, where BS NF = 7 dB for UL and UE NF = 10 dB for DL. |
| MediaTek | Yes |
| Qualcomm | Yes |
| ZTE,Sanechips | Yes |

# 5 Template for capacity impact evaluation

The updated draft template is provided in [RedCapCapacityTemplate-v001.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Inbox/drafts/8.6/PostPhase1/RedCapCapacityTemplate/RedCapCapacityTemplate-v001.xlsx). The first tab is general note for the template, followed by several tabs for collecting the results for different scenarios and frequency bands. The DL and UL results are separated in different tabs. On each tab, the non-full buffer traffic and the optional full buffer traffic are included for different percentages of RedCap UEs and different UE complexity reduction features (i.e. 1 Rx or 2 Rx).

For the non-full buffer traffic, the performance metric is based on 5% and 50% UPT, and company can report the actual value of resource utilization (RU) for low and medium loading. An SE row is also included in the non-full-buffer traffic 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.

In the first round email discussion, several responses (see FLS1) commented to clarify the purpose of the SLS evaluation. According to the SID, the evaluation of impact to network capacity and spectral efficiency is required under both UE complexity reduction and coverage recovery. However, there are no agreements on what coverage recovery solutions can be considered for RedCap UEs. The FL recommendation is to collect the evaluation results at least for UE complexity reduction, and companies are free to provide results for coverage recovery in their contributions to RAN1#103-e. Then we can discuss and decide whether to include the results or not in the TR in RAN1#103-e.

A couple of responses comment on the UE complexity reduction features for evaluation. One response proposes to start from the most ambitious cost reduction combination, e.g. 20 MHz, 1 layer, 1 Rx, DL 64QAM, and UL 16QAM in FR1 FDD. The FL recommendation is that both 1Rx and 2Rx are evaluated, and for other UE complexity reduction features, probably we can consider to limit the choice for easily comparing the results, e.g. 20MHz, 1 layer, DL 64QAM and UL 16QAM in FR1 and 100MHz, 1 layer, DL 16QAM and UL 16QAM in FR2.

Several responses propose to collect the statistics (e.g. UPT, cell SE) separately for RedCap and eMBB UEs. Based on the responses, the collection of the results separately for the RedCap and eMBB UEs as well as overall statistics has been included in the updated template.

One response comment whether the loading level is determined based on the limiting link (either DL or UL). To simplify the evaluation, the FL recommendation is to determine the loading separately for DL and UL for achieving a given RU target. In other words, the joint consideration of DL and UL loading is not required. One response also comment it is difficult to perfectly match the exact loading ratio, e.g. 30% or 50%. The FL recommendation is to use the 30% and 50% loading target as much as possible, and company can also declare the other values.

One response proposes to make FTP model 3 mandatory for both RedCap and eMBB UEs, and IM traffic model can be optional. Generally, the IM traffic model is used for less frequently small packet transmission while FTP model is used for file transfer, storage and application download and update. Therefore, the IM traffic model is more aligned with the RedCap user cases. It is also noted that in the last meeting, the IM traffic model has been agreed as the baseline for power saving evaluation of RedCap UE. Therefore, the FL recommendation is to follow the last meeting agreement on the non-full buffer traffic model, e.g. both FTP model 3 and IM traffic model are considered up to company to report.

One response proposes to discuss and decide whether the total number of UEs including both eMBB and RedCap UEs can be fixed for each evaluated cost reduction feature. For example, the total number of UEs is firstly determined assuming 0% RedCap UE ratio when adapting the target RU, and then applied to the other RedCap UE ratios and not changed for other cost reduction features. Although the proposal can reduce the efforts to determine the number of UEs, the target loading cannot be achieved when the RedCap UEs are added to the cell and the impact to the eMBB UE may not be correctly evaluated. Therefore, the FL recommendation is that for evaluation of each percentage of RedCap UE and eMBB UE, company are encouraged to determine the loading level to achieve the target RU.

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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Yes.Regarding which UE complexity reduction features to be considered for capacity evaluation, we agree with FL’s suggestion. Additional combinations can be evaluated and reported in contributions to RAN1#103-e. |
| vivo | We are fine with the updated template.  |
| Huawei, HiSilicon | No. It is appreciated if how to resolve the following two key issues could be clarified.For the traffic model of burst buffer evaluation, as commented before, maximum 1:50 traffic ratio between REDCAP UEs and eMBB UEs, as a result of IM traffic model, are too far small to make the simulations reasonable, which is the key issue that should be resolved here. Both FTP and IM are all typical traffic for RedCap UEs. For the perspective of network capacity evaluation, we think FTP model 3 is more suitable. So we suggest to make FTP model 3 mandatory for both RedCap and eMBB UEs, and IM traffic model can be optional.For the number of UEs of burst buffer evaluation, as commented before, the key issue is to evaluate the impact from introduction of REDCAP UEs rather than the increase of total number of UEs. Therefore, we suggest to align the SLS evaluation methodology to distinguish the impact of cost reduction feature from the impact of varying number of UEs. In this sense, we suggest the following. The total number of UEs is firstly determined assuming 0% RedCap UE ratio when adapting the target RU, and then applied to the other RedCap UE ratios and not changed for other cost reduction features. Then the changes of RU can reflect the performance loss due to RedCap UE complexity reduction. Meanwhile, the other metrics also be used to evaluate the performance loss, such as, SE and UPT. If it is not acceptable, please clarify what the other SLS evaluation methodology would be and how it resolve the key issue above.In addition, for burst buffer evaluation, the definition of spectrum efficiency should be adapted as following considering excluded the influence of traffic model:SE (bps/Hz)= cell average throughput(Mbps) / ( cell bandwidth(MHz) \* RU)  |
| MediaTek | Yes |
| Qualcomm | We are fine with the template in general.Based on TR 36.814, SE is not included in the SLS performance metrices needed for non-full buffer traffic. Therefore, it would be good to clarify its meaning/definition if reported. |
| ZTE,Sanechips | We agree that the capacity is evaluated for the cost reduction with the following candidate features : 20MHz, 1 layer, DL 64QAM and UL 16QAM for FR1100MHz, 1 layer, DL 16QAM and UL 16QAM for FR2.Besides, it is also necessary to clarify NR UE’s configuration, for example 2RX for both FR1 and FR2 |