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

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

**Agenda item:** 8.6.3

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

**Title:** FL summary #5 on Coverage Recovery and Capacity Impact for RedCap

**Document for:** Discussion and Decision

# Introduction

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

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

|  |
| --- |
| [103-e-NR-RedCap-04] Email discussion for coverage recovery and capacity impact– Chao (Qualcomm)   * 1st check point: 10/29 * 2nd check point: 11/4 * 3rd check point: 11/10 * Last check point 11/12 |

In this round of the email discussion, please check the proposals/questions tagged ‘FL5’ (search for ‘FL5’).

FL note (11/11): please check the updated proposals/questions tagged “FL6” (search for “FL6”)

# Target Performance Requirement

**[FL5]** The only remaining issue is how to address the FFS part in the following agreement made in the 11/5 online (GTW) session:

|  |
| --- |
| Agreements:   * Agree in principle using Option 3 for determining the coverage recovery target   + Option 3: The coverage recovery target for each channel of RedCap UE corresponds to the link budget of the bottleneck channel(s) for the reference NR UE within the same deployment scenario   + Note: The reference UE is a Rel-15/16 NR UE with mandatory features only * FFS For Option 3, companies report their individual observations of the amount of compensation for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)   + A representative value of the amount of compensation is derived by taking the mean value (in dB domain) from all the compensation values including both negative and non-negative values     - Excluding the highest & the lowest values when the number of samples is more than 3     - If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification     - In this case, observations may still be drawn   + The representative value of a channel is used for identifying whether the channel needs coverage recovery     - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero |

The FL’s understanding is there are possible two approaches for deriving representative value. The first is to follow the approach used in the Rel-17 CE SI. That is, for each channel of the reference NR UE, we calculate a mean value of the MIL performance from all the companies results by excluding the highest & lowest values and find the channel with the lowest mean MIL value as the bottleneck channel. Then, for each channel of RedCap UE we compare the MIL performance to the mean MIL of the bottleneck channel and derive a representative value of the coverage difference.

The second approach is what is described in the FFS part of the agreement. Compared to the first approach, the bottleneck channel for the reference NR UE by sourcing companies is not necessary to be aligned. Companies could report their individual observations of the bottleneck channel for the reference NR UE and compare the MIL of each RedCap UE channel with that of the bottleneck channel for deriving a representative value of the coverage difference.

According to the email discussion, when the same observation of the bottleneck channel for the reference NR UE is reported by companies, the difference between the two approaches will be minor. When the observations of the bottleneck channel for the reference NR UE are different among companies, the first approach may give a relatively larger value for amount of coverage loss for RedCap UE. In the following we will use one example for further explanation.

As discussed, for the first approach we need to firstly determine the bottleneck channel for the reference NR UE, i.e. the channel with the lowest mean MIL value. As seen from Table 2-1, for indoor 28 GHz, the bottleneck channel is PDSCH and the mean MIL is 138.8 dB. However, as seen from Table 2-2, based on the individual observation by each company, the bottleneck channel for the reference NR UE is very diverse. Only A few companies (i.e. 2 out of 10) report PDSCH is the bottleneck.

**Table 2-1: Mean MIL loss (dB) for Ref NR UE in Indoor 28 GHz (Approach #1)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH |
| Mean MIL (dB) | 142.5 | 144.0 | 138.8 | 141.7 | 140.9 | 141.1 | 159.0 | 156.7 | 155.1 | 139.1 | 152.4 | 152.5 |

**Table 2-3: Bottleneck channel and MIL for Ref NR UE in Indoor 28 GHz (Approach #2)**

|  |  |  |
| --- | --- | --- |
|  | Bottleneck channel | MIL |
| Samsung | PUSCH | 133.3 |
| ZTE | PUSCH | 134.3 |
| OPPO | PUSCH | 141.9 |
| vivo | PUSCH | 131.4 |
| Nokia | PDSCH | 139.3 |
| DCM | Msg4 | 142.0 |
| Ericsson | Msg4 | 128.0 |
| IDCC | Msg4 | 142.5 |
| QC | PUSCH | 138.8 |
| Intel | PDSCH | 132.1 |

We compare the MIL of each RedCap UE channel to the target performance (i.e. 138.8 dB for Approach #1 and the MIL value in Table 2-3 for Approach #2) and the results are shown in Table 2-3 and 2-4 for Approach #1 and 2, respectively.

**Table 2-3: Coverage loss (dB) for 1Rx/100MHz RedCap UE in Indoor 28 GHz (Approach #1)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH |
| Samsung | 3.5 | 3.6 | -2.4 | 0.7 | -1.6 |  | 18.7 | 15.1 | 11.6 | -5.5 | 10.6 |  |
| ZTE | -2.3 | -1.6 | -9.6 | -4.7 | -4.1 |  | 18.7 | 14.3 | 13.5 | -4.5 | 13.5 |  |
| OPPO | 2.2 | 2.2 | 0.0 | 1.3 | 0.6 |  | 21.2 | 20.9 | 21.2 | 3.1 | 21.4 |  |
| vivo | -7.0 | -2.0 | -8.0 | -11.5 | -8.3 | -4.5 | 15.1 | 13.5 | 10.2 | -7.4 | 4.0 | 3.8 |
| Nokia | 0.7 | 0.5 | -2.8 | 3.7 | 2.7 |  | 21.7 |  | 20.1 | 6.1 | 14.3 | 18.7 |
| DCM | 6.1 | 6.1 | -0.4 | -1.7 | -1.8 |  | 19.8 | 25.2 |  | 8.5 | 21.5 |  |
| Ericsson | -10.6 | -9.6 | -14.4 | -14.0 | -15.3 | -8.2 | 11.7 | 11.7 | 9.3 | -0.1 | 7.5 | 10.3 |
| IDCC | 4.7 | 4.7 | -0.2 | -0.8 | -0.9 |  | 27.5 |  | 21.9 | 4.6 | 20.6 |  |
| QC | 1.3 | 7.3 | -1.1 | -0.3 | 5.0 | 10.9 | 32.0 | 25.9 | 23.4 | 0.0 | 8.6 | 24.6 |
| Intel | -3.7 | -2.9 | -10.8 | -1.7 | -4.8 | -1.0 | 18.2 | 18.5 | 15.4 | -1.4 | 12.1 | 12.1 |
| Representative value (dB) | **-0.1** | **1.3** | **-4.4** | **-2.3** | **-2.3** | **-2.8** | **20.1** | **17.9** | **16.3** | **0.3** | **13.6** | **13.7** |

**Table 2-4: Coverage loss (dB) for 1Rx/100MHz RedCap UE in Indoor 28 GHz (Approach #2)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH |
| Samsung | 9.0 | 9.1 | 3.1 | 6.2 | 3.9 |  | 24.2 | 20.6 | 17.1 | 0.0 | 16.1 |  |
| ZTE | 2.1 | 2.8 | -5.2 | -0.2 | 0.3 |  | 23.1 | 18.8 | 18.0 | 0.0 | 18.0 |  |
| OPPO | -0.9 | -0.9 | -3.1 | -1.7 | -2.5 |  | 18.2 | 17.8 | 18.1 | 0.0 | 18.4 |  |
| vivo | 0.4 | 5.4 | -0.6 | -4.0 | -0.8 | 2.9 | 22.6 | 20.9 | 17.6 | 0.0 | 11.4 | 11.2 |
| Nokia | 0.3 | 0.0 | -3.3 | 3.2 | 2.2 |  | 21.2 |  | 19.6 | 5.6 | 13.8 | 18.2 |
| DCM | 2.9 | 2.9 | -3.5 | -4.8 | -5.0 |  | 16.6 | 22.0 |  | 5.4 | 18.3 |  |
| Ericsson | 0.2 | 1.2 | -3.6 | -5.6 | -4.5 | 2.6 | 22.5 | 22.6 | 20.1 | 10.7 | 18.3 | 21.1 |
| IDCC | 1.0 | 1.0 | -3.9 | -4.5 | -4.6 |  | 23.8 |  | 18.2 | 0.9 | 16.9 |  |
| QC | 1.3 | 7.3 | -1.2 | -0.4 | 5.0 | 10.8 | 32.0 | 25.8 | 23.3 | 0.0 | 8.6 | 24.6 |
| Intel | 3.0 | 3.8 | -4.1 | 5.0 | 1.9 | 5.7 | 24.9 | 25.2 | 22.1 | 5.3 | 18.8 | 18.7 |
| Representative value (dB) | **1.4** | **3.0** | **-2.9** | **-0.9** | **-0.5** | **4.3** | **22.6** | **21.7** | **19.1** | **2.2** | **16.4** | **19.3** |

By comparing Table 2-3 to Table 2-4, it can be observed that Approach #1 may give a large estimate of potential coverage loss for RedCap UE, e.g. 1-2 dB more. Also, Approach #1 may indicate some channels that may not be needed for compensation having to compensate. For example, PBCH is assumed for coverage recovery based on Approach #1, but not needed for Approach #2.

The large fluctuation by Approach #1 may be caused by different assumption of antenna array gain correction factors by each company and an absolute target performance by averaging over all the companies results seems not a good metric to evaluate the coverage loss for RedCap UE. Approach #2 allow companies to individually calculate the performance difference between RedCap and the reference NR UE and the use of the representative value can further remove some outlies to avoid having to compensate to channel that may not need compensation.

Therefore, the FL suggestion is to use Approach #2 for deriving the representative value for Option 3.

**[FL5] Proposal 2-1:**

* For Option 3, companies report their individual observations of the amount of compensation for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)
  + A representative value of the amount of compensation is derived by taking the mean value (in dB domain) from all the compensation values including both negative and non-negative values
    - Excluding the highest & the lowest values when the number of samples is more than 3
    - If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification
    - In this case, observations may still be drawn
  + The representative value of a channel is used for identifying whether the channel needs coverage recovery
    - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero

**[FL5] Question 2-1:** **Can the above proposal be agreed? If not, please provide technical justification**.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Panasonic | Y | We support approach#2 as it is straightforward. In addition, for the next step, there could be controversial between companies to determine how much dB to compensate the coverage loss due to different values derived from approach#1 and approach#2. A compromise solution for each channel could be expressed as the presentative value derived in approach#2 + X dB, where X can be 1 or 2 dB selected up to RAN1 group discussion. |
| vivo |  | No strong position between approach#1 and approach#2, maybe approach#2 could make sense since the impact due to different detailed assumptions might be mitigated.  However, we still have concern to solely based on Option 3 to determine the coverage compensation for FR2 indoor scenario. Even though we did not agree to option 1, but at least we should keep in mind what will be targeting scenario when making the decision. We would like to avoid the case that some channel are recommended for coverage compensation but actually no real coverage issue in the filed deployment, i.e. overcompensation.  Our analysis on FR2 indoor scenario is shown in the figure below, it can be seen that no coverage compensation for RedCap UEs is needed even if we target up to 100m ISD, however, coverage compensation is required if the decision is solely made based on option 3.  cid:image002.png@01D6B6B1.B14EB3C0 |
| ZTE | Y | With the understanding that current proposal (Option 3+Alt1) is a compromise between Option 1 and Option 3 + Alt2, we are fine with the proposal. |
| Qualcomm | Y | We also support Panasonic’s view on the need to potentially add some extra compensation to some individual channels |
| Futurewei |  | We believe that Approach 2 (from the FFS) adequately represents the amounts of compensations at least for FR1. There is little difference between Approach 1 and Approach 2 for FR1 however. For FR2 we are concerned with overcompensating. The bullet that was deleted online [The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc] was in part there to handle the FR2 case, where we may not decide to fully compensate even if Opt 3 shows some compensations. There are a few ways to handle this, one way is to conclude for FR1 and discuss FR2 further. |
| InterDigital | Y |  |
| Ericsson | Y | Thanks to FL for an illuminating example! We support the FL5 proposal.  We would like to suggest adding a sub-bullet at the end of the proposal “*The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc.*” This sub-bullet was in the FL4 proposal. We think it is good to keep this sub-bullet for addressing potential issues of over-compensation in certain scenarios.  But, we would be fine to move on with the FL5 proposal as is as well. |
| Samsung | Y | OK with the FL proposal. |
| Intel | Y | OK with the FL proposal. |
| OPPO | Y | OK with the FL proposal. |
| Lenovo, Motorola Mobility | Y | OK with the proposal. |
| LG | Y | OK with the FL proposal. |
| CATT | Y | If possible, we prefer keep the same evaluation methodology as Rel-17 CE SI. The assumptions of antenna array gains may be largely different in FR2, leading to divergent LB results, while Approach#1 should be at least stable in FR1. But we are OK with the proposal for the sake of progress. |
| FL5 | Two responses have raised the concern on how to address the overcompensating issue for FR2 indoor scenario. The FL understanding is it can be further discussed and not limited by the proposal. If we think the bullet that was deleted online [The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc] is useful for addressing the issue of over-compensation, we can consider adding it back.  **Updated Proposal 2-1:**   * For Option 3, companies report their individual observations of the amount of ~~compensation~~ coverage loss for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)   + A representative value of the amount of ~~compensation~~ coverage loss is derived by taking the mean value (in dB domain) from all the ~~compensation~~ values including both negative and non-negative values     - Excluding the highest & the lowest values when the number of samples is more than 3     - If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification     - In this case, observations may still be drawn   + The representative value of a channel is used for identifying whether the channel needs coverage recovery     - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero     - [The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc] | |
| FL5 | Agreements (in 11/10 GTW session)**:**   * For Option 3, companies report their individual observations of the amount of coverage loss for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)   + A representative value of the amount of coverage loss is derived by taking the mean value (in dB domain) from all the compensation values including both negative and non-negative values     - Excluding the highest & the lowest values when the number of samples is more than 3     - If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification     - In this case, observations may still be drawn   + The representative value of a channel is used for identifying whether the channel needs coverage recovery     - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero     - The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc | |

# Coverage Recovery

## FR1, Urban with the carrier frequency of 2.6 GHz

Based on the latest available evaluation results in [RedCapCoverage-2.6GHz-v019-Panasonic.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Inbox/drafts/8.6/EvaluationResults/RedCapCoverage/2.6GHz/RedCapCoverage-2.6GHz-v019-Panasonic.xlsx), the link budget performance for both the reference UE and RedCap UE in Urban scenario at 2.6GHz is summarized in Table 3.1-1 to Table 3.1-3 (Company please double check whether your results are correctly captured in these tables. I have found there are some mismatch between the spreadsheet and the contribution for some companies results).

In the link budget tables, the maximum isotropic loss (MIL) is used as the coverage evaluation metric and for each channel the margin to the target performance is also shown, where the target performance is a company specific value and derived based on the link budget of the bottleneck channel for the reference NR UE (i.e. Option 3). The coverage limiting channel for RedCap UE, e.g. the link budget for the channel worse than that target performance, is highlighted with RED.

**Table 3.1-1: Link budget performance for the reference NR UE (100MHz BW, 4Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Urban 2.6GHz, 4Rx Reference UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 165.9 | 170.1 | 163.6 | 162.3 | 162.4 |  | 158.6 | 154.8 | 151.8 | 139.4 | 150.0 |  | 139.4 |
| Margin (dB) | 26.4 | 30.6 | 24.1 | 22.8 | 22.9 |  | 19.2 | 15.4 | 12.4 | 0.0 | 10.6 |  |  |
| ZTE | MIL (dB) | 157.0 | 167.4 | 167.6 | 157.7 | 158.0 |  | 162.6 | 160.9 | 158.4 | 142.0 | 156.5 |  | 142.0 |
| Margin (dB) | 15.0 | 25.4 | 25.7 | 15.7 | 16.0 |  | 20.7 | 18.9 | 16.4 | 0.0 | 14.5 |  |  |
| OPPO | MIL (dB) | 167.5 | 171.5 | 169.9 | 162.2 | 165.2 |  | 155.0 | 155.1 | 155.2 | 145.1 | 154.7 |  | 145.1 |
| Margin (dB) | 22.3 | 26.3 | 24.8 | 17.1 | 20.1 |  | 9.9 | 9.9 | 10.1 | 0.0 | 9.6 |  |  |
| CATT | MIL (dB) | 164.7 | 168.7 | 167.6 | 161.5 | 163.8 |  | 160.3 | 158.9 | 156.9 | 145.9 | 153.5 |  | 145.9 |
| Margin (dB) | 18.7 | 22.7 | 21.6 | 15.5 | 17.8 |  | 14.4 | 12.9 | 10.9 | 0.0 | 7.6 |  |  |
| vivo | MIL (dB) | 157.6 | 165.6 | 162.0 | 157.1 | 158.6 | 160.8 | 156.2 | 153.6 | 151.1 | 137.8 | 152.5 | 149.7 | 137.8 |
| Margin (dB) | 19.8 | 27.8 | 24.2 | 19.4 | 20.9 | 23.0 | 18.4 | 15.9 | 13.3 | 0.0 | 14.7 | 11.9 |  |
| Xiaomi | MIL (dB) | 166.3 | 166.3 | 168.4 | 162.9 | 165.3 |  | 161.6 | 158.9 | 157.2 | 146.7 | 154.6 |  | 146.7 |
| Margin (dB) | 19.5 | 19.5 | 21.6 | 16.1 | 18.5 |  | 14.9 | 12.2 | 10.5 | 0.0 | 7.9 |  |  |
| Futurewei | MIL (dB) | 164.8 | 166.8 | 164.3 | 162.8 | 163.2 |  |  |  |  | 151.6 | 153.5 |  | 151.6 |
| Margin (dB) | 13.1 | 15.1 | 12.6 | 11.1 | 11.5 |  |  |  |  | 0.0 | 1.9 |  |  |
| Nokia | MIL (dB) | 168.3 | 168.3 | 166.8 | 167.3 | 165.8 |  | 151.7 |  | 150.2 | 138.6 | 147.8 | 150.3 | 138.6 |
| Margin (dB) | 29.7 | 29.7 | 28.2 | 28.7 | 27.2 |  | 13.1 |  | 11.6 | 0.0 | 9.2 | 11.7 |  |
| DOCOMO | MIL (dB) | 165.6 | 169.6 | 166.2 | 160.5 | 162.6 |  | 161.1 | 164.9 |  | 145.7 | 154.6 |  | 145.7 |
| Margin (dB) | 19.9 | 23.9 | 20.4 | 14.7 | 16.9 |  | 15.4 | 19.2 |  | 0.0 | 8.9 |  |  |
| CMCC | MIL (dB) | 162.8 | 168.4 | 166.7 | 160.8 | 163.4 | 163.8 | 156.3 | 154.5 | 152.3 | 139.8 | 152.8 | 158.6 | 139.8 |
| Margin (dB) | 23.0 | 28.6 | 26.9 | 21.0 | 23.6 | 24.1 | 16.5 | 14.7 | 12.6 | 0.0 | 13.1 | 18.9 |  |
| Panasonic | MIL (dB) |  | 169.0 | 161.0 |  |  |  |  |  |  |  |  |  |  |
| Margin (dB) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Huawei | MIL (dB) | 164.0 | 168.0 | 164.2 | 161.1 | 160.9 |  | 160.6 |  | 158.3 | 139.0 | 149.6 |  | 139.0 |
| Margin (dB) | 25.0 | 29.0 | 25.3 | 22.1 | 21.9 |  | 21.6 |  | 19.3 | 0.0 | 10.7 |  |  |
| Spreadtrum | MIL (dB) | 165.0 | 169.0 | 166.9 | 163.8 | 163.8 | 166.3 | 158.4 | 156.6 | 156.2 | 145.7 | 153.5 | 155.8 | 145.7 |
| Margin (dB) | 19.3 | 23.3 | 21.2 | 18.1 | 18.1 | 20.6 | 12.7 | 10.9 | 10.5 | 0.0 | 7.8 | 10.1 |  |
| Apple | MIL (dB) | 160.5 | 168.5 | 163.9 | 153.8 | 157.0 |  |  |  | 150.8 | 140.0 | 144.7 |  | 140.0 |
| Margin (dB) | 20.5 | 28.5 | 23.9 | 13.8 | 17.0 |  |  |  | 10.8 | 0.0 | 4.8 |  |  |
| Ericsson | MIL (dB) | 162.0 | 162.0 | 162.5 | 156.9 | 159.4 | 163.8 | 154.8 | 155.5 | 153.6 | 143.9 | 151.2 | 155.1 | 143.9 |
| Margin (dB) | 18.0 | 18.0 | 18.5 | 12.9 | 15.4 | 19.8 | 10.9 | 11.6 | 9.6 | 0.0 | 7.3 | 11.1 |  |
| InterDigital | MIL (dB) | 164.47 | 168.47 | 166.15 | 160.47 | 162.55 |  | 160.6 |  | 156.4 | 143.24 | 152.84 |  | 143.24 |
| Margin (dB) | 21.23 | 25.23 | 22.91 | 17.23 | 19.31 |  | 17.36 |  | 13.16 | 0.0 | 9.6 |  |  |
| Qualcomm | MIL (dB) | 161.3 |  | 163.4 | 158.3 | 159.8 |  |  |  | 146.5 | 139.4 | 148.2 |  | 139.4 |
| Margin (dB) | 22.0 |  | 24.0 | 18.9 | 20.4 |  |  |  | 7.2 | 0.0 | 8.9 |  |  |
| Intel | MIL (dB) | 165.7 | 166.9 | 163.5 | 166.4 | 164.1 | 165.7 | 162.0 | 160.8 | 158.2 | 143.9 | 154.6 | 156.8 | 143.9 |
| Margin (dB) | 21.7 | 23.0 | 19.6 | 22.4 | 20.1 | 21.8 | 18.1 | 16.8 | 14.2 | 0.0 | 10.6 | 12.8 |  |

**Table 3.1-2: Link budget performance for the RedCap UE (20MHz BW, 2Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Urban 2.6GHz, 2Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 160.1 | 164.1 | 156.7 | 155.8 | 156.7 |  | 155.2 | 151.6 | 148.3 | 136.4 | 147.0 |  | 139.4 |
| Margin (dB) | 20.6 | 24.6 | 17.2 | 16.3 | 17.2 |  | 15.8 | 12.2 | 8.9 | -3.0 | 7.6 |  |  |
| ZTE | MIL (dB) |  |  |  |  |  |  | 159.6 | 157.9 | 155.4 | 139.0 | 153.5 |  | 142.0 |
| Margin (dB) |  |  |  |  |  |  | 17.7 | 15.9 | 13.4 | -3.0 | 11.5 |  |  |
| OPPO | MIL (dB) | 161.2 | 165.2 | 164.6 | 155.2 | 159.0 |  | 151.9 | 152.0 | 151.9 | 141.9 | 151.7 |  | 145.1 |
| Margin (dB) | 16.0 | 20.0 | 19.5 | 10.1 | 13.8 |  | 6.8 | 6.8 | 6.7 | -3.2 | 6.6 |  |  |
| CATT | MIL (dB) | 159.2 | 163.2 | 161.7 | 153.7 | 157.4 |  | 157.3 | 155.9 | 153.9 | 142.9 | 150.5 |  | 145.9 |
| Margin (dB) | 13.2 | 17.2 | 15.7 | 7.8 | 11.4 |  | 11.4 | 10.0 | 7.9 | -3.0 | 4.6 |  |  |
| vivo | MIL (dB) | 151.9 | 160.0 | 154.9 | 149.6 | 151.4 | 155.4 | 153.2 | 150.6 | 148.1 | 135.0 | 149.4 | 146.7 | 137.8 |
| Margin (dB) | 14.2 | 22.2 | 17.2 | 11.8 | 13.7 | 17.6 | 15.4 | 12.9 | 10.3 | -2.8 | 11.6 | 8.9 |  |
| Xiaomi | MIL (dB) | 160.8 | 160.8 | 160.9 | 155.4 | 158.4 |  | 158.6 | 155.9 | 154.2 | 143.7 | 151.6 |  | 146.7 |
| Margin (dB) | 14.0 | 14.0 | 14.1 | 8.6 | 11.6 |  | 11.9 | 9.2 | 7.5 | -3.0 | 4.9 |  |  |
| Futurewei | MIL (dB) | 159.0 | 161.0 | 159.3 | 157.3 | 158.1 |  |  |  |  | 148.6 | 150.5 |  | 151.6 |
| Margin (dB) | 7.3 | 9.3 | 7.6 | 5.6 | 6.4 |  |  |  |  | -3.0 | -1.1 |  |  |
| Nokia | MIL (dB) | 162.5 | 162.5 | 160.3 | 161.5 | 160.3 |  | 148.7 |  | 147.2 | 135.6 | 144.8 | 147.3 | 138.6 |
| Margin (dB) | 23.9 | 23.9 | 21.7 | 22.9 | 21.7 |  | 10.1 |  | 8.6 | -3.0 | 6.2 | 8.7 |  |
| DOCOMO | MIL (dB) | 159.8 | 163.8 | 159.9 | 152.9 | 156.0 |  | 158.1 | 161.9 |  | 142.7 | 151.6 |  | 145.7 |
| Margin (dB) | 14.1 | 18.1 | 14.1 | 7.2 | 10.3 |  | 12.4 | 16.2 |  | -3.0 | 5.9 |  |  |
| CMCC | MIL (dB) | 157.2 | 162.8 | 161.1 | 154.6 | 157.4 | 158.8 | 153.3 | 151.5 | 149.3 | 136.8 | 149.8 | 155.6 | 139.8 |
| Margin (dB) | 17.4 | 23.0 | 21.3 | 14.8 | 17.6 | 19.0 | 13.5 | 11.7 | 9.6 | -3.0 | 10.1 | 15.9 |  |
| Panasonic | MIL (dB) |  | 163.5 | 154.7 |  |  |  |  |  |  |  |  |  |  |
| Margin (dB) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Huawei | MIL (dB) | 158.0 | 162.0 | 156.9 | 154.6 | 154.6 |  | 157.6 |  | 155.3 | 136.0 | 146.6 |  | 139.0 |
| Margin (dB) | 19.0 | 23.0 | 17.9 | 15.7 | 15.6 |  | 18.6 |  | 16.3 | -3.0 | 7.7 |  |  |
| Spreadtrum | MIL (dB) | 159.0 | 163.0 | 160.9 | 157.8 | 157.8 | 160.3 | 155.4 | 153.6 | 153.2 | 142.7 | 147.5 | 152.8 | 145.7 |
| Margin (dB) | 13.2 | 17.2 | 15.1 | 12.0 | 12.0 | 14.5 | 9.7 | 7.9 | 7.5 | -3.0 | 1.8 | 7.0 |  |
| Apple | MIL (dB) | 154.4 | 162.4 | 157.4 | 147.3 | 150.4 |  |  |  | 147.8 | 137.0 | 141.7 |  | 140.0 |
| Margin (dB) | 14.4 | 22.4 | 17.4 | 7.3 | 10.4 |  |  |  | 7.8 | -3.0 | 1.8 |  |  |
| Ericsson | MIL (dB) | 155.8 | 155.8 | 156.5 | 150.2 | 152.9 | 157.8 | 151.9 | 152.5 | 150.6 | 140.9 | 148.2 | 152.1 | 143.9 |
| Margin (dB) | 11.8 | 11.8 | 12.5 | 6.2 | 8.9 | 13.8 | 8.0 | 8.6 | 6.7 | -3.0 | 4.3 | 8.1 |  |
| InterDigital | MIL (dB) | 158.77 | 162.8 | 160.29 | 153.87 | 156.80 |  | 157.1 |  | 152.8 | 140.24 | 149.84 |  | 143.24 |
| Margin (dB) | 15.53 | 19.56 | 17.05 | 10.63 | 13.56 |  | 13.86 |  | 9.56 | -3.0 | 6.6 |  |  |
| Qualcomm | MIL (dB) | 155.8 |  | 157.8 | 152.0 | 154.3 |  |  |  | 143.5 | 136.4 | 145.2 |  | 139.4 |
| Margin (dB) | 16.5 |  | 18.4 | 12.6 | 14.9 |  |  |  | 4.2 | -3.0 | 5.9 |  |  |
| Intel | MIL (dB) | 159.8 | 161.0 | 157.6 | 160.7 | 158.0 | 162.7 | 159.0 | 157.8 | 155.2 | 140.9 | 151.6 | 153.8 | 143.9 |
| Margin (dB) | 15.8 | 17.1 | 13.7 | 16.7 | 14.0 | 18.8 | 15.1 | 13.8 | 11.2 | -3.0 | 7.6 | 9.8 |  |

**Table 3.1-3: Link budget performance for the RedCap UE (20MHz BW, 1Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Urban 2.6GHz, 1Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 156.6 | 160.6 | 151.9 | 150.6 | 153.2 |  | 155.2 | 151.6 | 148.3 | 136.4 | 147.0 |  | 139.4 |
| Margin (dB) | 17.1 | 21.1 | 12.4 | 11.1 | 13.7 |  | 15.8 | 12.2 | 8.9 | -3.0 | 7.6 |  |  |
| ZTE | MIL (dB) | 147.8 | 158.3 | 160.8 | 151.0 | 151.4 |  | 159.6 | 157.9 | 155.4 | 139.0 | 153.5 |  | 142.0 |
| Margin (dB) | 5.9 | 16.3 | 18.8 | 9.0 | 9.4 |  | 17.7 | 15.9 | 13.4 | -3.0 | 11.5 |  |  |
| OPPO | MIL (dB) | 157.2 | 161.2 | 162.0 | 149.2 | 155.1 |  | 151.9 | 152.0 | 151.9 | 141.9 | 151.7 |  | 145.1 |
| Margin (dB) | 12.1 | 16.1 | 16.9 | 4.1 | 9.9 |  | 6.8 | 6.8 | 6.7 | -3.2 | 6.6 |  |  |
| CATT | MIL (dB) | 155.5 | 159.5 | 157.8 | 147.6 | 154.0 |  | 157.3 | 155.9 | 153.9 | 142.9 | 150.5 |  | 145.9 |
| Margin (dB) | 9.5 | 13.5 | 11.9 | 1.6 | 8.0 |  | 11.4 | 10.0 | 7.9 | -3.0 | 4.6 |  |  |
| vivo | MIL (dB) | 148.7 | 156.8 | 150.6 | 144.7 | 146.8 | 152.3 | 153.2 | 150.6 | 148.1 | 135.0 | 149.4 | 146.7 | 137.8 |
| Margin (dB) | 10.9 | 19.0 | 12.8 | 6.9 | 9.0 | 14.5 | 15.4 | 12.9 | 10.3 | -2.8 | 11.6 | 8.9 |  |
| Xiaomi | MIL (dB) | 157.6 | 157.6 | 157.3 | 150.2 | 154.4 |  | 158.6 | 155.9 | 154.2 | 143.7 | 151.6 |  | 146.7 |
| Margin (dB) | 10.9 | 10.9 | 10.5 | 3.4 | 7.6 |  | 11.9 | 9.2 | 7.5 | -3.0 | 4.9 |  |  |
| Futurewei | MIL (dB) | 156.4 | 158.4 | 157.3 | 154.3 | 154.9 |  |  |  |  | 148.6 | 150.5 |  | 151.6 |
| Margin (dB) | 4.7 | 6.7 | 5.6 | 2.6 | 3.2 |  |  |  |  | -3.0 | -1.1 |  |  |
| Nokia | MIL (dB) | 158.5 | 158.5 | 156.8 | 157.8 | 156.5 |  | 148.7 |  | 147.2 | 135.6 | 144.8 | 147.3 | 138.6 |
| Margin (dB) | 19.9 | 19.9 | 18.2 | 19.2 | 17.9 |  | 10.1 |  | 8.6 | -3.0 | 6.2 | 8.7 |  |
| DOCOMO | MIL (dB) | 156.4 | 160.4 | 155.7 | 147.3 | 151.9 |  | 158.1 | 161.9 |  | 142.7 | 151.6 |  | 145.7 |
| Margin (dB) | 10.7 | 14.7 | 10.0 | 1.5 | 6.1 |  | 12.4 | 16.2 |  | -3.0 | 5.9 |  |  |
| CMCC | MIL (dB) |  |  |  |  |  |  | 153.3 | 151.5 | 149.3 | 136.8 | 149.8 | 155.6 | 139.8 |
| Margin (dB) |  |  |  |  |  |  | 13.5 | 11.7 | 9.6 | -3.0 | 10.1 | 15.9 |  |
| Panasonic | MIL (dB) |  | 160.6 | 150.9 |  |  |  |  |  |  |  |  |  |  |
| Margin (dB) |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Huawei | MIL (dB) | 154.9 | 158.9 | 153.1 | 150.3 | 150.7 |  | 157.6 |  | 155.3 | 136.0 | 146.6 |  | 139.0 |
| Margin (dB) | 15.9 | 19.9 | 14.1 | 11.4 | 11.7 |  | 18.6 |  | 16.3 | -3.0 | 7.7 |  |  |
| Spreadtrum | MIL (dB) | 156.0 | 160.0 | 157.9 | 154.8 | 154.8 | 157.3 | 155.4 | 153.6 | 153.2 | 142.7 | 147.5 | 152.8 | 145.7 |
| Margin (dB) | 10.2 | 14.2 | 12.1 | 9.0 | 9.0 | 11.5 | 9.7 | 7.9 | 7.5 | -3.0 | 1.8 | 7.0 |  |
| Apple | MIL (dB) | 151.0 | 159.0 | 152.8 | 141.8 | 146.1 |  |  |  | 147.8 | 137.0 | 141.7 |  | 140.0 |
| Margin (dB) | 11.0 | 19.0 | 12.8 | 1.8 | 6.1 |  |  |  | 7.8 | -3.0 | 1.8 |  |  |
| Ericsson | MIL (dB) | 152.8 | 152.8 | 153.3 | 145.3 | 148.9 | 153.9 | 151.9 | 152.5 | 150.6 | 140.9 | 148.2 | 152.1 | 143.9 |
| Margin (dB) | 8.8 | 8.8 | 9.3 | 1.3 | 4.9 | 9.9 | 8.0 | 8.6 | 6.7 | -3.0 | 4.3 | 8.1 |  |
| InterDigital | MIL (dB) | 155.57 | 159.57 | 157.22 | 149.27 | 153.69 |  | 157.1 |  | 152.8 | 140.24 | 149.84 |  | 143.24 |
| Margin (dB) | 12.33 | 16.33 | 13.98 | 6.03 | 10.45 |  | 13.86 |  | 9.56 | -3.0 | 6.6 |  |  |
| Qualcomm | MIL (dB) | 152.5 |  | 154.7 | 148.1 | 151.0 |  |  |  | 143.5 | 136.4 | 145.2 |  | 139.4 |
| Margin (dB) | 13.2 |  | 15.3 | 8.7 | 11.6 |  |  |  | 4.2 | -3.0 | 5.9 |  |  |
| Intel | MIL (dB) |  |  |  |  |  |  | 159.0 | 157.8 | 155.2 | 140.9 | 151.6 | 153.8 | 143.9 |
| Margin (dB) |  |  |  |  |  |  | 15.1 | 13.8 | 11.2 | -3.0 | 7.6 | 9.8 |  |

**Question 3.1-1: Can the link budget evaluation results in Table 3.1-1 to Table 3.1-3 be captured to TR 38.875? (Companies are invited to check the result and if any modification is needed, please also indicate here.)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | If possible, it would be useful to clarify the assumption in the simulation   1. For PRACH, the simulated format 2. For MSG2, whether existing TBS scaling is used? |
| ZTE | Y | Fine to capture the tables into the TR. |
| Qualcomm | Y | We think the results for Urban 2.6GHz are relatively stable. |
| Nokia, NSB | Y |  |
| Futurewei |  | We think having a summary observation as in question 3.1-2 is more important than including all link budget evaluation results in the TR, so if agree to this it should be in addition to the summary observation.  A conclusion could be in the form of mentioning the assumption of the option (Option 1 or 3), choice of MIL/ MPL/ MCL and the resulting channel that may need compensation. Something like table 3.1-4. Representative values are preferred. Also assumptions on Msg2 could vary widely due to having different number of user.  If included, we recommend to note it will be in an Appendix and using 'Source 1' etc rather than company names like 36.888. (keeping the company names is good for now for checking) |
| NTT DOCOMO | Y |  |
| Ericsson | Y |  |
| CATT | Y |  |
| Intel | Y | Fine to capture the tables into TR |
| Samsung |  | For Msg 2, it should be clarified whether or not Rel-15 TBS scaling was applied for each simulation result. |
| InterDigital | Y | We have provide some update on our results. |
| FL4 | Majority of responses are fine with capturing the above link budget evaluation results to TR 38.875. One response suggests the results can be captured in an Appendix of TR 38.875 by replacing company names with “source N”. Several responses comment to clarify evaluation assumption for msg2 and PRACH.  For Msg2 results, some companies might have considered TBS scaling and some others have not. However, the assumption for TBS scaling is not available in the evaluation spreadsheet. FL suggests the sourcing companies to clarify whether TBS scaling is used for Msg2 and also PRACH format.  Based on the responses, FL makes the following proposal:  **[FL4] Proposal 3.1-1:**   * Capture the link budget evaluation results (Urban 2.6 GHz) in Table 3.1-1 to Table 3.1-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated coverage recovery evaluation results and a clarification of assumption for Msg2 and PRACH. | |
| vivo |  | For MSG2, we use MCS#0 with no TBS scaling  For PRACH, only format B4 is captured according to the template. However, we believe for TDD, PRACH format 0 is possible for better coverage, therefore not proper to draw conclusion based on PRACH format B4 only. We also provided results for format 0 in the contribution R1-2007670 |
| Qualcomm |  | We are fine with the FL updated proposal  For Msg2, no TBS scaling is used (3 RBs, MCS0, and TBS = 9 bytes) |
| Huawei, Hisilicon | N | Since the margin value assumes only “Option 3” which has not been agreed yet. We prefer to wait until proposal 1 is agreed.  In addition MIL, MPL results should also be captured in TR. We suggest FL to treat them equally. |
| Futurewei |  | No tbs scaling |
| Intel | Y | We simulate Msg2 with scaling factor 1/4 and PRACH format B4 |
| Ericsson |  | We are fine with the FL’s updated proposal.  Regarding TBS scaling for Msg2, we have provided results with and without TBS scaling. We suggest using results based on no TBS scaling as a baseline. TBS scaling can be considered as a coverage recovery technique for Msg2.  Regarding PRACH, our results are based on Format B4 (30 KHz SCS). |
| Samsung |  | No TBS scaling was used for Msg2. |
| CATT |  | For Msg2, we use MCS#0 with no TBS scaling. |
| Xiaomi |  | For Msg.2, we use MCS#0 w/o TBS scaling |
| ZTE |  | We are fine with the proposal.  For Msg.2, we use (3 RBs, MCS#0, TBS = 9 bytes) w/o TBS scaling. |
| CMCC |  | For Msg2, we use MCS#0 with no TBS scaling.  For PRACH, we use Format B4. |
| InterDigital |  | For Msg2, we used 3 RBs, MCS0, 72 bits. |
| OPPO |  | For Msg2, we used 3 RBs, MCS0, without TBS scaling. |
| **FL5** | Based on the received responses, the FL’s updated suggestion is as following.  **[FL5] Updated Proposal 3.1-1:**   * Capture the link budget evaluation results (Urban 2.6 GHz) in Table 3.1-1 to Table 3.1-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables. | |
| Panasonic | Y |  |
| vivo |  | Fine with the proposal. |
| Qualcomm | Y | Fine with FL proposal |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Samsung | Y |  |
| Intel |  | One clarification, assuming the different simulated scaling factors for msg2 and different simulated PRACH formats are clarified, is it the intention that a different representative value is derived for each different scaling factor and different PRACH format? For TB scaling, our view is that the lowest available scaling factor assumption should be used. |
| OPPO | Y |  |
| CATT | Y |  |
| FL5 | All responses agree with the proposal except that one response suggests to clarify how to handle different assumptions for Msg2 TBS scaling and PRACH format.  The FL understanding is that Msg2 with no TBS scaling will be used as baseline for deriving representative value. Categorization by different scaling factors may not be acceptable since the number of samples in each category will be small and not useful to draw the conclusion  Based on the received responses, one company considers ¼ TBS scaling for Msg2 and the other companies evaluate Msg2 with no TBS scaling and one company evaluates both scaling and no scaling. Therefore, the representation value based on all the companies results (with and without TBS scaling) can be acceptable since the outlier value with TBS scaling has been removed.  For PRACH format, it seems all the companies use the same format as recommended in the template. Therefore, no divergence is observed.  **Further updated Proposal 3.1-1:**   * Capture the link budget evaluation results (Urban 2.6 GHz) in Table 3.1-1 to Table 3.1-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables | |

Based on the evaluation results in Table 3.1-1, 3.1-2 and 3.1-3, the channels that potentially need coverage recovery in Urban scenario at 2.6 GHz and the summary of companies evaluation results for the margin to the coverage recovery target (i.e. the MIL of bottleneck channel for the reference NR UE) are summarized in Table 3.1-4, where the numbers in bracket is the number of samples.

**Table 3.1-4: Coverage recovery for RedCap UE in Urban scenario at 2.6 GHz (Option 3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Channels | Mean | Median | Range | Representative value |
| 2Rx RedCap | PUSCH (17) | **-3.0** | **-3.0** | **0.4** | **-3.0** |
| 1Rx RedCap | PUSCH (17) | **-3.0** | **-3.0** | **0.4** | **-3.0** |

**Question 3.1-2: Can Table 3.1-4 be captured to TR 38.875? If not, any other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FL |  | Table 3.1-4 has been updated by considering all the companies’ evaluation results. The representative value in the table is expected to be updated based on the agreement for the coverage recovery target in section 2, and the positive representative value indicates the LB of the concerned channel is better than the MIL of the bottleneck channel of the reference NR UE. |
| ZTE |  | Considering there is an FFS point regarding how to use the representative value as discussed in section 2, it may be also necessary to capture the representative value for case ‘100MHz BW, 4Rx’. In addition, it would be more informative if we can provide the representative values for all channels, e.g., by adding a row for representative value for each channel in Table 3.1.1~3.1.4. Of course, it would need tremendous efforts from moderator.  *Details are FFS (e.g. coverage recovery is not needed if the representative value of a channel is larger than zero)* |
| Qualcomm | N | Prefer to wait until proposal 1 is stable/agreed |
| Nokia, NSB |  | We prefer to wait until proposal 1 is agreed. The details of how the amount for coverage recovery will be determined from the representative value is FFS. If the representative value is meant to indicate the amount of coverage recovery, then we think that it is better to resolve the FFS first before agreeing to capture this table. |
| Futurewei | Y | 2.6 GHz seems to be consistent as such conclusion is OK |
| NTT DOCOMO |  | The outcome is derived based on the current proposal in Section 2, it may be better to wait the consensus in Section2, though we are fine with the proposal. |
| Ericsson | Y | It appears that the results from all companies are well aligned.  We suggest clarifying (1) the meaning of the numbers in parentheses, and (2) how the range is computed (e.g., maximum-minimum) |
| CATT | Y | Generally fine.  Also, we think the values in the above table are more like ‘coverage loss’ compared to the bottleneck channel, a little different from ‘coverage recovery’ which are still under discussion in proposal 1. May consider revising the title from ‘recovery’ to ‘loss’. |
| Intel |  | The table can be formed after proposal is section 2 is finalized. |
| Samsung |  | FFS in proposal #1 should be determined before agreeing this. |
| Huawei, Hisilicon | N | We prefer to wait until proposal 1 is agreed. The representative value is apparently related to the target performance requirements. |
| Xiaomi |  | It would be better to wait for more stable proposal 1 |
| OPPO |  | Share the comments with Samsung. |

Based on the results in Table 3.1-4, the following observations are proposed for discussion for the TP drafting for TR 38.875.

**Moderator’s observation**

* P1: For RedCap UE in Urban scenario at 2.6 GHz, PUSCH is the channel that needs recovery and the amount of compensation is approximately 3Db.
* P2: A coverage degradation of approximately 1 dB relative to the target coverage is observed for Msg3 at 2.6 GHz carrier frequency by one source company
* P3: For a RedCap UE with 1Rx and 2 Rx antenna at 2.6 GHz carrier frequency, all downlink channels can reach the target coverage requirement thus requiring no compensation

**Question 3.1-3: Can the above list (P1-P3) be used as a baseline text for TR 38.875? If not, what other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | N | Prefer to wait until proposal 1 is stable/agreed |
| Nokia, NSB |  | We prefer to wait until proposal 1 is agreed |
| Futurewei | Y | Can add that MIL was used for this analysis |
| NTT DOCOMO |  | We can wait the agreement of proposal 1. |
| Ericsson |  | P1: For PUSCH, it can be clarified the 3 dB coverage compensation is needed if the target data rate for RedCap Ues is the same as reference UE. We should add a note here to state that the 3 dB coverage compensation is not needed if the target data rate for RedCap Ues is reduced.  We can further mention that the 3 dB loss is resulting from the UE antenna efficiency loss assumed for the wearable use cases only. |
| CATT |  | Generally fine with the observation. Also OK to wait until further progress of proposal 1 is made. |
| Samsung |  | It can be mentioned that 3dB antenna loss is resulted from reduced antenna efficiency due to device size limitations for wearables. |
| Huawei, Hisilicon | N | We prefer to wait until proposal 1 is agreed. |
| Xiaomi |  | It would be better to wait for more stable proposal 1 |

**[FL5] Based on the received responses, the FL’s updated text proposal is as following.**

**(FL note: based on the outcome of Proposal 2-1, some numbers in the tables can be further updated, however, the conclusion is expected to be same)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| For Urban scenario at 2.6 GHz, the bottleneck channel for the reference NR UE and the corresponding maximum isotropic loss (MIL) value by the sourcing companies are shown in Table 9.1-1. The estimated coverage loss for the RedCap UE relative to the bottleneck channel of the reference NR UE is summarized in Table 9.1-2 and Table 9.1-3. It is noted that the 3dB antenna efficiency loss is assumed in both DL and UL for the RedCap UE.  **Table 9.1-1: Bottleneck channel and MIL value for Reference NR UE in Urban 2.6 GHz**   |  |  |  | | --- | --- | --- | |  | Bottleneck Channel | MIL (dB) | | Samsung | PUSCH | 139.4 | | ZTE | PUSCH | 142.0 | | OPPO | PUSCH | 145.1 | | CATT | PUSCH | 145.9 | | vivo | PUSCH | 137.8 | | Xiaomi | PUSCH | 146.7 | | Futurewei | PUSCH | 151.6 | | Nokia | PUSCH | 138.6 | | DCM | PUSCH | 145.7 | | CMCC | PUSCH | 139.8 | | Huawei | PUSCH | 139.0 | | SPRD | PUSCH | 145.7 | | Apple | PUSCH | 140.0 | | Ericsson | PUSCH | 143.9 | | IDCC | PUSCH | 143.2 | | QC | PUSCH | 139.4 | | Intel | PUSCH | 143.9 |   The representative values in the last row of Table 9.1-2 and Table 9.1-3 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE and coverage recovery is needed.  As can be seen in the last row for the representative value, all the channels except for PUSCH have better coverage than that of the bottleneck channel thus requiring no compensation. On average, a coverage degradation of approximately 3dB is observed for PUSCH.  It should be noted that the 3dB loss is resulted from the UE antenna efficiency loss assumed for the wearable use cases. Furthermore, the same target data rate of 1Mbps for PUSCH is assumed for both RedCap UE and the reference UE (see evaluation methodology described in clause 6.3). A smaller or no coverage loss for PUSCH is expected if the target data rate for RedCap UE is reduced.  **Table 9.1-2: Coverage loss (dB) for 2Rx RedCap UE in Urban scenario at 2.6 GHz (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | Samsung | 20.6 | 24.6 | 17.2 | 16.3 | 17.2 |  | 15.8 | 12.2 | 8.9 | -3.0 | 7.6 |  | | ZTE |  |  |  |  |  |  | 17.7 | 15.9 | 13.4 | -3.0 | 11.5 |  | | OPPO | 16.0 | 20.0 | 19.5 | 10.1 | 13.8 |  | 6.8 | 6.8 | 6.7 | -3.2 | 6.6 |  | | CATT | 13.2 | 17.2 | 15.7 | 7.8 | 11.4 |  | 11.4 | 10.0 | 7.9 | -3.0 | 4.6 |  | | vivo | 14.2 | 22.2 | 17.2 | 11.8 | 13.7 | 17.6 | 15.4 | 12.9 | 10.3 | -2.8 | 11.6 | 8.9 | | Xiaomi | 14.0 | 14.0 | 14.1 | 8.6 | 11.6 |  | 11.9 | 9.2 | 7.5 | -3.0 | 4.9 |  | | Futurewei | 7.3 | 9.3 | 7.6 | 5.6 | 6.4 |  |  |  |  | -3.0 | -1.1 |  | | Nokia | 23.9 | 23.9 | 21.7 | 22.9 | 21.7 |  | 10.1 |  | 8.6 | -3.0 | 6.2 | 8.7 | | DCM | 14.1 | 18.1 | 14.1 | 7.2 | 10.3 |  | 12.4 | 16.2 |  | -3.0 | 5.9 |  | | CMCC | 17.4 | 23.0 | 21.3 | 14.8 | 17.6 | 19.0 | 13.5 | 11.7 | 9.6 | -3.0 | 10.1 | 15.9 | | Huawei | 19.0 | 23.0 | 17.9 | 15.7 | 15.6 |  | 18.6 |  | 16.3 | -3.0 | 7.7 |  | | SPRD | 13.2 | 17.2 | 15.1 | 12.0 | 12.0 | 14.5 | 9.7 | 7.9 | 7.5 | -3.0 | 1.8 | 7.0 | | Apple | 14.4 | 22.4 | 17.4 | 7.3 | 10.4 |  |  |  | 7.8 | -3.0 | 1.8 |  | | Ericsson | 11.8 | 11.8 | 12.5 | 6.2 | 8.9 | 13.8 | 8.0 | 8.6 | 6.7 | -3.0 | 4.3 | 8.1 | | IDCC | 15.5 | 19.6 | 17.1 | 10.6 | 13.6 |  | 13.9 |  | 9.6 | -3.0 | 6.6 |  | | QC | 16.5 |  | 18.4 | 12.6 | 14.9 |  |  |  | 4.2 | -3.0 | 5.9 |  | | Intel | 15.8 | 17.1 | 13.7 | 16.7 | 14.0 | 18.8 | 15.1 | 13.8 | 11.2 | -3.0 | 7.6 | 9.8 | | Representative value (dB) | **15.4** | **19.2** | **16.5** | **11.3** | **13.2** | **17.0** | **12.9** | **11.3** | **8.9** | **-3.0** | **6.2** | **8.9** |   Note: All sources except for Source X (Intel) assume no TBS scaling for Msg2 evaluation  **Table 9.1-3: Coverage loss (dB) for 1Rx RedCap UE in Urban scenario at 2.6 GHz (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | Samsung | 17.1 | 21.1 | 12.4 | 11.1 | 13.7 |  | 15.8 | 12.2 | 8.9 | -3.0 | 7.6 |  | | ZTE | 5.9 | 16.3 | 18.8 | 9.0 | 9.4 |  | 17.7 | 15.9 | 13.4 | -3.0 | 11.5 |  | | OPPO | 12.1 | 16.1 | 16.9 | 4.1 | 9.9 |  | 6.8 | 6.8 | 6.7 | -3.2 | 6.6 |  | | CATT | 9.5 | 13.5 | 11.9 | 1.6 | 8.0 |  | 11.4 | 10.0 | 7.9 | -3.0 | 4.6 |  | | vivo | 10.9 | 19.0 | 12.8 | 6.9 | 9.0 | 14.5 | 15.4 | 12.9 | 10.3 | -2.8 | 11.6 | 8.9 | | Xiaomi | 10.9 | 10.9 | 10.5 | 3.4 | 7.6 |  | 11.9 | 9.2 | 7.5 | -3.0 | 4.9 |  | | Futurewei | 4.7 | 6.7 | 5.6 | 2.6 | 3.2 |  |  |  |  | -3.0 | -1.1 |  | | Nokia | 19.9 | 19.9 | 18.2 | 19.2 | 17.9 |  | 10.1 |  | 8.6 | -3.0 | 6.2 | 8.7 | | DCM | 10.7 | 14.7 | 10.0 | 1.5 | 6.1 |  | 12.4 | 16.2 |  | -3.0 | 5.9 |  | | CMCC |  |  |  |  |  |  | 13.5 | 11.7 | 9.6 | -3.0 | 10.1 | 15.9 | | Huawei | 15.9 | 19.9 | 14.1 | 11.4 | 11.7 |  | 18.6 |  | 16.3 | -3.0 | 7.7 |  | | SPRD | 10.2 | 14.2 | 12.1 | 9.0 | 9.0 | 11.5 | 9.7 | 7.9 | 7.5 | -3.0 | 1.8 | 7.0 | | Apple | 11.0 | 19.0 | 12.8 | 1.8 | 6.1 |  |  |  | 7.8 | -3.0 | 1.8 |  | | Ericsson | 8.8 | 8.8 | 9.3 | 1.3 | 4.9 | 9.9 | 8.0 | 8.6 | 6.7 | -3.0 | 4.3 | 8.1 | | IDCC | 12.3 | 16.3 | 14.0 | 6.0 | 10.5 |  | 13.9 |  | 9.6 | -3.0 | 6.6 |  | | QC | 13.2 |  | 15.3 | 8.7 | 11.6 |  |  |  | 4.2 | -3.0 | 5.9 |  | | Intel\* |  |  |  |  |  |  | 15.1 | 13.8 | 11.2 | -3.0 | 7.6 | 9.8 | | Representative value (dB) | **11.4** | **15.7** | **13.1** | **5.9** | **9.1** | **12.0** | **12.9** | **11.3** | **8.9** | **-3.0** | **6.2** | **8.9** |   Note: All sources except for Source X (Intel) assume no TBS scaling for Msg2 evaluation |

**[FL5] Question 3.1-1A:** **Can the above observations of the relative coverage loss be used as a baseline text for TR 38.875? If not, what aspects to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Panasonic | Y |  |
| vivo |  | It would be useful to make if clear   * + - 1. All companies except one company does not apply TBS scaling for MSG2       2. PRACH format B4 is simulated |
| ZTE | Y | Fine with the observation. |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y | The observations are fine.  The numbers in the tables need to be doble-checked. For example, it appears that Ericsson results for Msg2 are based on no TBS scaling (see v015 or later for results with TBS scaling for Msg2). TBS scaling in this case does not affect the observation. So we are fine with the observations. |
| Samsung |  | In “Note”, \* seems missing because all companies except only one company indicated no TBS scaling. |
| Intel | Y |  |
| OPPO | Y |  |
| CATT | Y | Generally OK.  Regarding to the sentence “A smaller coverage loss for PUSCH is expected if the target data rate for RedCap UE is reduced”, we think it is right intuitively. But if the target data rate for RedCap is reduced (e.g. to half), it is possible no coverage loss will be observed:  A smaller/no coverage loss for PUSCH is expected if the target data rate for RedCap UE is reduced.  And similar to Samsung, it seems a mark \* is missing. |
| FL5 | The TP above has been updated based on the received response. The PRACH format has been added in the Table 9.1-2 and Table 9.1-3. The note for Msg2 assumption has been updated to make it clearer.  **Proposal 3.1-1A:**   * Adopted the updated TP in section 3.1 of R1-2009660 as baseline text for TR clause 9.1 | |
| vivo | modifications | We have agreed the following in the last GTW call   * + The representative value of a channel is used for identifying whether the channel needs coverage recovery     - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero     - The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc   Therefore the need and amount of coverage compensation should be discussed separately, not solely based on the coverage degradation. We should make the following change  The representative values in the last row of Table 9.1-2 and Table 9.1-3 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE ~~and coverage recovery is needed.~~ |
| FL5 | The proposal to remove “and coverage recovery is needed” may be okay based on the agreement we made in last GTW call. The FL’s updated proposal is as following.  **Updated proposal 3.1-1A:**   * Adopted the updated TP in section 3.1 of R1-2009660 as baseline text for TR clause 9.1   + Remove “and coverage recovery is needed” from the TP | |
| Huawei, Hisilicon | Y | Fine with the observation. |
| CMCC | Y | Fine with the observation. |

## FR1, Rural with the carrier frequency of 0.7 GHz

Based on the latest available evaluation results in [RedCapCoverage-700MHz-v018-Panasonic](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Inbox/drafts/8.6/EvaluationResults/RedCapCoverage/700MHz/RedCapCoverage-700MHz-v018-Panasonic.xlsx), the link budget performance for both the reference UE and RedCap UE in rural scenario at 0.7GHz is summarized in Table 3.2-1 to Table 3.2-3 (Company please double check whether your results are correctly captured in these tables. We have found there are some mismatch between the spreadsheet and the contribution for some companies results).

In the link budget tables, the maximum isotropic loss (MIL) is used as the coverage evaluation metric and for each channel the margin to the target performance is also shown, where the target performance is a company specific value and derived based on the link budget of the bottleneck channel for the reference NR UE (i.e. Option 3). The coverage limiting channel for RedCap UE, e.g. the link budget for the channel worse than that target performance, is highlighted with RED.

**Table 3.2-1: Link budget performance for the reference NR UE (20MHz BW, 2Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Rural 700MHz, 2Rx Reference UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 162.4 | 162.4 | 157.9 | 157.9 | 158.9 |  | 158.3 | 154.5 | 151.5 | 146.6 | 149.5 |  | 146.6 |
| Margin (dB) | 15.9 | 15.9 | 11.4 | 11.4 | 12.4 |  | 11.7 | 7.9 | 4.9 | 0.0 | 2.9 |  |  |
| ZTE | MIL (dB) | 154.8 | 158.5 | 157.4 | 154.4 | 154.7 |  | 152.6 | 150.6 | 147.9 | 143.6 | 143.2 |  | 143.2 |
| Margin (dB) | 11.6 | 15.3 | 14.2 | 11.2 | 11.5 |  | 9.4 | 7.4 | 4.7 | 0.4 | 0.0 |  |  |
| OPPO | MIL (dB) | 163.1 | 163.1 | 162.0 | 157.0 | 161.0 |  | 149.0 | 149.1 | 148.9 | 150.0 | 149.5 |  | 148.9 |
| Margin (dB) | 14.2 | 14.2 | 13.0 | 8.0 | 12.1 |  | 0.1 | 0.2 | 0.0 | 1.1 | 0.5 |  |  |
| CATT | MIL (dB) | 158.7 | 158.7 | 155.9 | 153.5 | 156.8 |  | 156.7 | 155.4 | 153.3 | 147.9 | 150.7 |  | 147.9 |
| Margin (dB) | 10.7 | 10.7 | 8.0 | 5.6 | 8.9 |  | 8.7 | 7.5 | 5.4 | 0.0 | 2.7 |  |  |
| vivo | MIL (dB) | 155.0 | 155.1 | 152.0 | 149.8 | 152.7 | 159.2 | 150.3 | 147.4 | 145.0 | 144.0 | 146.3 | 145.7 | 144.0 |
| Margin (dB) | 11.0 | 11.1 | 8.0 | 5.8 | 8.8 | 15.2 | 6.3 | 3.5 | 1.1 | 0.0 | 2.3 | 1.7 |  |
| Xiaomi | MIL (dB) | 160.0 | 160.0 | 157.6 | 154.9 | 158.1 |  | 158.0 | 155.4 | 152.9 | 149.7 | 150.9 |  | 149.7 |
| Margin (dB) | 10.3 | 10.3 | 7.9 | 5.2 | 8.4 |  | 8.3 | 5.7 | 3.2 | 0.0 | 1.2 |  |  |
| Futurewei | MIL (dB) | 161.1 | 161.1 | 158.1 | 157.9 | 159.1 |  |  |  |  | 150.8 | 153.0 |  | 150.8 |
| Margin (dB) | 10.4 | 10.4 | 7.4 | 7.2 | 8.4 |  |  |  |  | 0.0 | 2.2 |  |  |
| Nokia | MIL (dB) | 158.0 | 158.0 | 159.5 | 156.7 | 159.4 |  | 144.9 |  | 143.7 | 144.2 | 138.5 | 147.9 | 138.5 |
| Margin (dB) | 19.5 | 19.5 | 21.0 | 18.1 | 20.9 |  | 6.4 |  | 5.2 | 5.6 | 0.0 | 9.4 |  |
| DOCOMO | MIL (dB) | 162.5 | 162.5 | 158.1 | 155.1 | 158.1 |  | 155.9 | 161.2 |  | 146.7 | 149.5 |  | 146.7 |
| Margin (dB) | 15.8 | 15.8 | 11.4 | 8.4 | 11.4 |  | 9.2 | 14.6 |  | 0.0 | 2.8 |  |  |
| Panasonic | MIL (dB) |  | 161.8 | 151.8 |  |  |  | 152.6 | 150.2 | 146.2 | 141.8 | 144.6 |  | 141.8 |
| Margin (dB) |  | 20.0 | 10.0 |  |  |  | 10.8 | 8.4 | 4.4 | 0.0 | 2.8 |  |  |
| Huawei | MIL (dB) | 157.2 | 157.2 | 152.9 | 152.9 | 153.6 |  | 152.8 |  | 150.6 | 141.8 | 145.3 |  | 141.8 |
| Margin (dB) | 15.5 | 15.5 | 11.1 | 11.1 | 11.8 |  | 11.0 |  | 8.8 | 0.0 | 3.5 |  |  |
| Spreadtrum | MIL (dB) | 161.0 | 161.0 | 159.0 | 160.0 | 160.0 | 163.0 | 160.5 | 157.5 | 157.3 | 151.5 | 154.5 | 156.8 | 151.5 |
| Margin (dB) | 9.6 | 9.6 | 7.6 | 8.6 | 8.6 | 11.6 | 9.0 | 6.0 | 5.8 | 0.0 | 3.0 | 5.4 |  |
| Apple | MIL (dB) | 157.7 | 157.7 | 155.9 | 151.5 | 155.7 |  |  |  |  | 143.7 |  |  | 143.7 |
| Margin (dB) | 14.0 | 14.0 | 12.2 | 7.8 | 12.0 |  |  |  |  | 0.0 |  |  |  |
| Ericsson | MIL (dB) | 157.3 | 156.6 | 155.6 | 153.2 | 155.9 | 157.3 | 149.4 | 157.9 | 147.4 | 142.9 | 145.0 | 147.9 | 142.9 |
| Margin (dB) | 14.5 | 13.8 | 12.8 | 10.4 | 13.1 | 14.5 | 6.5 | 15.0 | 4.5 | 0.0 | 2.1 | 5.1 |  |
| InterDigital | MIL (dB) | 161.2 | 161.2 | 158.5 | 152.31 | 155.16 |  | 155.8 |  | 150.8 | 146.7 | 144.44 |  | 144.44 |
| Margin (dB) | 16.76 | 16.76 | 14.06 | 7.87 | 10.72 |  | 11.36 |  | 6.36 | 2.26 | 0.0 |  |  |
| Qualcomm | MIL (dB) | 158.4 |  | 154.5 | 152.9 | 154.9 |  |  |  | 143.8 | 141.3 | 143.8 |  | 141.3 |
| Margin (dB) | 17.1 |  | 13.2 | 11.6 | 13.6 |  |  |  | 2.5 | 0.0 | 2.5 |  |  |
| Intel | MIL (dB) | 161.6 | 161.6 | 158.3 | 162.7 | 160.1 | 160.4 | 154.4 | 154.7 | 152.0 | 146.7 | 149.6 | 152.3 | 146.7 |
| Margin (dB) | 14.9 | 14.9 | 11.6 | 16.0 | 13.4 | 13.7 | 7.7 | 8.0 | 5.3 | 0.0 | 2.8 | 5.6 |  |

**Table 3.2-2: Link budget performance for the RedCap UE (20MHz BW, 2Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Rural 700MHz, 2Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 159.4 | 159.4 | 154.9 | 154.9 | 155.9 |  | 155.3 | 151.5 | 148.5 | 143.6 | 146.5 |  | 146.6 |
| Margin (dB) | 12.9 | 12.9 | 8.4 | 8.4 | 9.4 |  | 8.7 | 4.9 | 1.9 | -3.0 | -0.1 |  |  |
| ZTE | MIL (dB) |  |  |  |  |  |  | 149.6 | 147.6 | 144.9 | 140.6 | 140.2 |  | 143.2 |
| Margin (dB) |  |  |  |  |  |  | 6.4 | 4.4 | 1.7 | -2.6 | -3.0 |  |  |
| OPPO | MIL (dB) | 160.1 | 160.1 | 159.0 | 154.0 | 158.0 |  | 146.0 | 146.1 | 145.9 | 147.0 | 146.5 |  | 148.9 |
| Margin (dB) | 11.2 | 11.2 | 10.0 | 5.0 | 9.1 |  | -2.9 | -2.8 | -3.0 | -1.9 | -2.5 |  |  |
| CATT | MIL (dB) | 155.4 | 155.4 | 152.8 | 150.5 | 153.8 |  | 153.6 | 152.4 | 150.3 | 144.9 | 147.7 |  | 147.9 |
| Margin (dB) | 7.5 | 7.5 | 4.9 | 2.6 | 5.9 |  | 5.6 | 4.5 | 2.4 | -3.1 | -0.3 |  |  |
| vivo | MIL (dB) | 152.0 | 152.1 | 149.0 | 146.8 | 149.7 | 156.2 | 147.3 | 144.4 | 142.0 | 141.0 | 143.3 | 142.7 | 144.0 |
| Margin (dB) | 8.0 | 8.1 | 5.0 | 2.8 | 5.8 | 12.2 | 3.3 | 0.5 | -1.9 | -3.0 | -0.7 | -1.3 |  |
| Xiaomi | MIL (dB) | 157.0 | 157.0 | 154.6 | 151.9 | 155.1 |  | 155.0 | 152.4 | 149.9 | 146.7 | 147.9 |  | 149.7 |
| Margin (dB) | 7.3 | 7.3 | 4.9 | 2.2 | 5.4 |  | 5.3 | 2.7 | 0.2 | -3.0 | -1.8 |  |  |
| Futurewei | MIL (dB) | 158.1 | 158.1 | 155.1 | 154.9 | 156.1 |  |  |  |  | 147.8 | 150.0 |  | 150.8 |
| Margin (dB) | 7.4 | 7.4 | 4.4 | 4.2 | 5.4 |  |  |  |  | -3.0 | -0.8 |  |  |
| Nokia | MIL (dB) | 155.0 | 155.0 | 156.5 | 153.7 | 156.4 |  | 141.9 |  | 140.7 | 141.2 | 135.5 | 144.9 | 138.5 |
| Margin (dB) | 16.5 | 16.5 | 18.0 | 15.1 | 17.9 |  | 3.4 |  | 2.2 | 2.6 | -3.0 | 6.4 |  |
| DOCOMO | MIL (dB) |  |  |  |  |  |  | 152.9 | 158.2 |  | 143.7 | 146.5 |  | 146.7 |
| Margin (dB) |  |  |  |  |  |  | 6.2 | 11.6 |  | -3.0 | -0.2 |  |  |
| Panasonic | MIL (dB) |  | 158.8 | 148.8 |  |  |  | 149.6 | 147.2 | 143.2 | 138.8 | 141.6 |  | 141.8 |
| Margin (dB) |  | 17.0 | 7.0 |  |  |  | 7.8 | 5.4 | 1.4 | -3.0 | -0.2 |  |  |
| Huawei | MIL (dB) | 154.2 | 154.2 | 149.9 | 149.9 | 150.6 |  | 149.8 |  | 147.6 | 138.8 | 142.3 |  | 141.8 |
| Margin (dB) | 12.5 | 12.5 | 8.1 | 8.1 | 8.8 |  | 8.0 |  | 5.8 | -3.0 | 0.5 |  |  |
| Spreadtrum | MIL (dB) | 158.0 | 158.0 | 156.0 | 157.0 | 157.0 | 160.0 | 157.5 | 154.5 | 154.3 | 148.5 | 151.5 | 153.8 | 151.5 |
| Margin (dB) | 6.6 | 6.6 | 4.6 | 5.6 | 5.6 | 8.6 | 6.0 | 3.0 | 2.8 | -3.0 | 0.0 | 2.4 |  |
| Apple | MIL (dB) | 154.7 | 154.7 | 152.9 | 148.5 | 152.7 |  |  |  |  | 140.7 |  |  | 143.7 |
| Margin (dB) | 11.0 | 11.0 | 9.2 | 4.8 | 9.0 |  |  |  |  | -3.0 |  |  |  |
| Ericsson | MIL (dB) | 154.3 | 153.6 | 149.0 | 150.2 | 152.9 | 154.3 | 146.4 | 154.9 | 144.4 | 139.9 | 142.0 | 144.9 | 142.9 |
| Margin (dB) | 11.5 | 10.8 | 6.2 | 7.4 | 10.1 | 11.5 | 3.5 | 12.0 | 1.5 | -3.0 | -0.9 | 2.1 |  |
| InterDigital | MIL (dB) | 158.2 | 158.2 | 155.52 | 149.31 | 152.16 |  | 152.8 |  | 147.8 | 143.7 | 141.44 |  | 144.44 |
| Margin (dB) | 13.76 | 13.76 | 11.08 | 4.87 | 7.72 |  | 8.36 |  | 3.36 | -0.74 | -3.0 |  |  |
| Qualcomm | MIL (dB) | 155.4 |  | 151.5 | 149.9 | 151.9 |  |  |  | 140.8 | 138.3 | 140.8 |  | 141.3 |
| Margin (dB) | 14.1 |  | 10.2 | 8.6 | 10.6 |  |  |  | -0.5 | -3.0 | -0.5 |  |  |
| Intel | MIL (dB) |  |  |  |  |  |  | 151.4 | 151.7 | 149.0 | 143.7 | 146.6 | 149.3 | 146.7 |
| Margin (dB) |  |  |  |  |  |  | 4.7 | 5.0 | 2.3 | -3.0 | -0.2 | 2.6 |  |

**Table 3.2-3: Link budget performance for the RedCap UE (20MHz BW, 1Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Rural 700MHz, 1Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 155.7 | 155.7 | 150.6 | 149.0 | 152.2 |  | 155.3 | 151.5 | 148.5 | 143.6 | 146.5 |  | 146.6 |
| Margin (dB) | 9.2 | 9.2 | 4.1 | 2.5 | 5.7 |  | 8.7 | 4.9 | 1.9 | -3.0 | -0.1 |  |  |
| ZTE | MIL (dB) | 148.3 | 152.0 | 149.7 | 146.5 | 146.7 |  | 149.6 | 147.6 | 144.9 | 140.6 | 140.2 |  | 143.2 |
| Margin (dB) | 5.1 | 8.8 | 6.5 | 3.3 | 3.5 |  | 6.4 | 4.4 | 1.7 | -2.6 | -3.0 |  |  |
| OPPO | MIL (dB) | 155.5 | 155.5 | 155.4 | 148.6 | 153.8 |  | 146.0 | 146.1 | 145.9 | 147.0 | 146.5 |  | 148.9 |
| Margin (dB) | 6.6 | 6.6 | 6.5 | -0.4 | 4.8 |  | -2.9 | -2.8 | -3.0 | -1.9 | -2.5 |  |  |
| CATT | MIL (dB) | 152.0 | 152.0 | 149.6 | 144.1 | 149.5 |  | 153.6 | 152.4 | 150.3 | 144.9 | 147.7 |  | 147.9 |
| Margin (dB) | 4.0 | 4.0 | 1.7 | -3.9 | 1.5 |  | 5.6 | 4.5 | 2.4 | -3.1 | -0.3 |  |  |
| vivo | MIL (dB) | 149.3 | 149.3 | 145.5 | 141.5 | 145.7 | 152.4 | 147.3 | 144.4 | 142.0 | 141.0 | 143.3 | 142.7 | 144.0 |
| Margin (dB) | 5.3 | 5.3 | 1.5 | -2.5 | 1.8 | 8.4 | 3.3 | 0.5 | -1.9 | -3.0 | -0.7 | -1.3 |  |
| Xiaomi | MIL (dB) | 153.6 | 153.6 | 150.5 | 146.2 | 150.6 |  | 155.0 | 152.4 | 149.9 | 146.7 | 147.9 |  | 149.7 |
| Margin (dB) | 3.9 | 3.9 | 0.8 | -3.5 | 0.9 |  | 5.3 | 2.7 | 0.2 | -3.0 | -1.8 |  |  |
| Futurewei | MIL (dB) | 154.2 | 154.2 | 150.9 | 149.0 | 153.1 |  |  |  |  | 147.8 | 150.0 |  | 150.8 |
| Margin (dB) | 3.5 | 3.5 | 0.1 | -1.7 | 2.4 |  |  |  |  | -3.0 | -0.8 |  |  |
| Nokia | MIL (dB) | 150.7 | 150.7 | 153.9 | 150.0 | 153.4 |  | 141.9 |  | 140.7 | 141.2 | 135.5 | 144.9 | 138.5 |
| Margin (dB) | 12.2 | 12.2 | 15.4 | 11.5 | 14.9 |  | 3.4 |  | 2.2 | 2.6 | -3.0 | 6.4 |  |
| DOCOMO | MIL (dB) | 156.2 | 156.2 | 150.9 | 145.8 | 150.8 |  | 152.9 | 158.2 |  | 143.7 | 146.5 |  | 146.7 |
| Margin (dB) | 9.5 | 9.5 | 4.2 | -0.9 | 4.1 |  | 6.2 | 11.6 |  | -3.0 | -0.2 |  |  |
| Panasonic | MIL (dB) |  | 155.9 | 145.1 |  |  |  | 149.6 | 147.2 | 143.2 | 138.8 | 141.6 |  | 141.8 |
| Margin (dB) |  | 14.1 | 3.3 |  |  |  | 7.8 | 5.4 | 1.4 | -3.0 | -0.2 |  |  |
| Huawei | MIL (dB) | 150.9 | 150.9 | 146.2 | 145.6 | 146.6 |  | 149.8 |  | 147.6 | 138.8 | 142.3 |  | 141.8 |
| Margin (dB) | 9.1 | 9.1 | 4.4 | 3.8 | 4.8 |  | 8.0 |  | 5.8 | -3.0 | 0.5 |  |  |
| Spreadtrum | MIL (dB) | 155.0 | 155.0 | 153.0 | 154.0 | 153.0 | 157.0 | 157.5 | 154.5 | 154.3 | 148.5 | 151.5 | 153.8 | 151.5 |
| Margin (dB) | 3.6 | 3.6 | 1.6 | 2.6 | 1.6 | 5.6 | 6.0 | 3.0 | 2.8 | -3.0 | 0.0 | 2.4 |  |
| Apple | MIL (dB) | 151.7 | 151.7 | 148.8 | 144.0 | 148.0 |  |  |  |  | 140.7 |  |  | 143.7 |
| Margin (dB) | 8.0 | 8.0 | 5.1 | 0.3 | 4.3 |  |  |  |  | -3.0 |  |  |  |
| Ericsson | MIL (dB) | 149.9 | 150.1 | 149.0 | 146.1 | 149.2 | 149.9 | 146.4 | 154.9 | 144.4 | 139.9 | 142.0 | 144.9 | 142.9 |
| Margin (dB) | 7.1 | 7.3 | 6.2 | 3.3 | 6.4 | 7.1 | 3.5 | 12.0 | 1.5 | -3.0 | -0.9 | 2.1 |  |
| InterDigital | MIL (dB) | 154.4 | 154.4 | 151.87 | 143.79 | 148.53 |  | 152.8 |  | 147.8 | 143.7 | 141.44 |  | 144.44 |
| Margin (dB) | 9.96 | 9.96 | 7.43 | -0.65 | 4.09 |  | 8.36 |  | 3.36 | -0.74 | -3.0 |  |  |
| Qualcomm | MIL (dB) | 151.6 |  | 148.1 | 145.4 | 148.5 |  |  |  | 140.8 | 138.3 | 140.8 |  | 141.3 |
| Margin (dB) | 10.3 |  | 6.8 | 4.1 | 7.2 |  |  |  | -0.5 | -3.0 | -0.5 |  |  |
| Intel | MIL (dB) | 154.6 | 154.6 | 151.9 | 156.4 | 153.6 | 157.4 | 151.4 | 151.7 | 149.0 | 143.7 | 146.6 | 149.3 | 146.7 |
| Margin (dB) | 7.9 | 7.9 | 5.2 | 9.7 | 6.9 | 10.7 | 4.7 | 5.0 | 2.3 | -3.0 | -0.2 | 2.6 |  |

**Question 3.2-1: Can the link budget evaluation results in Table 3.2-1 to Table 3.2-3 be captured to TR 38.875? (Companies are invited to check the result and if any modification is needed, please also indicate here.)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | If possible, it would be useful to clarify the assumption in the simulation   1. For PRACH, the simulated format 2. For MSG2, whether existing TBS scaling is used? |
| ZTE | Y | Fine to capture the tables into the TR. |
| Qualcomm | Y | We support company to clarify whether TBS scaling is used for Msg2 evaluation. It may be difficult to derive this information from the spreadsheet since the use of a large number of PRB may be also for large payload of Msg2. However, we don’t think there is a need to split the tables for Msg2 with and without TBS scaling. |
| Nokia, NSB | Y |  |
| Futurewei |  | Same as 3.1-1 |
| NTT DOCOMO | Y |  |
| Ericsson | Y |  |
| CATT | Y |  |
| Intel | Y | Fine to capture the tables into TR. Fine to clarify PRACH format and TBS scaling for msg2. |
| Samsung |  | For Msg 2, it should be clarified whether or not Rel-15 TBS scaling was applied for each simulation result. |
| InterDigital | Y | We have provide some update on our results. |
| FL4 | Majority of responses are fine with capturing the above link budget evaluation results to TR 38.875. One response suggests the results can be captured in an Appendix of TR 38.875 by replacing company names with “source N”. Several responses comment to clarify evaluation assumption for msg2 and PRACH.  For Msg2 results, some companies might have considered TBS scaling and some others have not. However, the assumption for TBS scaling is not available in the evaluation spreadsheet. FL suggests the sourcing companies to clarify whether TBS scaling is used for Msg2 and also PRACH format.  Based on the responses, FL makes the following proposal:  **[FL4] Proposal 3.2-1:**   * Capture the link budget evaluation results (Rural 0.7 GHz) in Table 3.2-1 to Table 3.2-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated coverage recovery evaluation results and a clarification of assumption for Msg2, and PRACH | |
| vivo |  | For MSG2, we use MCS#0 with no TBS scaling  For PRACH, only format 0 is captured according to the template. However, we believe for FDD, PRACH format 2 is possible for better coverage, therefore not proper to draw conclusion based on PRACH format 0 only. |
| Qualcomm |  | We are fine with the FL updated proposal  For Msg2, no TBS scaling is used (3 RBs, MCS0, and TBS = 9 bytes) |
| Huawei, Hisilicon | N | Similar comment as to Question 3.1-1. |
| Futurewei |  | No tbs scaling is used |
| Intel | Y | We simulate Msg2 with scaling factor 1/4 and PRACH format 0 |
| Ericsson |  | We are fine with the FL’s updated proposal.  Regarding TBS scaling for Msg2, we have provided results with and without TBS scaling. We suggest using results based on no TBS scaling as a baseline. TBS scaling can be considered as a coverage recovery technique for Msg2.  Regarding PRACH, our results are based on Format 0 (1.25 KHz SCS). |
| Samsung |  | No TBS scaling was used for Msg2. |
| CATT |  | For Msg2, we use MCS#0 with no TBS scaling. |
| Xiaomi |  | For Msg.2, we use MCS#0 w/o TBS scaling |
| ZTE |  | We are fine with the proposal.  For Msg.2, we use (3 RBs, MCS#0, TBS = 9 bytes) w/o TBS scaling. |
| InterDigital |  | For Msg2, we used 3 RBs, MCS0, 72 bits. |
| OPPO |  | For Msg2, we used 3 RBs, MCS0, without TBS scaling. |
| **FL5** | Based on the received responses, the FL’s updated suggestion is as following.  **[FL5] Updated Proposal 3.2-1:**   * Capture the link budget evaluation results (rural 0.7 GHz) in Table 3.2-1 to Table 3.2-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables. | |
| Panasonic | Y |  |
| vivo | Y |  |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Samsung | Y |  |
| Intel |  | Similar comments as that for [FL5] Updated Proposal 3.1-1 |
| OPPO | Y |  |
| CATT | Y |  |
| FL5 | All responses agree with the proposal except that one response suggests to clarify how to handle different assumptions for Msg2 TBS scaling and PRACH format.  The FL understanding is that Msg2 with no TBS scaling will be used as baseline for deriving representative value. Categorization by different scaling factors may not be acceptable since the number of samples in each category will be small and not useful to draw the conclusion  Based on the received responses, one company considers ¼ TBS scaling for Msg2 and the other companies evaluate Msg2 with no TBS scaling and one company evaluates both scaling and no scaling. Therefore, the representation value based on all the companies results (with and without TBS scaling) can be acceptable since the outlier value with TBS scaling has been removed.  For PRACH format, it seems all the companies use the same format as recommended in the template. Therefore, no divergence is observed.  **Further updated Proposal 3.2-1:**   * Capture the link budget evaluation results (rural 0.7 GHz) in Table 3.2-1 to Table 3.2-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables. | |

Based on the evaluation results in Table 3.2-1 to Table 3.2-3, the channels that potentially need coverage recovery in rural scenario at 0.7 GHz and the summary of companies evaluation results for the margin to the coverage recovery target (i.e. the MIL of bottleneck channel for the reference NR UE) are summarized in Table 3.2-4, where the numbers in bracket is the number of samples.

**Table 3.2-4: Coverage recovery for RedCap UE in rural scenario at 0.7 GHz (Option 3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Channels | Mean | Median | Range | Representative value |
| 2Rx RedCap | PUSCH (17) | -2.6 | -3.0 | 5.7 | -2.9 |
| Msg3 (15) | -0.9 | -0.5 | 3.5 | -0.8 |
| PUCCH PF3 22 bits (14) | 1.3 | 1.6 | 8.8 | 1.3 |
| 1Rx RedCap | PUSCH (17) | -2.6 | -3.0 | 5.7 | -2.9 |
| Msg3 (15) | -0.9 | -0.5 | 3.5 | -0.8 |
| PUCCH PF3 with 22 bits (14) | 1.3 | 1.6 | 8.8 | 1.3 |
| Msg2 (15) | 1.9 | 2.5 | 15.4 | 1.6 |

**Question 3.2-2: Can Table 3.2-4 be captured to TR 38.875? If not, any other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FL |  | Table 3.2-4 has been updated by considering all the companies’ evaluation results. The representative value in the table is expected to be updated based on the agreement for the coverage recovery target in section 2, and the positive representative value indicates the LB of the concerned channel is better than the MIL of the bottleneck channel of the reference NR UE. |
| vivo |  | The range for msg 2 is up to 15dB, which seems too large |
| ZTE |  | Similar comment as to Question 3.1-2. |
| Nokia, NSB |  | Similar comment as to Question 3.1-2 |
| Futurewei |  | Similar comment to 3.1-2. The range for msg2 may be higher due to different assumptions on the number of users etc. Also although higher range exists for PUCCH and Msg2, it seems most companies agree no compensation is needed for these two. |
| NTT DOCOMO |  | Similar comment as to Question 3.1-2. |
| Ericsson |  | We suggest clarifying (1) the meaning of the numbers in parentheses, and (2) how is the range computed (e.g., maximum-minimum). |
| CATT | Y | Similar comment as to Question 3.1-2 |
| Intel |  | The table can be formed after proposal is section 2 is finalized. |
| Samsung |  | For some DL channel, a big gap (e.g., 15.4dB for Msg 2) between companies is observed. Before capturing the results, some clarification and analysis on the big gap are necessary. |
| Huawei, Hisilicon | N | We prefer to wait until proposal 1 is agreed. |
| Xiaomi |  | It would be better to wait for more stable proposal 1 |

Based on the results in Table 3.2-4, the following observations are proposed for discussion for the TP drafting for TR 38.875.

[FL notes: The observations will be updated based on the agreement for the coverage recovery target in section 2 and the update of Table 3.2-4]

**Moderator’s observation**

* P1: For RedCap UE in rural scenario at 0.7 GHz, three UL channels, PUSCH, Msg3, PUCCH format 3 with 22 bits do not reach the target coverage requirement and need for coverage recovery
  + A compensation of approximately 3 dB, 1.1 dB and 1.8 dB respectively, is observed for PUSCH, Msg3 and PUCCH format 3 with 22 bits
* P2: Compared to the target coverage requirement, a coverage degradation of approximately 2.8 dB and 1.3 dB respectively, is observed for PUCCH format 3 with 11 bits and PRACH format 0 by one source company
* P3: For a RedCap UE with 2 Rx antenna at 0.7 GHz carrier frequency, all downlink channels can reach the target coverage requirement thus requiring no compensation
* P4: For a RedCap UE with 1 Rx antenna at 0.7 GHz carrier frequency, all downlink channels except for Msg2 can reach the target coverage requirement thus requiring no compensation
  + A coverage compensation of approximately 2.1 dB is observed for Msg2 PDSCH

**Question 3.2-3: Can the above list (P1-P4) be used as a baseline text for TR 38.875? If not, what other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | N | Prefer to wait until proposal 1 is stable/agreed |
| Nokia, NSB |  | We prefer to wait until proposal 1 is agreed |
| Ericsson |  | P1: The conclusion that PUCCH format 3 with 22 bits needs more compensation than Msg3 is a bit problematic. Note that results from most companies do not indicate compensation is needed at all for PUCCH format 3 with 22 bits. We suggest stating the observation on PUCCH format 3 with 22 bits in a separate statement and clarifying that this observation is derived based on only 3 sourcing companies. Furthermore, in our view 22-bit PUCCH could be an overkill for a baseline RedCap UE in FR1 considering it does not need to support CA (possibly no MIMO support either).  For PUSCH, it can be clarified the 3 dB coverage compensation is needed if the target data rate for RedCap UEs is the same as reference UE. We should add a note here to state that the 3 dB coverage compensation is not needed if the target data rate for RedCap UEs is reduced.  We can further mention that the 3 dB loss is resulting from the UE antenna efficiency loss assumed for the wearable use cases only.  P4: it should be emphasized that this is based on results from 6 sourcing companies while all other sourcing companies indicate that Msg2 does not need coverage compensation.  As we have commented in replying to Question 2-1, perhaps we should consider determining the “*representative value of the amount of compensation*” based on both positive and negative values. |
| CATT |  | Generally fine with the observation. Also OK to wait until further progress of proposal 1 is made. |
| Samsung |  | It can be mentioned that 3dB antenna loss is resulted from reduced antenna efficiency due to device size limitations for wearables.  Some note for Msg 2 in the below P4 can be clarified. If TBS scaling for Msg 2 is not assumed in the simulation results, the following note as for exmaple is suggested in the below P4 given the TBS scaling is already supported in Rel-15:  Note that TBS scaling for Msg 2 has not been considered in the evaluation, which could provide some gain for Msg 2. |

**[FL5] Based on the received responses, the FL’s updated text proposal is as following.**

**(FL note: based on the outcome of Proposal 2-1, some numbers in the tables can be further updated, however, the conclusion is expected to be same)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| For rural scenario at 0.7 GHz, the bottleneck channel for the reference NR UE and the corresponding maximum isotropic loss (MIL) value by the sourcing companies are shown in Table 9.1-4. The estimated coverage loss for the RedCap UE in rural scenario at 0.7 GHz, relative to the bottleneck channel of the reference NR UE is summarized in Table 9.1-5 and Table 9.1-6. It is noted that the 3dB antenna efficiency loss is assumed in both DL and UL for the RedCap UE.  **Table 9.1-4: Bottleneck channel and MIL value for Reference NR UE in rural 0.7 GHz**   |  |  |  | | --- | --- | --- | |  | Bottleneck Channel | MIL (dB) | | Samsung | PUSCH | 146.6 | | ZTE | Msg3 | 143.2 | | OPPO | PUCCH PF3 22 bits | 148.9 | | CATT | PUSCH | 147.9 | | vivo | PUSCH | 144.0 | | Xiaomi | PUSCH | 149.7 | | Futurewei | PUSCH | 150.8 | | Nokia | Msg3 | 138.5 | | DCM | PUSCH | 146.7 | | Panasonic | PUSCH | 141.8 | | Huawei | PUSCH | 141.8 | | SPRD | PUSCH | 151.5 | | Apple | PUSCH | 143.7 | | Ericsson | PUSCH | 142.9 | | IDCC | Msg3 | 144.4 | | QC | PUSCH | 141.3 | | Intel | PUSCH | 146.7 |   The representative values in the last row of Table 9.1-5 and Table 9.1-6 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE and coverage recovery is needed.  As can be seen in the last row for the representative value, all the channels except for PUSCH and Msg3 have better coverage than that of the bottleneck channel thus requiring no compensation. On average, a coverage degradation of approximately 2.8 dB and 1 dB, respectively is observed for PUSCH and Msg3.  It should be noted that the 3 dB loss is resulted from the UE antenna efficiency loss assumed for the wearable use cases. Furthermore, the same target data rate of 100 kbps for PUSCH is assumed for both RedCap UE and the reference NR UE (see evaluation methodology described in clause 6.3). A smaller or no coverage loss for PUSCH is expected if the target data rate for RedCap UE is reduced.  **Table 9.1-5: Coverage loss (dB) for 2Rx RedCap UE in rural scenario at 0.7 GHz (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH Format 0 | | Samsung | 12.9 | 12.9 | 8.4 | 8.4 | 9.4 |  | 8.7 | 4.9 | 1.9 | -3.0 | -0.1 |  | | ZTE |  |  |  |  |  |  | 6.4 | 4.4 | 1.7 | -2.6 | -3.0 |  | | OPPO | 11.2 | 11.2 | 10.0 | 5.0 | 9.1 |  | -2.9 | -2.8 | -3.0 | -1.9 | -2.5 |  | | CATT | 7.5 | 7.5 | 4.9 | 2.6 | 5.9 |  | 5.6 | 4.5 | 2.4 | -3.1 | -0.3 |  | | vivo | 8.0 | 8.1 | 5.0 | 2.8 | 5.8 | 12.2 | 3.3 | 0.5 | -1.9 | -3.0 | -0.7 | -1.3 | | Xiaomi | 7.3 | 7.3 | 4.9 | 2.2 | 5.4 |  | 5.3 | 2.7 | 0.2 | -3.0 | -1.8 |  | | Futurewei | 7.4 | 7.4 | 4.4 | 4.2 | 5.4 |  |  |  |  | -3.0 | -0.8 |  | | Nokia | 16.5 | 16.5 | 18.0 | 15.1 | 17.9 |  | 3.4 |  | 2.2 | 2.6 | -3.0 | 6.4 | | DCM |  |  |  |  |  |  | 6.2 | 11.6 |  | -3.0 | -0.2 |  | | Panasonic |  | 17.0 | 7.0 |  |  |  | 7.8 | 5.4 | 1.4 | -3.0 | -0.2 |  | | Huawei | 12.5 | 12.5 | 8.1 | 8.1 | 8.8 |  | 8.0 |  | 5.8 | -3.0 | 0.5 |  | | SPRD | 6.6 | 6.6 | 4.6 | 5.6 | 5.6 | 8.6 | 6.0 | 3.0 | 2.8 | -3.0 | 0.0 | 2.4 | | Apple | 11.0 | 11.0 | 9.2 | 4.8 | 9.0 |  |  |  |  | -3.0 |  |  | | Ericsson | 11.5 | 10.8 | 6.2 | 7.4 | 10.1 | 11.5 | 3.5 | 12.0 | 1.5 | -3.0 | -0.9 | 2.1 | | IDCC | 13.8 | 13.8 | 11.1 | 4.9 | 7.7 |  | 8.4 |  | 3.4 | -0.7 | -3.0 |  | | QC | 14.1 |  | 10.2 | 8.6 | 10.6 |  |  |  | -0.5 | -3.0 | -0.5 |  | | Intel |  |  |  |  |  |  | 4.7 | 5.0 | 2.3 | -3.0 | -0.2 | 2.6 | | Representative value (dB) | **10.6** | **10.8** | **7.5** | **5.7** | **7.9** | **11.5** | **5.7** | **4.7** | **1.4** | **-2.8** | **-1.0** | **2.3** |   Note: All sources except for Source X (Intel) assume no TBS scaling for Msg2 evaluation  **Table 9.1-6: Coverage loss (dB) for 1Rx RedCap UE in rural scenario at 0.7 GHz (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH Format 0 | | Samsung | 9.2 | 9.2 | 4.1 | 2.5 | 5.7 |  | 8.7 | 4.9 | 1.9 | -3.0 | -0.1 |  | | ZTE | 5.1 | 8.8 | 6.5 | 3.3 | 3.5 |  | 6.4 | 4.4 | 1.7 | -2.6 | -3.0 |  | | OPPO | 6.6 | 6.6 | 6.5 | -0.4 | 4.8 |  | -2.9 | -2.8 | -3.0 | -1.9 | -2.5 |  | | CATT | 4.0 | 4.0 | 1.7 | -3.9 | 1.5 |  | 5.6 | 4.5 | 2.4 | -3.1 | -0.3 |  | | vivo | 5.3 | 5.3 | 1.5 | -2.5 | 1.8 | 8.4 | 3.3 | 0.5 | -1.9 | -3.0 | -0.7 | -1.3 | | Xiaomi | 3.9 | 3.9 | 0.8 | -3.5 | 0.9 |  | 5.3 | 2.7 | 0.2 | -3.0 | -1.8 |  | | Futurewei | 3.5 | 3.5 | 0.1 | -1.7 | 2.4 |  |  |  |  | -3.0 | -0.8 |  | | Nokia | 12.2 | 12.2 | 15.4 | 11.5 | 14.9 |  | 3.4 |  | 2.2 | 2.6 | -3.0 | 6.4 | | DCM | 9.5 | 9.5 | 4.2 | -0.9 | 4.1 |  | 6.2 | 11.6 |  | -3.0 | -0.2 |  | | Panasonic |  | 14.1 | 3.3 |  |  |  | 7.8 | 5.4 | 1.4 | -3.0 | -0.2 |  | | Huawei | 9.1 | 9.1 | 4.4 | 3.8 | 4.8 |  | 8.0 |  | 5.8 | -3.0 | 0.5 |  | | SPRD | 3.6 | 3.6 | 1.6 | 2.6 | 1.6 | 5.6 | 6.0 | 3.0 | 2.8 | -3.0 | 0.0 | 2.4 | | Apple | 8.0 | 8.0 | 5.1 | 0.3 | 4.3 |  |  |  |  | -3.0 |  |  | | Ericsson | 7.1 | 7.3 | 6.2 | 3.3 | 6.4 | 7.1 | 3.5 | 12.0 | 1.5 | -3.0 | -0.9 | 2.1 | | IDCC | 10.0 | 10.0 | 7.4 | -0.7 | 4.1 |  | 8.4 |  | 3.4 | -0.7 | -3.0 |  | | QC | 10.3 |  | 6.8 | 4.1 | 7.2 |  |  |  | -0.5 | -3.0 | -0.5 |  | | Intel | 7.9 | 7.9 | 5.2 | 9.7 | 6.9 | 10.7 | 4.7 | 5.0 | 2.3 | -3.0 | -0.2 | 2.6 | | Representative value (dB) | **7.1** | **7.5** | **4.4** | **1.4** | **4.2** | **7.8** | **5.7** | **4.7** | **1.4** | **-2.8** | **-1.0** | **2.3** |   Note: All sources except for Source X (Intel) assume no TBS scaling for Msg2 evaluation |

**[FL5] Question 3.2-1A:** **Can the above observations of the relative coverage loss be used as a baseline text for TR 38.875? If not, what aspects to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Panasonic | Y |  |
| vivo |  | It would be useful to make if clear   * + - 1. All companies except one company does not apply TBS scaling for MSG2       2. PRACH format 0 is simulated |
| ZTE | Y | Fine with the observation. |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y | The observations are fine.  The numbers in the tables need to be doble-checked. For example, it appears that Ericsson results for Msg2 are based on no TBS scaling (see v015 or later for results with TBS scaling for Msg2). TBS scaling in this case does not affect the observation. So we are fine with the observations. |
| Samsung |  | In “Note”, \* seems missing because all companies except only one company indicated no TBS scaling. |
| Intel | Y |  |
| OPPO | Y |  |
| CATT | Y | Generally OK.  Regarding to the sentence “A smaller coverage loss for PUSCH is expected if the target data rate for RedCap UE is reduced”, we think it is right intuitively. But if the target data rate for RedCap is reduced (e.g. to half), it is possible no coverage loss will be observed:  A smaller/no coverage loss for PUSCH is expected if the target data rate for RedCap UE is reduced.  And similar to Samsung, it seems a mark \* is missing. |
| FL5 | The TP above has been updated based on the received response. The PRACH format has been added in the Table 9.1-5 and Table 9.1-6. The note for Msg2 assumption has been updated to make it clearer.  **Proposal 3.2-1A:**   * Adopted the updated TP in section 3.2 of R1-2009660 as baseline text for TR clause 9.1 | |
| vivo | modifications | We have agreed the following in the last GTW call   * + The representative value of a channel is used for identifying whether the channel needs coverage recovery     - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero     - The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc   Therefore the need and amount of coverage compensation should be discussed separately, not solely based on the coverage degradation. We should make the following change  The representative values in the last row of Table 9.1-2 and Table 9.1-3 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE ~~and coverage recovery is needed.~~ |
| FL5 | The proposal to remove “and coverage recovery is needed” may be okay based on the agreement we made in last GTW call. The FL’s updated proposal is as following.  **Updated proposal 3.2-1A:**   * Adopted the updated TP in section 3.2 of R1-2009660 as baseline text for TR clause 9.1   + Remove “and coverage recovery is needed” from the TP | |
| Huawei, Hisilicon | Y | Fine with the observation. |
| CMCC | Y | Fine with the observation. |

## FR1, Urban with the carrier frequency of 4 GHz

Based on the latest available evaluation results in [RedCapCoverage-4GHz-v014](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Inbox/drafts/8.6/EvaluationResults/RedCapCoverage/4GHz/RedCapCoverage-4GHz-v014.xlsx), the link budget performance for both the reference UE and RedCap UE in Urban scenario at 2.6GHz is summarized in Table 3.3-1 to Table 3.3-3 (Company please double check whether your results are correctly captured in these tables. We have found there are some mismatch between the spreadsheet and the contribution for some companies results).

In the link budget tables, the maximum isotropic loss (MIL) is used as the coverage evaluation metric and for each channel the margin to the target performance is also shown, where the target performance is a company specific value and derived based on the link budget of the bottleneck channel for the reference NR UE (i.e. Option 3). The coverage limiting channel for RedCap UE, e.g. the link budget for the channel worse than that target performance, is highlighted with RED.

**Table 3.3-1: Link budget performance for the reference NR UE (100MHz BW, 4Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Urban, 4GHz, 4Rx Ref NR UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 165.9 | 170.1 | 162.6 | 162.3 | 162.4 |  | 158.6 | 154.8 | 151.9 | 142.0 | 150.0 |  | 142.0 |
| Margin (dB) | 23.8 | 28.0 | 20.5 | 20.2 | 20.3 |  | 16.6 | 12.8 | 9.9 | 0.0 | 8.0 |  |  |
| ZTE | MIL (dB) | 147.8 | 158.2 | 157.3 | 148.3 | 148.6 |  | 162.6 | 160.9 | 158.3 | 143.0 | 156.3 |  | 143.0 |
| Margin (dB) | 4.8 | 15.2 | 14.3 | 5.3 | 5.5 |  | 19.6 | 17.9 | 15.3 | 0.0 | 13.3 |  |  |
| OPPO | MIL (dB) | 158.5 | 162.5 | 158.9 | 153.4 | 156.2 |  | 155.0 | 155.0 | 155.2 | 147.0 | 154.7 |  | 147.0 |
| Margin (dB) | 11.4 | 15.4 | 11.9 | 6.4 | 9.2 |  | 8.0 | 8.0 | 8.2 | 0.0 | 7.7 |  |  |
| vivo | MIL (dB) | 157.7 | 165.7 | 161.9 | 157.1 | 158.6 | 160.8 | 156.3 | 153.8 | 151.0 | 139.3 | 152.3 | 149.6 | 139.3 |
| Margin (dB) | 18.4 | 26.4 | 22.6 | 17.8 | 19.3 |  | 17.0 | 14.5 | 11.8 | 0.0 | 13.0 | 10.3 |  |
| Futurewei | MIL (dB) | 155.9 | 157.9 | 156.0 | 153.0 | 155.1 |  |  |  |  | 152.6 | 153.5 |  | 152.6 |
| Margin (dB) | 3.2 | 5.2 | 3.3 | 0.3 | 2.4 |  | -152.6 | -152.6 | -152.6 | 0.0 | 0.9 |  |  |
| Nokia | MIL (dB) | 168.4 | 168.4 | 165.3 | 168.8 | 165.9 |  | 151.7 |  | 150.2 | 140.8 | 147.3 | 155.1 | 140.8 |
| Margin (dB) | 27.6 | 27.6 | 24.5 | 28.0 | 25.1 |  | 10.9 | -140.8 | 9.4 | 0.0 | 6.5 | 14.3 |  |
| DOCOMO | MIL (dB) | 156.8 | 160.8 | 157.5 | 151.5 | 153.6 |  | 161.2 | 164.8 |  | 146.8 | 154.6 |  | 146.8 |
| Margin (dB) | 10.0 | 14.0 | 10.7 | 4.7 | 6.8 |  | 14.5 | 18.1 | -146.8 | 0.0 | 7.9 |  |  |
| Huawei | MIL (dB) | 164.0 | 168.0 | 164.2 | 161.1 | 160.9 |  | 160.5 |  | 158.8 | 140.0 | 149.7 |  | 140.0 |
| Margin (dB) | 24.0 | 28.0 | 24.2 | 21.1 | 20.8 |  | 20.5 | -140.0 | 18.7 | 0.0 | 9.6 |  |  |
| Spreadtrum | MIL (dB) | 155.8 | 160.0 | 157.8 | 154.8 | 154.8 | 157.8 | 158.2 | 156.2 | 158.0 | 145.4 | 153.5 | 155.6 | 145.4 |
| Margin (dB) | 10.3 | 14.5 | 12.3 | 9.3 | 9.3 |  | 12.8 | 10.8 | 12.6 | 0.0 | 8.1 | 10.1 |  |
| Ericsson | MIL (dB) | 149.0 | 153.0 | 149.7 | 143.6 | 146.5 | 150.9 | 153.6 | 155.5 | 153.6 | 144.0 | 151.3 | 154.9 | 143.6 |
| Margin (dB) | 5.4 | 9.4 | 6.1 | 0.0 | 2.9 |  | 10.0 | 12.0 | 10.1 | 0.5 | 7.7 | 11.3 |  |
| InterDigital | MIL (dB) | 155.47 | 159.5 | 157.13 | 160.42 | 162.55 |  | 160.6 |  | 156.6 | 144.9 | 152.87 |  | 144.9 |
| Margin (dB) | 10.57 | 14.6 | 12.23 | 15.52 | 17.65 |  | 15.7 |  | 11.7 | 0.0 | 7.97 |  |  |
| Qualcomm | MIL (dB) | 152.3 |  | 151.3 | 147.1 | 148.6 |  |  |  | 146.5 | 140.7 | 154.1 |  | 140.7 |
| Margin (dB) | 11.6 | -140.7 | 10.6 | 6.4 | 7.9 |  |  |  | 5.8 | 0.0 | 13.4 |  |  |
| Intel | MIL (dB) | 156.3 | 157.4 | 152.7 | 157.0 | 154.7 | 156.3 | 161.5 | 160.3 | 157.7 | 140.0 | 147.0 | 156.3 | 140.0 |
| Margin (dB) | 16.3 | 17.4 | 12.7 | 17.0 | 14.7 |  | 21.5 | 20.3 | 17.7 | 0.0 | 7.0 | 16.3 |  |
| Lenovo, Motorola Mobility | MIL (dB) | 157.8 |  | 152.5 | 153.1 | 156.0 |  | 163.0 | 158.2 | 154.0 | 148.3 | 154.2 |  | 148.3 |
| Margin (dB) | 9.5 |  | 4.2 | 4.8 | 7.7 |  | 14.7 | 9.9 | 5.7 | 0 | 5.9 |  |  |

**Table 3.3-2: Link budget performance for the RedCap UE (20MHz BW, 2Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Urban, 4GHz, 2Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 160.1 | 164.1 | 156.9 | 155.8 | 156.8 |  | 155.3 | 151.5 | 148.5 | 139.0 | 147.0 |  | 142.0 |
| Margin (dB) | 18.0 | 22.0 | 14.8 | 13.7 | 14.7 |  | 13.3 | 9.5 | 6.5 | -3.0 | 5.0 |  |  |
| OPPO | MIL (dB) | 152.2 | 156.2 | 154.5 | 146.3 | 150.0 |  | 151.9 | 152.0 | 151.9 | 144.0 | 151.7 |  | 147.0 |
| Margin (dB) | 5.1 | 9.1 | 7.5 | -0.7 | 3.0 |  | 4.9 | 5.0 | 4.9 | -3.0 | 4.7 |  |  |
| vivo | MIL (dB) | 152.0 | 160.0 | 155.2 | 149.6 | 151.5 | 155.3 | 153.3 | 150.8 | 148.0 | 136.4 | 149.6 | 146.6 | 139.3 |
| Margin (dB) | 12.7 | 20.7 | 16.0 | 10.3 | 12.3 | 16.0 | 14.0 | 11.5 | 8.8 | -2.8 | 10.3 | 7.3 |  |
| Futurewei | MIL (dB) | 150.3 | 152.3 | 150.1 | 146.3 | 149.1 |  |  |  |  | 149.6 | 150.5 |  | 152.6 |
| Margin (dB) | -2.4 | -0.4 | -2.6 | -6.4 | -3.6 |  |  |  |  | -3.0 | -2.1 |  |  |
| Nokia | MIL (dB) | 162.5 | 162.5 | 158.6 | 163.4 | 160.0 |  | 148.7 |  | 147.2 | 137.8 | 144.3 | 152.1 | 140.8 |
| Margin (dB) | 21.7 | 21.7 | 17.8 | 22.6 | 19.2 |  | 7.9 |  | 6.4 | -3.0 | 3.5 | 11.3 |  |
| DOCOMO | MIL (dB) | 150.9 | 154.9 | 150.8 | 143.9 | 147.0 |  | 158.2 | 161.8 |  | 143.8 | 151.6 |  | 146.8 |
| Margin (dB) | 4.1 | 8.1 | 4.0 | -2.8 | 0.2 |  | 11.5 | 15.1 |  | -3.0 | 4.9 |  |  |
| Huawei | MIL (dB) | 158.0 | 162.0 | 156.9 | 154.7 | 154.6 |  | 157.5 |  | 155.8 | 137.0 | 146.7 |  | 140.0 |
| Margin (dB) | 18.0 | 22.0 | 16.9 | 14.6 | 14.6 |  | 17.5 |  | 15.7 | -3.0 | 6.6 |  |  |
| Spreadtrum | MIL (dB) | 149.8 | 154.0 | 151.8 | 148.8 | 148.8 | 151.8 | 155.2 | 153.2 | 155.0 | 142.4 | 150.5 | 152.6 | 145.4 |
| Margin (dB) | 4.3 | 8.5 | 6.3 | 3.3 | 3.3 | 6.3 | 9.8 | 7.8 | 9.6 | -3.0 | 5.1 | 7.1 |  |
| Ericsson | MIL (dB) | 142.8 | 146.8 | 143.5 | 137.2 | 139.9 | 145.0 | 150.6 | 152.5 | 150.6 | 141.0 | 148.3 | 151.9 | 143.6 |
| Margin (dB) | -0.8 | 3.2 | -0.1 | -6.4 | -3.7 | 1.4 | 7.0 | 9.0 | 7.1 | -2.5 | 4.7 | 8.3 |  |
| InterDigital | MIL (dB) | 149.77 | 153.8 | 151.30 | 153.83 | 156.80 |  | 157.1 |  | 152.8 | 141.9 | 149.87 |  | 144.9 |
| Margin (dB) | 4.87 | 8.9 | 6.4 | 8.93 | 11.9 |  | 12.2 |  | 7.9 | -3.0 | 4.97 |  |  |
| Qualcomm | MIL (dB) | 146.8 |  | 145.6 | 140.8 | 143.1 |  |  |  | 143.5 | 137.0 | 144.0 |  | 140.7 |
| Margin (dB) | 6.1 |  | 4.9 | 0.1 | 2.4 |  |  |  | 2.8 | -3.7 | 3.3 |  |  |
| Intel | MIL (dB) | 150.4 | 151.5 | 146.5 | 151.4 | 148.6 | 153.3 | 158.5 | 157.3 | 154.7 | 137.7 | 151.1 | 153.3 | 140.0 |
| Margin (dB) | 10.4 | 11.5 | 6.5 | 11.4 | 8.6 | 13.3 | 18.5 | 17.3 | 14.7 | -2.3 | 11.2 | 13.3 |  |

**Table 3.3-3: Link budget performance for the RedCap UE (20MHz BW, 1Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Urban, 4GHz, 1Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 156.6 | 160.6 | 152.2 | 150.6 | 153.2 |  | 155.3 | 151.5 | 148.5 | 139.0 | 147.0 |  | 142.0 |
| Margin (dB) | 14.5 | 18.5 | 10.1 | 8.5 | 11.1 |  | 13.3 | 9.5 | 6.5 | -3.0 | 5.0 |  |  |
| ZTE | MIL (dB) | 138.6 | 149.0 | 151.6 | 141.7 | 141.9 |  | 159.6 | 157.9 | 155.3 | 140.0 | 153.3 |  | 143.0 |
| Margin (dB) | -4.5 | 6.0 | 8.6 | -1.3 | -1.1 |  | 16.6 | 14.9 | 12.3 | -3.0 | 10.3 |  |  |
| OPPO | MIL (dB) | 148.2 | 152.2 | 151.9 | 140.8 | 146.2 |  | 151.9 | 152.0 | 151.9 | 144.0 | 151.7 |  | 147.0 |
| Margin (dB) | 1.2 | 5.2 | 4.9 | -6.2 | -0.8 |  | 4.9 | 5.0 | 4.9 | -3.0 | 4.7 |  |  |
| vivo | MIL (dB) | 148.8 | 156.8 | 150.6 | 144.8 | 146.8 | 152.6 | 153.3 | 150.8 | 148.0 | 136.4 | 149.6 | 146.6 | 139.3 |
| Margin (dB) | 9.6 | 17.6 | 11.4 | 5.6 | 7.5 | 13.4 | 14.0 | 11.5 | 8.8 | -2.8 | 10.3 | 7.3 |  |
| Futurewei | MIL (dB) | 146.7 | 148.7 | 145.3 | 139.3 | 143.0 |  |  |  |  | 149.6 | 150.5 |  | 152.6 |
| Margin (dB) | -6.0 | -4.0 | -7.4 | -13.4 | -9.7 |  |  |  |  | -3.0 | -2.1 |  |  |
| Nokia | MIL (dB) | 158.5 | 158.5 | 154.8 | 159.6 | 156.5 |  | 148.7 |  | 147.2 | 137.8 | 144.3 | 152.1 | 140.8 |
| Margin (dB) | 17.7 | 17.7 | 14.0 | 18.8 | 15.7 |  | 7.9 |  | 6.4 | -3.0 | 3.5 | 11.3 |  |
| DOCOMO | MIL (dB) | 147.6 | 151.6 | 146.8 | 138.3 | 142.9 |  | 158.2 | 161.8 |  | 143.8 | 151.6 |  | 146.8 |
| Margin (dB) | 0.8 | 4.8 | 0.0 | -8.5 | -3.9 |  | 11.5 | 15.1 |  | -3.0 | 4.9 |  |  |
| Huawei | MIL (dB) | 154.5 | 158.5 | 153.1 | 150.4 | 150.8 |  | 157.5 |  | 155.8 | 137.0 | 146.7 |  | 140.0 |
| Margin (dB) | 14.5 | 18.5 | 13.0 | 10.3 | 10.7 |  | 17.5 |  | 15.7 | -3.0 | 6.6 |  |  |
| Spreadtrum | MIL (dB) | 146.8 | 151.0 | 148.8 | 145.8 | 145.8 | 148.8 | 155.2 | 153.2 | 155.0 | 142.4 | 150.5 | 152.6 | 145.4 |
| Margin (dB) | 1.3 | 5.5 | 3.3 | 0.3 | 0.3 | 3.3 | 9.8 | 7.8 | 9.6 | -3.0 | 5.1 | 7.1 |  |
| Ericsson | MIL (dB) | 139.7 | 143.8 | 139.8 | 132.4 | 136.0 | 141.4 | 150.6 | 152.5 | 150.6 | 141.0 | 148.3 | 151.9 | 143.6 |
| Margin (dB) | -3.9 | 0.2 | -3.8 | -11.2 | -7.6 | -2.2 | 7.0 | 9.0 | 7.1 | -2.5 | 4.7 | 8.3 |  |
| InterDigital | MIL (dB) | 146.57 | 150.6 | 148.23 | 149.29 | 153.67 |  | 157.1 |  | 152.8 | 141.9 | 149.87 |  | 144.9 |
| Margin (dB) | 1.67 | 5.7 | 3.33 | 4.39 | 8.77 |  | 12.2 |  | 7.9 | -3.0 | 4.97 |  |  |
| Qualcomm | MIL (dB) | 143.5 |  | 142.4 | 136.9 | 139.8 |  |  |  | 143.5 | 137.0 | 144.0 |  | 140.7 |
| Margin (dB) | 2.8 |  | 1.7 | -3.8 | -0.9 |  |  |  | 2.8 | -3.7 | 3.3 |  |  |
| Lenovo, Motorola Mobility | MIL (dB) | 146.3 |  | 145.7 | 140.2 | 145.4 |  | 160.0 | 155.2 | 154.0 | 145.3 | 151.2 |  | 148.3 |
| Margin (dB) | -2.0 |  | -2.6 | -8.1 | -2.9 |  | 11.7 | 6.9 | 5.7 | -3.0 | 2.9 |  |  |

**Question 3.3-1: Can the link budget evaluation results in Table 3.3-1 to Table 3.3-3 be captured to TR 38.875? (Companies are invited to check the results and if any modification is needed, please also indicate here.)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | If possible, it would be useful to clarify the assumption in the simulation   1. For PRACH, the simulated format 2. For MSG2, whether existing TBS scaling is used? 3. The assumed DL PSD, 24dBm/MHz, or 33dBm/MHz |
| ZTE | Y | Fine to capture the tables into the TR. |
| Qualcomm | Y | We don’t support to split the tables based on DL PSD values since the insufficient number of samples is difficult to make a decision. |
| Nokia, NSB | Y |  |
| Futurewei |  | Same as above |
| NTT DOCOMO | Y |  |
| Ericsson |  | Some evaluations are based on downlink power spectrum density 24 dBm/MHz, whereas some are based on 33 dBm/MHz. It might be better to have separate tables for the two different power spectrum density settings.  Also for Msg2 results, some companies might have considered TBS scaling and some others have not. Could the sourcing companies clarify whether TBS scaling is used for Msg2. Ericsson will update our results to include performance with and without TBS scaling. |
| Intel | Y | Fine to capture the tables into TR. Fine to clarify PRACH format, TBS scaling for msg2 and DL PSD. |
| Samsung |  | For Msg 2, it should be clarified whether or not Rel-15 TBS scaling was applied for each simulation result. |
| InterDigital | Y | We have provide some update on our results. |
| FL4 | Majority of responses are fine with capturing the above link budget evaluation results to TR 38.875. One response suggests the results can be captured in an Appendix of TR 38.875 by replacing company names with “source N”. Several responses comment to clarify evaluation assumption for msg2, PRACH and the assumed DL PSD.  For Msg2 results, some companies might have considered TBS scaling and some others have not. However, the assumption for TBS scaling is not available in the evaluation spreadsheet. The FL suggests the sourcing companies to clarify whether TBS scaling is used for Msg2 and also PRACH format.  Based on the responses, the FL makes the following proposal:  **[FL4] Proposal 3.3-1:**   * Capture the link budget evaluation results (Urban 4 GHz) in Table 3.3-1 to Table 3.3-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated coverage recovery evaluation results and a clarification of assumption for Msg2, PRACH and DL PSD. | |
| vivo |  | For MSG2, we use MCS#0 with no TBS scaling  For PRACH, only format B4 is captured according to the template. However, we believe for TDD, PRACH format 0 is possible for better coverage, therefore not proper to draw conclusion based on PRACH format B4 only.  For DL PSD, we assumed 33dBm/MHz |
| Qualcomm |  | We are fine with the FL updated proposal  For Msg2, no TBS scaling is used (3 RBs, MCS0, and TBS = 9 bytes) |
| Huawei, Hisilicon | N | Similar as Question 3.1-1.  We also suggest to clarify TBS scaling for msg2 and DL PSD.  For Msg2, TBS scaling is not enabled in our simulation.  For DL PSD, we assumed 33dBm/MHz |
| Intel | Y | We simulate Msg2 with scaling factor 1/4, PRACH format B4 and DL PSD 33dBm |
| Ericsson |  | Regarding DL PSD, our results are based on 24dBm/MHz. DL PSD assumption has very significant impacts on what observations to be drawn. So we suggest having separate tables for 24 dBm and 33 dBm. Separate observations may be drawn for the two different DL PSD settings.  Regarding TBS scaling for Msg2, we have provided results with and without TBS scaling. We suggest using results based on no TBS scaling as a baseline. TBS scaling can be considered as a coverage recovery technique for Msg2.  Regarding PRACH, our results are based on Format B4 (30 KHz SCS). |
| Samsung |  | No TBS scaling was used for Msg2. |
| Lenovo, Motorola Mobility |  | We updated table 3.3-1 and 3.3-2 and added our results.  No TBS scaling was used for Msg2. |
| ZTE |  | We are fine with the proposal.  For Msg.2, we use (3 RBs, MCS#0, TBS = 9 bytes) w/o TBS scaling. |
| InterDigital |  | For Msg2, we used 3 RBs, MCS0, 72 bits. |
| OPPO |  | For Msg2, we used 3 RBs, MCS0, without TBS scaling. |
| **FL5** | Based on the received responses, the FL’s updated suggestion is as following.  **[FL5] Updated Proposal 3.3-1:**   * Capture the link budget evaluation results (Urban 4 GHz) in Table 3.3-1 to Table 3.3-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables. | |
| vivo | Y |  |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson |  | It would be good to add PSD assumptions in these tables. Perhaps, we can add it to the sourcing company name, e.g. “Ericsson (24 dBm/MHz)”. |
| Samsung | Y |  |
| Intel |  | Similar comments as that for [FL5] Updated Proposal 3.1-1 |
| OPPO | Y |  |
| Lenovo, Motorola Mobility | Y |  |
| FL5 | All responses agree with the proposal except that one response suggests to clarify how to handle different assumptions for Msg2 TBS scaling and PRACH format.  The FL understanding is that Msg2 with no TBS scaling will be used as baseline for deriving representative value. Categorization by different scaling factors may not be acceptable since the number of samples in each category will be small and not useful to draw the conclusion  Based on the received responses, one company considers ¼ TBS scaling for Msg2 and the other companies evaluate Msg2 with no TBS scaling and one company evaluates both scaling and no scaling. Therefore, the representation value based on all the companies results (with and without TBS scaling) can be acceptable since the outlier value with TBS scaling has been removed.  For PRACH format, it seems all the companies use the same format as recommended in the template. Therefore, no divergence is observed.  **Further updated Proposal 3.3-1:**   * Capture the link budget evaluation results (Urban 4 GHz) in Table 3.3-1 to Table 3.3-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2, PRACH and DL PSD.   + MPL results to be included also. Up to editor to use the same or different tables. | |

Based on the evaluation results in Table 3.3-1 to Table 3.3-3, the channels that potentially need coverage recovery in Urban scenario at 4 GHz and the summary of companies evaluation results for the margin to the coverage recovery target (i.e. the MIL of bottleneck channel for the reference NR UE) are summarized in Table 3.3-4, where the numbers in bracket is the number of samples.

**Table 3.3-4: Coverage recovery for RedCap UE in Urban scenario at 4 GHz (Option 3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Channels | Mean | Median | Range | Representative value |
| 2Rx RedCap | PUSCH (12) | -3.0 | -3.0 | 1.4 | -2.9 |
| PDCCH CSS (12) | 8.9 | 7.5 | 24.1 | 8.7 |
| PDSCH (12) | 8.3 | 6.8 | 20.4 | 8.4 |
| Msg2 (11) | 5.4 | 3.3 | 29 | 4.9 |
| Msg4 (11) | 6.5 | 3.3 | 22.9 | 6.2 |
| 1Rx RedCap | PUSCH (12) | -3.0 | -3.0 | 1.2 | -3.0 |
| PDCCH CSS (12) | 4.5 | 2.8 | 23.7 | 4.5 |
| PDSCH (12) | 5.0 | 4.9 | 21.4 | 5.4 |
| Msg2 (11) | -0.1 | -0.5 | 32.2 | -0.9 |
| Msg4 (11) | 2.0 | -0.2 | 25.4 | 1.5 |

**Question 3.3-2: Can Table 3.3-4 be captured to TR 38.875? If not, any other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FL |  | Table 3.3-4 has been updated by considering all the companies’ evaluation results. The representative value in the table is expected to be updated based on the agreement for the coverage recovery target in section 2, and the representative positive value indicates the LB of the concerned channel is better than the MIL of the bottleneck channel of the reference NR UE. |
| vivo |  | In the table, all channels except PUSCH have a range of 20+dB difference among companies, which seems too large. If possible, should we discuss a bit trying to identify the reason for such a large difference?  One thing worth noting is that companies are using power spectrum density of 24dBm/MHz find that downlink channels of MSG2 and MSG4 need to be enhanced, while there seems no coverage issue if 33dBm/MHz is assumed, hence the assumption for PSD should be mentioned in the proposals. |
| ZTE |  | Similar comment as to Question 3.1-2. |
| Nokia, NSB |  | Similar comment as to Question 3.1-2 |
| Futurewei |  | Same comment as 3.1-2. Since representative values have removed outliers its seems reasonable the values provided. |
| NTT DOCOMO |  | Similar comment as to Question 3.1-2.  And also we have the same view with vivo. We find large range for DL channels, so it may be better to identify the reason, and one of them might be the PSD difference. |
| Ericsson |  | We suggest clarifying (1) the meaning of the numbers in parentheses, and (2) how is the range computed (e.g., maximum-minimum).  Some evaluations are based on downlink power spectrum density 24 dBm/MHz, whereas some are based on 33 dBm/MHz. It might be better to have separate tables for the two different power spectrum density settings. |
| Intel |  | The table can be formed after proposal is section 2 is finalized. |
| Samsung |  | For DL channels, big gaps between companies are observed. Before capturing the results, some clarification and analysis on the big gap are necessary. |

Based on the results in Table 3.3-4, the following observations are proposed for discussion for the TP drafting for TR 38.875.

[FL notes: The observations will be updated based on the agreement for the coverage recovery target in section 2 and the update of Table 3.3-4]

**Moderator’s observation**

* P1: For RedCap UE in Urban scenario at 4 GHz, PUSCH is the channel that needs recovery and the amount of compensation is approximately 3dB.
* P2: For a RedCap UE with 2 Rx and 1Rx antenna at 4 GHz carrier frequency, four downlink channels, PDCCH CSS, Msg2, Msg4 and PDSCH do not reach the target coverage requirement and need for coverage recovery
  + A compensation of approximately 1.6 dB, 4.1 dB, 3.6 dB and 1.3 dB respectively, is observed for PDCCH CSS, Msg2, Msg4 and PDSCH for RedCap UE with 2Rx antenna
  + A compensation of approximately 4.8 dB, 7.4 dB, 4.0 dB and 5.6 dB respectively, is observed for PDCCH CSS, Msg2, Msg4 and PDSCH for RedCap UE with 1Rx antenna
* P3: Compared to the target coverage requirement, a coverage degradation of approximately 0.4 dB and 2.1 dB, respectively is observed for PDCCH USS and Msg3 by one source company for RedCap UE with 2 Rx
* P4: Compared to the target coverage requirement, a coverage degradation of approximately 4 dB, 2.2 dB and 2.1 dB, respectively is observed for PDCCH USS, PBCH and Msg3 by one source company for RedCap UE with 1 Rx

**Question 3.3-3: Can the above list (P1-P4) be used as a baseline text for TR 38.875? If not, what other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | N | Prefer to wait until proposal 1 is stable/agreed |
| Nokia, NSB |  | We prefer to wait until proposal 1 is agreed |
| Ericsson |  | Some evaluations are based on downlink power spectrum density 24 dBm/MHz, whereas some are based on 33 dBm/MHz. It might be better to have separate observations for the two different power spectrum density settings.  Furthermore, as our comments above, it will be good if the sourcing companies can clarify whether TBS scaling has been considered for Msg2. (This clarification may be needed for all the scenarios.)  P1: For PUSCH, it can be clarified the 3 dB coverage compensation is needed if the target data rate for RedCap UEs is the same as reference UE. We should add a note here to state that the 3 dB coverage compensation is not needed if the target data rate for RedCap UEs is reduced.  We can further mention that the 3 dB loss is resulting from the UE antenna efficiency loss assumed for the wearable use cases only. |
| Samsung |  | It can be mentioned that 3dB antenna loss is resulted from reduced antenna efficiency due to device size limitations for wearables. |
| Huawei, Hisilicon | N | Similar comment as to Question 3.1-2. |

**[FL5] Based on the received responses, the FL’s updated text proposal is as following.**

**(FL note: based on the outcome of Proposal 2-1, some numbers in the tables can be further updated, however, the conclusion is expected to be same)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| For Urban scenario at 4 GHz, the bottleneck channel for the reference NR UE and the corresponding maximum isotropic loss (MIL) value by the sourcing companies are shown in Table 9.1-7.  For RedCap UE with 1 Rx and 2 Rx, the MIL loss relative to the bottleneck channel of the reference NR UE is studied under different downlink power spectrum density assumptions. For DL PSD 33 dBm/MHz, the estimated coverage loss for 1 Rx and 2 Rx is summarized in Table 9.1-8 and Table 9.1-9, respectively. For DL PSD 24 dBm/MHz, the estimated coverage loss for 1 Rx and 2 Rx is summarized in Table 9.1-10 and Table 9.1-11, respectively. It is noted that the 3dB antenna efficiency loss is assumed in both DL and UL for the RedCap UE.  **Table 9.1-7: Bottleneck channel and MIL values for Reference NR UE in Urban 4 GHz**   |  |  |  | | --- | --- | --- | |  | Bottleneck Channel | MIL (dB) | | Samsung | PUSCH | 142.0 | | ZTE | PUSCH | 143.0 | | OPPO | PUSCH | 147.0 | | vivo | PUSCH | 139.3 | | Futurewei | PUSCH | 152.6 | | Nokia | PUSCH | 140.8 | | DCM | PUSCH | 146.8 | | Huawei | PUSCH | 140.0 | | SPRD | PUSCH | 145.4 | | Ericsson | Msg2 | 143.6 | | IDCC | PUSCH | 144.9 | | QC | PUSCH | 140.7 | | Intel | PUSCH | 140.0 | | Lenovo | PUSCH | 148.3 |   The representative values in the last row of Table 9.1-8 to Table 9.1-11 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE and coverage recovery is needed.  As can be seen in the last row for the representative value, all uplink channels except for PUSCH have better coverage than that of the bottleneck channel thus requiring no compensation. On average, a coverage degradation of approximately 3dB is observed for PUSCH.  It should be noted that the 3dB loss is resulted from the UE antenna efficiency loss assumed for the wearable use cases. Furthermore, the same target data rate of 1 Mbps for PUSCH is assumed for both RedCap UE and the reference NR UE (see evaluation methodology described in clause 6.3). A smaller or no coverage loss for PUSCH is expected if the target data rate for RedCap UE is reduced.  As seen from Table 9.1-8 and Table 9.1-9, for DL PSD 33 dBm/MHz, all the downlink channels are not coverage limited for both 1 Rx and 2 Rx RedCap UEs. The same conclusion is observed for DL PSD 24 dBm/MHz and 2 Rx RedCap UE. However, for DL PSD 24 dBm/MHz and 1 Rx RedCap UE, a coverage degradation of approximately 5.5 dB, 2.4 dB and 0.8 dB, respectively is observed for Msg2, Msg4 and PDCCH CSS as seen from Table 9.1-11.  **Table 9.1-8: Coverage loss (dB) for 2Rx RedCap UE in Urban 4 GHz with 33 dBm/MHz PSD (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | Samsung | 18.0 | 22.0 | 14.8 | 13.7 | 14.7 |  | 13.3 | 9.5 | 6.5 | -3.0 | 5.0 |  | | vivo | 12.7 | 20.7 | 16.0 | 10.3 | 12.3 | 16.0 | 14.0 | 11.5 | 8.8 | -2.8 | 10.3 | 7.3 | | Nokia | 21.7 | 21.7 | 17.8 | 22.6 | 19.2 |  | 7.9 |  | 6.4 | -3.0 | 3.5 | 11.3 | | Huawei | 18.0 | 22.0 | 16.9 | 14.6 | 14.6 |  | 17.5 |  | 15.7 | -3.0 | 6.6 |  | | Representative value (dB) | **18.0** | **21.9** | **16.4** | **14.2** | **14.7** | **16.0** | **13.6** | **10.5** | **7.6** | **-3.0** | **5.8** | **9.3** |   Note: All sources assume no TBS scaling for Msg2 evaluation  **Table 9.1-9: Coverage loss (dB) for 1Rx RedCap UE in Urban 4 GHz with 33 dBm/MHz PSD (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | Samsung | 14.5 | 18.5 | 10.1 | 8.5 | 11.1 |  | 13.3 | 9.5 | 6.5 | -3.0 | 5.0 |  | | ZTE | 9.6 | 17.6 | 11.4 | 5.6 | 7.5 | 13.4 | 14.0 | 11.5 | 8.8 | -2.8 | 10.3 | 7.3 | | OPPO | 17.7 | 17.7 | 14.0 | 18.8 | 15.7 |  | 7.9 |  | 6.4 | -3.0 | 3.5 | 11.3 | | CATT | 14.5 | 18.5 | 13.0 | 10.3 | 10.7 |  | 17.5 |  | 15.7 | -3.0 | 6.6 |  | | Representative value (dB) | **14.5** | **18.1** | **12.2** | **9.4** | **10.9** | **13.4** | **13.6** | **10.5** | **7.6** | **-3.0** | **5.8** | **9.3** |   Note: All sources assume no TBS scaling for Msg2 evaluation  **Table 9.1-10: Coverage loss (dB) for 2Rx RedCap UE in Urban 4 GHz with 24 dBm/MHz PSD (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | OPPO | 5.1 | 9.1 | 7.5 | -0.7 | 3.0 |  | 4.9 | 5.0 | 4.9 | -3.0 | 4.7 |  | | Futurewei | -2.4 | -0.4 | -2.6 | -6.4 | -3.6 |  |  |  |  | -3.0 | -2.1 |  | | DCM | 4.1 | 8.1 | 4.0 | -2.8 | 0.2 |  | 11.5 | 15.1 |  | -3.0 | 4.9 |  | | SPRD | 4.3 | 8.5 | 6.3 | 3.3 | 3.3 | 6.3 | 9.8 | 7.8 | 9.6 | -3.0 | 5.1 | 7.1 | | Ericsson | -0.8 | 3.2 | -0.1 | -6.4 | -3.7 | 1.4 | 7.0 | 9.0 | 7.1 | -2.5 | 4.7 | 8.3 | | IDCC | 4.9 | 8.9 | 6.4 | 8.9 | 11.9 |  | 12.2 |  | 7.9 | -3.0 | 5.0 |  | | QC | 6.1 |  | 4.9 | 0.1 | 2.4 |  |  |  | 2.8 | -3.7 | 3.3 |  | | Intel | 10.4 | 11.5 | 6.5 | 11.4 | 8.6 | 13.3 | 18.5 | 17.3 | 14.7 | -2.3 | 11.2 | 13.3 | | Representative value (dB) | **4.0** | **7.6** | **4.7** | **0.4** | **2.3** | **6.3** | **10.1** | **10.6** | **7.4** | **-2.9** | **4.6** | **8.3** |   Note: All sources except for Source X (Intel) assume no TBS scaling for Msg2 evaluation  **Table 9.1-11: Coverage loss (dB) for 1Rx RedCap UE in Urban 4 GHz with 24 dBm/MHz PSD (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | ZTE | -4.5 | 6.0 | 8.6 | -1.3 | -1.1 |  | 16.6 | 14.9 | 12.3 | -3.0 | 10.3 |  | | OPPO | 1.2 | 5.2 | 4.9 | -6.2 | -0.8 |  | 4.9 | 5.0 | 4.9 | -3.0 | 4.7 |  | | Futurewei | -6.0 | -4.0 | -7.4 | -13.4 | -9.7 |  |  |  |  | -3.0 | -2.1 |  | | DCM | 0.8 | 4.8 | 0.0 | -8.5 | -3.9 |  | 11.5 | 15.1 |  | -3.0 | 4.9 |  | | SPRD | 1.3 | 5.5 | 3.3 | 0.3 | 0.3 | 3.3 | 9.8 | 7.8 | 9.6 | -3.0 | 5.1 | 7.1 | | Ericsson | -3.9 | 0.2 | -3.8 | -11.2 | -7.6 | -2.2 | 7.0 | 9.0 | 7.1 | -2.5 | 4.7 | 8.3 | | IDCC | 1.7 | 5.7 | 3.3 | 4.4 | 8.8 |  | 12.2 |  | 7.9 | -3.0 | 5.0 |  | | QC | 2.8 |  | 1.7 | -3.8 | -0.9 |  |  |  | 2.8 | -3.7 | 3.3 |  | | Lenovo | -2.0 |  | -2.6 | -8.1 | -2.9 |  | 11.7 | 6.9 | 5.7 | -3.0 | 2.9 |  | | Representative value (dB) | **-0.8** | **4.3** | **1.0** | **-5.5** | **-2.4** | **0.6** | **10.4** | **9.6** | **7.0** | **-3.0** | **4.4** | **7.7** |   Note: All sources assume no TBS scaling for Msg2 evaluation |

**[FL5] Question 3.3-1A:** **Can the above observations of the relative coverage loss be used as a baseline text for TR 38.875? If not, what aspects to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Panasonic | Y |  |
| vivo |  | It would be useful to make if clear   * + - 1. All companies except one company does not apply TBS scaling for MSG2       2. PRACH format B4 is simulated |
| ZTE | Y | Fine with the observation. |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson |  | Some updates are needed.  (1) Ericsson results for Msg2 need to be updated based on TBS scaling factor ¼. (see v015 or later)  (2) Ericsson results based on TBS scaling factor ¼ for Msg2 end up having PUSCH as the bottleneck channel (MIL 144). So Table 9.1-7 need to be updated accordingly. |
| Samsung |  | In “Note”, \* seems missing because all companies except only one company indicated no TBS scaling. |
| Intel | Y |  |
| OPPO | Y |  |
| Lenovo, Motorola Mobility | Y |  |
| FL5 | The TP above has been updated based on the received response. The PRACH format has been added in the Table 9.1-8 to Table 9.1-11. The note for Msg2 assumption has been updated to make it clearer.  **Proposal 3.3-1A:**   * Adopted the updated TP in section 3.3 of R1-2009660 as baseline text for TR clause 9.1 | |
| vivo | modifications | 1. It is necessary to clarify that no TBS scaling is applied for MSG2 for the case with 24dBm/MHz PSD where coverage loss for MSG2 is observed. Propose the following text addition   As seen from Table 9.1-8 and Table 9.1-9, for DL PSD 33 dBm/MHz, all the downlink channels are not coverage limited for both 1 Rx and 2 Rx RedCap UEs. The same conclusion is observed for DL PSD 24 dBm/MHz and 2 Rx RedCap UE. However, for DL PSD 24 dBm/MHz and 1 Rx RedCap UE, a coverage degradation of approximately 5.5 dB, 2.4 dB and 0.8 dB, respectively is observed for Msg2, Msg4 and PDCCH CSS as seen from Table 9.1-11. For PSD 24dBm/MHz and 1Rx RedCap UE case, TBS scaling for MSG2 is not applied from all the sources that submitted the results.   1. We have agreed the following in the last GTW call    * The representative value of a channel is used for identifying whether the channel needs coverage recovery      + Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero      + The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc   Therefore the need and amount of coverage compensation should be discussed separately, not solely based on the coverage degradation. We should make the following change  The representative values in the last row of Table 9.1-2 and Table 9.1-3 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE ~~and coverage recovery is needed.~~ |
| FL5 | The proposal to remove “and coverage recovery is needed” may be okay based on the agreement we made in last GTW call. The FL’s updated proposal is as following.  **Updated proposal 3.3-1A:**   * Adopted the updated TP in section 3.3 of R1-2009660 as baseline text for TR clause 9.1   + Remove “and coverage recovery is needed” from the TP   + Add the following sentence to the last paragraph of the TP     - It should be noted that for DL PSD 24 dBm/MHz and 1 Rx RedCap UE case Msg2 results are based on no TBS scaling | |
| Huawei, HiSilicon |  | Huawei’s results are missing in Table 9.1-9, please add them. |

## FR2, Indoor with the carrier frequency of 28 GHz

Based on the latest available evaluation results in [RedCapCoverage-28GHz-v012-QC-Ericsson.xlsx](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Inbox/drafts/8.6/EvaluationResults/RedCapCoverage/28GHz/RedCapCoverage-28GHz-v012-QC-Ericsson.xlsx), the link budget performance for both the reference UE and RedCap UE is summarized in Table 3.4-1 to Table 3.4-4 (Company please double check whether your results are correctly captured in these tables. We have found there are some mismatch between the spreadsheet and the contribution for some companies results).

In the link budget tables, the maximum isotropic loss (MIL) is used as the coverage evaluation metric and for each channel the margin to the target performance is also shown, where the target performance is a company specific value and derived based on the link budget of the bottleneck channel for the reference NR UE. The coverage limiting channel for RedCap UE, e.g. the link budget for the channel worse than that target performance, is highlighted with RED.

**Table 3.4-1: Link budget performance for the reference NR UE**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Indoor, 28GHz, 100MHz, 2Rx Ref NR UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 146.5 | 146.5 | 141.3 | 145.1 | 142.5 |  | 157.8 | 153.8 | 150.9 | 133.3 | 149.4 |  | 133.3 |
| Margin (dB) | 13.2 | 13.2 | 8.0 | 11.8 | 9.2 |  | 24.5 | 20.5 | 17.6 | 0.0 | 16.1 |  |  |
| ZTE | MIL (dB) | 139.8 | 140.5 | 134.5 | 139.0 | 139.3 |  | 157.5 | 153.1 | 152.3 | 134.3 | 152.3 |  | 134.3 |
| Margin (dB) | 5.5 | 6.2 | 0.2 | 4.6 | 4.9 |  | 23.1 | 18.8 | 18.0 | 0.0 | 18.0 |  |  |
| OPPO | MIL (dB) | 145.9 | 145.9 | 142.9 | 144.6 | 144.2 |  | 160.0 | 159.7 | 160.0 | 141.9 | 160.2 |  | 141.9 |
| Margin (dB) | 4.0 | 4.0 | 1.0 | 2.8 | 2.3 |  | 18.2 | 17.8 | 18.1 | 0.0 | 18.4 |  |  |
| vivo | MIL (dB) | 135.5 | 140.5 | 136.0 | 133.7 | 135.1 | 139.8 | 153.9 | 152.3 | 149.0 | 131.4 | 142.8 | 142.6 | 131.4 |
| Margin (dB) | 4.1 | 9.1 | 4.6 | 2.3 | 3.8 | 8.4 | 22.6 | 20.9 | 17.6 | 0.0 | 11.4 | 11.2 |  |
| Nokia | MIL (dB) | 142.5 | 142.5 | 139.3 | 144.9 | 144.1 |  | 160.5 |  | 158.9 | 144.9 | 153.1 | 157.5 | 139.3 |
| Margin (dB) | 3.3 | 3.3 | 0.0 | 5.6 | 4.8 |  | 21.2 |  | 19.6 | 5.6 | 13.8 | 18.2 |  |
| DOCOMO | MIL (dB) | 148.6 | 148.6 | 143.0 | 143.3 | 142.0 |  | 158.6 | 164.0 |  | 147.3 | 160.3 |  | 142.0 |
| Margin (dB) | 6.6 | 6.6 | 1.0 | 1.3 | 0.0 |  | 16.6 | 22.0 |  | 5.4 | 18.3 |  |  |
| Ericsson | MIL (dB) | 132.1 | 133.1 | 128.4 | 128.2 | 128.0 | 134.3 | 150.5 | 150.9 | 148.4 | 138.7 | 146.3 | 149.1 | 128.0 |
| Margin (dB) | 4.1 | 5.1 | 0.4 | 0.2 | 0.0 | 6.3 | 22.5 | 22.9 | 20.4 | 10.7 | 18.3 | 21.1 |  |
| InterDigital | MIL (dB) | 147.3 | 147.3 | 142.67 | 143.32 | 142.47 |  | 166.3 |  | 160.7 | 143.4 | 159.35 |  | 142.47 |
| Margin (dB) | 4.8 | 4.8 | 0.2 | 0.85 | 0.0 |  | 23.83 |  | 18.2 | 0.9 | 16.88 |  |  |
| Qualcomm | MIL (dB) | 143.4 | 149.4 | 141.9 | 143.9 | 147.3 | 153.0 | 170.8 | 164.7 | 162.2 | 138.8 | 147.4 | 163.4 | 138.8 |
| Margin (dB) | 4.6 | 10.6 | 3.1 | 5.1 | 8.5 | 14.1 | 32.0 | 25.8 | 23.3 | 0.0 | 8.6 | 24.6 |  |
| Intel | MIL (dB) | 139.2 | 140.0 | 132.1 | 140.5 | 137.6 | 142.3 | 157.0 | 157.3 | 154.2 | 137.4 | 150.9 | 150.9 | 132.1 |
| Margin (dB) | 1.8 | 2.6 | 0 | 3.1 | 0.2 | 4.9 | 19.6 | 19.9 | 16.8 | 5.3 | 13.5 | 13.5 |  |

**Table 3.4-2: Link budget performance for the RedCap UE (100MHz BW, 1Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Indoor, 28GHz, 100MHz, 1Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 142.3 | 142.4 | 136.4 | 139.5 | 137.2 |  | 157.5 | 153.9 | 150.4 | 133.3 | 149.4 |  | 133.3 |
| Margin (dB) | 9.0 | 9.1 | 3.1 | 6.2 | 3.9 |  | 24.2 | 20.6 | 17.1 | 0.0 | 16.1 |  |  |
| ZTE | MIL (dB) | 136.5 | 137.2 | 129.2 | 134.1 | 134.7 |  | 157.5 | 153.1 | 152.3 | 134.3 | 152.3 |  | 134.3 |
| Margin (dB) | 2.1 | 2.8 | -5.2 | -0.2 | 0.3 |  | 23.1 | 18.8 | 18.0 | 0.0 | 18.0 |  |  |
| OPPO | MIL (dB) | 141.0 | 141.0 | 138.8 | 140.1 | 139.4 |  | 160.0 | 159.7 | 160.0 | 141.9 | 160.2 |  | 141.9 |
| Margin (dB) | -0.9 | -0.9 | -3.1 | -1.7 | -2.5 |  | 18.2 | 17.8 | 18.1 | 0.0 | 18.4 |  |  |
| vivo | MIL (dB) | 131.8 | 136.8 | 130.8 | 127.3 | 130.5 | 134.3 | 153.9 | 152.3 | 149.0 | 131.4 | 142.8 | 142.6 | 131.4 |
| Margin (dB) | 0.4 | 5.4 | -0.6 | -4.0 | -0.8 | 2.9 | 22.6 | 20.9 | 17.6 | 0.0 | 11.4 | 11.2 |  |
| Nokia | MIL (dB) | 139.5 | 139.3 | 136.0 | 142.5 | 141.5 |  | 160.5 |  | 158.9 | 144.9 | 153.1 | 157.5 | 139.3 |
| Margin (dB) | 0.3 | 0.0 | -3.3 | 3.2 | 2.2 |  | 21.2 |  | 19.6 | 5.6 | 13.8 | 18.2 |  |
| DOCOMO | MIL (dB) | 144.9 | 144.9 | 138.4 | 137.1 | 137.0 |  | 158.6 | 164.0 |  | 147.3 | 160.3 |  | 142.0 |
| Margin (dB) | 2.9 | 2.9 | -3.5 | -4.8 | -5.0 |  | 16.6 | 22.0 |  | 5.4 | 18.3 |  |  |
| Ericsson | MIL (dB) | 128.2 | 129.2 | 124.4 | 124.8 | 123.5 | 130.6 | 150.5 | 150.5 | 148.1 | 138.7 | 146.3 | 149.1 | 128.0 |
| Margin (dB) | 0.2 | 1.2 | -3.6 | -3.2 | -4.5 | 2.6 | 22.5 | 22.6 | 20.1 | 10.7 | 18.3 | 21.1 |  |
| InterDigital | MIL (dB) | 143.5 | 143.5 | 138.56 | 138.0 | 137.90 |  | 166.3 |  | 160.7 | 143.4 | 159.35 |  | 142.47 |
| Margin (dB) | 1.0 | 1.0 | -3.9 | -4.47 | -4.57 |  | 23.9 |  | 18.2 | 0.9 | 16.88 |  |  |
| Qualcomm | MIL (dB) | 140.1 | 146.1 | 137.7 | 138.5 | 143.8 | 149.7 | 170.8 | 164.7 | 162.2 | 138.8 | 147.4 | 163.4 | 138.8 |
| Margin (dB) | 1.3 | 7.3 | -1.2 | -0.4 | 5.0 | 10.8 | 32.0 | 25.8 | 23.3 | 0.0 | 8.6 | 24.6 |  |
| Intel | MIL (dB) | 135.1 | 135.9 | 128.0 | 137.1 | 134.0 | 137.8 | 157.0 | 157.3 | 154.2 | 137.4 | 150.9 | 150.9 | 132.1 |
| Margin (dB) | 3.0 | 3.8 | -4.1 | 5.0 | 1.9 | 5.7 | 24.9 | 25.2 | 22.1 | 5.3 | 18.8 | 18.7 |  |

**Table 3.4-3: Link budget performance for the RedCap UE (50MHz BW, 2Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Indoor, 28GHz, 50MHz, 2Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 146.0 | 145.9 | 137.0 | 145.1 | 142.5 |  | 157.5 | 153.9 | 150.4 | 133.3 | 149.4 |  | 133.3 |
| Margin (dB) | 12.7 | 12.6 | 3.7 | 11.8 | 9.2 |  | 24.2 | 20.6 | 17.1 | 0.0 | 16.1 |  |  |
| OPPO | MIL (dB) | 145.7 | 145.7 | 137.2 | 144.6 | 144.2 |  | 160.0 | 159.7 | 160.0 | 144.8 | 160.2 |  | 141.9 |
| Margin (dB) | 3.9 | 3.9 | -4.6 | 2.8 | 2.3 |  | 18.2 | 17.8 | 18.1 | 3.0 | 18.4 |  |  |
| DOCOMO | MIL (dB) | 144.8 | 144.8 | 137.4 | 143.3 | 142.0 |  | 158.6 | 164.0 |  | 145.9 | 160.3 |  | 142.0 |
| Margin (dB) | 2.9 | 2.9 | -4.6 | 1.3 | 0.0 |  | 16.6 | 22.0 |  | 4.0 | 18.3 |  |  |
| Ericsson | MIL (dB) | 130.2 | 131.2 | 124.8 | 129.2 | 128.0 | 134.3 | 150.5 | 150.5 | 148.1 | 143.6 | 146.3 | 149.1 | 128.0 |
| Margin (dB) | 2.2 | 3.2 | -3.2 | 1.2 | 0.0 | 6.3 | 22.5 | 22.6 | 20.1 | 15.7 | 18.3 | 21.1 |  |
| Qualcomm | MIL (dB) |  |  | 138.4 | 143.9 | 144.2 | 152.9 | 170.8 | 164.7 | 162.2 | 138.9 | 147.4 | 163.4 | 138.8 |
| Margin (dB) |  |  | -0.4 | 5.1 | 5.4 | 14.1 | 32.0 | 25.8 | 23.3 | 0.1 | 8.6 | 24.6 |  |

**Table 3.4-4: Link budget performance for the RedCap UE (50MHz BW, 1Rx)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Indoor, 28GHz, 50MHz, 1Rx RedCap UE** | | | | | | | | | | | | | | |
|  |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22bits | PUSCH | Msg3 | PRACH | Target /Option3 |
| Samsung | MIL (dB) | 141.6 | 141.6 | 130.9 | 139.5 | 137.2 |  | 157.5 | 153.9 | 150.4 | 133.3 | 149.4 |  | 133.3 |
| Margin (dB) | 8.3 | 8.3 | -2.4 | 6.2 | 3.9 |  | 24.2 | 20.6 | 17.1 | 0.0 | 16.1 |  |  |
| OPPO | MIL (dB) | 140.9 | 140.9 | 131.8 | 140.1 | 139.4 |  | 160.0 | 159.7 | 160.0 | 144.8 | 160.2 |  | 141.9 |
| Margin (dB) | -1.0 | -1.0 | -10.1 | -1.7 | -2.5 |  | 18.2 | 17.8 | 18.1 | 3.0 | 18.4 |  |  |
| DOCOMO | MIL (dB) | 140.3 | 140.3 | 131.3 | 137.1 | 137.0 |  | 158.6 | 164.0 |  | 145.9 | 160.3 |  | 142.0 |
| Margin (dB) | -1.7 | -1.7 | -10.7 | -4.8 | -5.0 |  | 16.6 | 22.0 |  | 4.0 | 18.3 |  |  |
| Ericsson | MIL (dB) | 126.1 | 127.1 | 120.1 | 124.8 | 123.5 | 130.6 | 150.5 | 150.5 | 148.1 | 143.6 | 146.3 | 149.1 | 128.0 |
| Margin (dB) | -1.9 | -0.9 | -7.9 | -3.2 | -4.5 | 2.6 | 22.5 | 22.6 | 20.1 | 15.7 | 18.3 | 21.1 |  |
| Qualcomm | MIL (dB) |  |  | 133.4 | 138.5 | 140.2 | 149.9 | 170.8 | 164.7 | 162.2 | 138.9 | 147.4 | 163.4 | 138.8 |
| Margin (dB) |  |  | -5.4 | -0.4 | 1.4 | 11.1 | 32.0 | 25.8 | 23.3 | 0.1 | 8.6 | 24.6 |  |

**Question 3.4-1: Can the link budget evaluation results in Table 3.4-1 to Table 3.4-4 be captured to TR 38.875? (Companies are invited to check the results and if any modification is needed, please also indicate here.)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| ZTE | Y | Fine to capture the tables into the TR. |
| Qualcomm | Y |  |
| NTT DOCOMO | Y |  |
| Ericsson | Y |  |
| Intel | Y |  |
| Samsung |  | For Msg 2, it should be clarified whether or not Rel-15 TBS scaling was applied for each simulation result. |
| InterDigital | Y | We have provide some update on our results. |
| FL4 | Majority of responses are fine with capturing the above link budget evaluation results to TR 38.875. One responses comments to clarify evaluation assumption for msg2.  For Msg2 results, some companies might have considered TBS scaling and some others have not. However, the assumption for TBS scaling is not available in the evaluation spreadsheet. The FL suggests the sourcing companies to clarify whether TBS scaling is used for Msg2.  Based on the responses, the FL makes the following proposal:  **[FL4] Proposal 3.4-1:**   * Capture the link budget evaluation results (indoor 28 GHz) in Table 3.4-1 to Table 3.4-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated coverage recovery evaluation results and a clarification of assumption for Msg2 | |
| vivo |  | For MSG2, we used MCS#0 with no TBS scaling |
| Qualcomm |  | We are fine with the FL updated proposal  For Msg2, no TBS scaling is used (4 RBs, MCS0, and TBS = 96) |
| Huawei, Hisilicon | N | We prefer to wait until proposal 1 is agreed.  For Msg2, no TBS scaling is assumed in our simulation. |
| Intel | Y | We simulate Msg2 with scaling factor 1/4 |
| Ericsson |  | Regarding TBS scaling for Msg2, we have provided results with and without TBS scaling. We suggest using results based on no TBS scaling as a baseline. TBS scaling can be considered as a coverage recovery technique for Msg2. |
| Samsung |  | No TBS scaling was used for Msg2. |
| ZTE |  | We are fine with the proposal.  For Msg.2, we use (3 RBs, MCS#0, TBS = 9 bytes) w/o TBS scaling. |
| InterDigital | Y | For Msg2, we used 3 RBs, MCS0, 72 bits. |
| OPPO | Y | For Msg2, we used 3 RBs, MCS0, without TBS scaling. |
| FL5 | Based on the received responses, the FL’s updated suggestion is as following.  **[FL5] Updated Proposal 3.4-1:**   * Capture the link budget evaluation results (indoor 28 GHz) in Table 3.4-1 to Table 3.4-3 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables | |
| vivo | Y |  |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Samsung | Y |  |
| Intel |  | Similar comments as that for [FL5] Updated Proposal 3.1-1  Further, I may miss something. Is there a fixed assumption on the UE maximum TX power, 23 or 12dBm? |
| OPPO | Y |  |
| FL5 | All responses agree with the proposal except that one response suggests to clarify how to handle different assumptions for Msg2 TBS scaling and PRACH format.  The FL understanding is that Msg2 with no TBS scaling will be used as baseline for deriving representative value. Categorization by different scaling factors may not be acceptable since the number of samples in each category will be small and not useful to draw the conclusion  Based on the received responses, one company considers ¼ TBS scaling for Msg2 and the other companies evaluate Msg2 with no TBS scaling and one company evaluates both scaling and no scaling. Therefore, the representation value based on all the companies results (with and without TBS scaling) can be acceptable since the outlier value with TBS scaling has been removed.  For PRACH format, it seems all the companies use the same format as recommended in the template. Therefore, no divergence is observed.  **Further updated Proposal 3.4-1:**   * Capture the link budget evaluation results (indoor 28 GHz) in Table 3.4-1 to Table 3.4-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2, PRACH and UE maximum Tx power.   + MPL results to be included also. Up to editor to use the same or different tables | |
| Samsung | For the evaluation assumption on Msg 4, we noticed that some companies assume 18 PRBs with MCS 3, while some other companies used about 40 PRBs with MCS 0, and 66 PRBs are also used for Msg 4. The MCS/occupied PRB may impact on the coverage of Msg 4. In addition, the length of symbols is restricted to default table where not all the symbols. Therefore, we like to update the proposals 3.4-1 as below:   * + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2, Msg 4, PRACH …… | |
| **FL6** | The FL understanding is that there is no agreement on the MCS/RB assumption for Msg4 evaluation, i.e. up to companies to report same as PDSCH and PUSCH. Therefore, it is not necessary to clarify the Msg4 assumption for these tables. If we make it, then we need also to clarify the assumption for PDSCH and PUSCH etc. Since there is a separate clause 6.3 in the TR for evaluation methodology and assumptions for coverage evaluation, it is not necessary to include also the assumptions in the tables. If needed, perhaps we can clarify in the TP for FR2 indoor scenario by adding “some Msg4 results are not based on the lowest MCS0 assumption”. | |
| vivo |  | We agree to add the note “some Msg4 results are not based on the lowest MCS0 assumption” |
| Huawei, HiSilicon |  | Better to add note to clarify assumption for Msg4, e.g. the note suggested by vivo. |
| Futurewei |  | OK with suggestion |
| Qualcomm |  | We agree with FL’s comment |
| Ericsson |  | We propose the following alternative wording for the suggested note. “Most of the Msg4 results are based on MCS0. However, a few results are based on a higher MCS.” |
| Intel |  | We agree with FL’s comment |
| Samsung |  | Agree with the suggestion from Ericsson to add:  *Most of the Msg4 results are based on MCS0. However, a few results are based on a higher MCS* |

Based on the evaluation results in Table 3.4-1 to Table 3.4-4, the channels that potentially need coverage recovery in indoor scenario at 28 GHz and the summary of companies evaluation results for the margin to the coverage recovery target (i.e. the MIL of bottleneck channel for the reference NR UE) are summarized in Table 3.4-5, where the numbers in bracket is the number of samples.

**Table 3.4-5: Coverage recovery for RedCap UE in indoor scenario at 28 GHz (Option 3)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Channels | Mean | Median | Range | Representative value |
| 1Rx RedCap 100MHz BW | PDSCH (10) | -3.1 | -3.4 | 12.4 | -3.1 |
| Msg2 (9) | -0.9 | -0.4 | 11.8 | -1.2 |
| Msg4 (9) | -0.5 | -0.8 | 10.0 | -0.7 |
| PDCCH CSS (5) | 1.4 | 0.7 | 11.3 | 0.9 |
| 2Rx RedCap 50MHz BW | PDSCH (5) | -1.8 | -3.2 | 8.3 | -2.7 |
| Msg2 (5) | 0.7 | 2.8 | 11.8 | 1.0 |
| Msg4 (5) | 0.4 | 2.3 | 10.4 | 0.5 |
| 1Rx RedCap 50MHz BW | PDSCH (5) | -7.3 | -7.9 | 8.2 | -7.8 |
| Msg2 (5) | -1.3 | -1.7 | 11.8 | -2.3 |
| Msg4 (5) | -1.3 | -2.5 | 8.8 | -1.9 |
| PDCCH CSS (4) | 0.9 | -1.4 | 10.2 | -1.4 |
| PDCCH USS (4) | 1.2 | -1.0 | 10.0 | -1.0 |

**Question 3.4-2: Can Table 3.4-5 be captured to TR 38.875? If not, any other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FL |  | Table 3.4-5 has been updated by considering all the companies’ evaluation results. The representative value in the table is expected to be updated based on the agreement for the coverage recovery target in section 2, and the positive representative value indicates the LB of the concerned channel is better than the MIL of the bottleneck channel of the reference NR UE. |
| vivo |  | We have concern to use option 3 to determine the coverage issue and the amount of coverage compensation. From the simulation results, we found that with 20m or even 100m ISD target, there will be no coverage issue based on option1, however, based on option 3 there are many channels requiring compensation. We need to discuss what is the real target for FR2 indoor, do we really target >100m ISD for real deployment? |
| ZTE |  | Similar comment as to Question 3.1-2.  An editorial comment: It should be 1 Rx for RedCap 100MHz BW in Table 3.4-5. |
| Qualcomm | N | There is a typo in Table 3.4-5. 2Rx RedCap 100MHz BW shall be changed to 1Rx RedCap 100MHz BW.  Prefer to wait until proposal 1 is stable/agreed |
| Nokia, NSB |  | Similar comment as to Question 3.1-2 |
| Futurewei |  | A general remark seems only few companies (5) have provided results for the worst case redcap where it shown PDSCH that requires 7.8 dB compensation. It could be that due to having a smaller number of samples the compensation seems larger. Even with such existing techniques may be sufficient to for its recovery. |
| NTT DOCOMO |  | Similar comment as to Question 3.1-2. |
| Ericsson |  | We suggest clarifying (1) the meaning of the numbers in parentheses, and (2) how is the range computed (e.g., maximum-minimum).  “2Rx RedCap 100MHz BW” should be changed to “1Rx RedCap 100MHz BW” according to the caption of Table 3.4-2. |
| Samsung |  | For DL channels, big gaps between companies are observed. Before capturing the results, some clarification and analysis on the big gap are necessary. |

Based on the results in Table 3.4-5, the following observations are proposed for discussion for the TP drafting for TR 38.875.

[FL notes: The observations will be updated based on the agreement for the coverage recovery target in section 2 and the update of Table 3.4-5]

**Moderator’s observation**

* P1: For RedCap UE in indoor scenario at 28 GHz, all uplink channels can reach the target coverage requirement thus requiring no compensation
* P2: For RedCap UE with 100MHz BW and 1Rx antenna at 28 GHz carrier frequency, five downlink channels, PDSCH, Msg2, Msg4, PDCCH CSS and USS do not reach the target coverage requirement and need for coverage recovery
  + A compensation of approximately 3.8 dB, 2.4 dB, 3.2 dB, 1.6 dB and 1.2 dB respectively, is observed for PDSCH, Msg2, Msg4, PDCCH CSS and USS
* P3: For RedCap UE with 50MHz BW and 2Rx antenna at 28 GHz carrier frequency, three downlink channels, PDSCH, Msg2, and Msg4 do not reach the target coverage requirement and need for coverage recovery
  + A compensation of approximately 3.2 dB, 5.2 dB, and 4.7 dB respectively, is observed for PDSCH, Msg2 and Msg4
* P4: For RedCap UE with 50MHz BW and 1Rx antenna at 28 GHz carrier frequency, five downlink channels, PDSCH, Msg2, Msg4, PDCCH CSS and USS do not reach the target coverage requirement and need for coverage recovery
  + A compensation of approximately 7.3 dB, 3.1 dB, 4.0 dB, 1.5 dB and 1.2 dB respectively, is observed for PDSCH, Msg2, Msg4, PDCCH CSS and USS

**Question 3.4-3: Can the above list (P1-P4) be used as a baseline text for TR 38.875? If not, what other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | N | Prefer to wait until proposal 1 is stable/agreed |
| Ericsson |  | P1: ok  P2/P3/P4: need to clarify whether TBS scaling is considered. Perhaps, we can have separate observations for Msg2 with and without TBS scaling. (This clarification may be needed for all the scenarios.) |
| Samsung |  | We think PUSCH data rate at the cell edge in the simulation is too high for RedCap comparing with peak data rate. In practical network, a lower data rate might be used. In this case, the MIL of the bottleneck channel for reference UE gets close to PUCCH MIL. In this case, MIL values for DL control channels for the RedCap would become lower than the MIL of the bottleneck channels. Due to the reason, we think coverage compensation for DL channels (i.e. PDCCH) is needed. |
| Huawei, Hisilicon | N | We prefer to wait until proposal 1 is agreed. |

**[FL5] Based on the received responses, the FL’s updated text proposal is as following.**

**(FL note: based on the outcome of Proposal 2-1, some numbers in the tables can be further updated, and the observations for the channels to compensate may also be changed as discussed in section 2)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| For indoor scenario at 28 GHz, the bottleneck channel for the reference NR UE and the corresponding maximum isotropic loss (MIL) value by the sourcing companies are shown in Table 9.1-12.  For RedCap UE with 1 Rx and 2 Rx, the MIL loss relative to the bottleneck channel of the reference NR UE is studied under different maximum UE bandwidth assumptions. The estimated coverage loss for maximum 100 MHz BW and 1 Rx RedCap UE is summarized in Table 9.1-13. The estimated coverage loss for maximum 50 MHz BW and 1 Rx and 2 Rx is summarized in Table 9.1-14 and Table 9.1-15, respectively.  **Table 9.1-12: Bottleneck channel and MIL values for Reference NR UE in indoor 28 GHz**   |  |  |  | | --- | --- | --- | |  | Bottleneck channel | MIL | | Samsung | PUSCH | 133.3 | | ZTE | PUSCH | 134.3 | | OPPO | PUSCH | 141.9 | | vivo | PUSCH | 131.4 | | Nokia | PDSCH | 139.3 | | DCM | Msg4 | 142.0 | | Ericsson | Msg4 | 128.0 | | IDCC | Msg4 | 142.5 | | QC | PUSCH | 138.8 | | Intel | PDSCH | 132.1 |   The representative values in the last row of Table 9.1-13 to Table 9.1-15 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE and coverage recovery is needed.  As can be seen in the last row for the representative value, all uplink channels are not coverage limited for the RedCap UE with either better or similar coverage as the bottleneck channel of the reference NR UE. This is because at FR2 there is no assumption of reduced antenna efficiency for the RedCap UE and UL coverage is same as the reference NR UE.  For RedCap UE with maximum 100MHz BW and 1Rx, an averaged coverage degradation of approximately 2.9 dB, 0.9 dB and 0.5 dB respectively, is observed for PDSCH, Msg2 and Msg4. It should be noted that for Msg2 results, some companies might have considered TBS scaling and some others have not.  By comparing Table 9.1-7 with Table 9.1-9, it can be seen a smaller maximum UE bandwidth may request a larger compensation. For example, the averaged coverage degradation for PDSCH is increased to 7.8 dB for RedCap UE with maximum 50MHz BW and 1Rx.  For RedCap UE with maximum 50MHz BW and 2Rx, PDSCH needs to be compensated as seen from Table 9.1-14. It should be noted that there may not be enough observations since not much sourcing companies have provided results.  For RedCap UE with maximum 50MHz BW and 1Rx, an averaged coverage degradation of approximately 7.8 dB, 1.8 dB and 1.9 dB respectively, is observed for PDSCH, Msg2 and Msg4. A coverage degradation of approximately 1.4 dB is also observed for PDCCH CSS. It should be noted that there may not be enough observations since not much sourcing companies have provided results.  **Table 9.1-13: Coverage loss (dB) for RedCap UE (1Rx, 100MHz BW) in indoor scenario at 28 GHz (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | Samsung | 9.0 | 9.1 | 3.1 | 6.2 | 3.9 |  | 24.2 | 20.6 | 17.1 | 0.0 | 16.1 |  | | ZTE | 2.1 | 2.8 | -5.2 | -0.2 | 0.3 |  | 23.1 | 18.8 | 18.0 | 0.0 | 18.0 |  | | OPPO | -0.9 | -0.9 | -3.1 | -1.7 | -2.5 |  | 18.2 | 17.8 | 18.1 | 0.0 | 18.4 |  | | vivo | 0.4 | 5.4 | -0.6 | -4.0 | -0.8 | 2.9 | 22.6 | 20.9 | 17.6 | 0.0 | 11.4 | 11.2 | | Nokia | 0.3 | 0.0 | -3.3 | 3.2 | 2.2 |  | 21.2 |  | 19.6 | 5.6 | 13.8 | 18.2 | | DCM | 2.9 | 2.9 | -3.5 | -4.8 | -5.0 |  | 16.6 | 22.0 |  | 5.4 | 18.3 |  | | Ericsson | 0.2 | 1.2 | -3.6 | -5.6 | -4.5 | 2.6 | 22.5 | 22.6 | 20.1 | 10.7 | 18.3 | 21.1 | | IDCC | 1.0 | 1.0 | -3.9 | -4.5 | -4.6 |  | 23.8 |  | 18.2 | 0.9 | 16.9 |  | | QC | 1.3 | 7.3 | -1.2 | -0.4 | 5.0 | 10.8 | 32.0 | 25.8 | 23.3 | 0.0 | 8.6 | 24.6 | | Intel | 3.0 | 3.8 | -4.1 | 5.0 | 1.9 | 5.7 | 24.9 | 25.2 | 22.1 | 5.3 | 18.8 | 18.7 | | Representative value (dB) | **1.4** | **3.0** | **-2.9** | **-0.9** | **-0.5** | **4.3** | **22.6** | **21.7** | **19.1** | **2.2** | **16.4** | **19.3** |   Note: All sources except for Source X (Intel) assume no TBS scaling for Msg2 evaluation  **Table 9.1-14: Coverage loss (dB) for RedCap UE (2Rx, 50MHz BW) in indoor scenario at 28 GHz (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | Samsung | 12.7 | 12.6 | 3.7 | 11.8 | 9.2 |  | 24.2 | 20.6 | 17.1 | 0.0 | 16.1 |  | | OPPO | 3.9 | 3.9 | -4.6 | 2.8 | 2.3 |  | 18.2 | 17.8 | 18.1 | 3.0 | 18.4 |  | | DCM | 2.9 | 2.9 | -4.6 | 1.3 | 0.0 |  | 16.6 | 22.0 |  | 4.0 | 18.3 |  | | Ericsson | 2.2 | 3.2 | -3.2 | 1.2 | 0.0 | 6.3 | 22.5 | 22.6 | 20.1 | 15.7 | 18.3 | 21.1 | | QC |  |  | -0.4 | 5.1 | 5.4 | 14.1 | 32.0 | 25.8 | 23.3 | 0.1 | 8.6 | 24.6 | | Representative value (dB) | **3.4** | **3.5** | **-2.7** | **3.1** | **2.6** | **10.2** | **21.6** | **21.7** | **19.1** | **2.3** | **17.6** | **22.8** |   Note: All sources assume no TBS scaling for Msg2 evaluation  **Table 9.1-15: Coverage loss (dB) for RedCap UE (1Rx, 50MHz BW) in indoor scenario at 28 GHz (Option 3)**   |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | PDCCH CSS | PDCCH USS | PDSCH | Msg2 | Msg4 | PBCH | PUCCH 2bits | PUCCH 11 bits | PUCCH 22 bits | PUSCH | Msg3 | PRACH B4 | | Samsung | 8.3 | 8.3 | -2.4 | 6.2 | 3.9 |  | 24.2 | 20.6 | 17.1 | 0.0 | 16.1 |  | | OPPO | -1.0 | -1.0 | -10.1 | -1.7 | -2.5 |  | 18.2 | 17.8 | 18.1 | 3.0 | 18.4 |  | | DCM | -1.7 | -1.7 | -10.7 | -4.8 | -5.0 |  | 16.6 | 22.0 |  | 4.0 | 18.3 |  | | Ericsson | -1.9 | -0.9 | -7.9 | -3.2 | -4.5 | 2.6 | 22.5 | 22.6 | 20.1 | 15.7 | 18.3 | 21.1 | | QC |  |  | -5.4 | -0.4 | 1.4 | 11.1 | 32.0 | 25.8 | 23.3 | 0.1 | 8.6 | 24.6 | | Representative value (dB) | **-1.4** | **-1.0** | **-7.8** | **-1.8** | **-1.9** | **6.8** | **21.6** | **21.7** | **19.1** | **2.3** | **17.6** | **22.8** |   Note: All sources assume no TBS scaling for Msg2 evaluation |

**[FL5] Question 3.4-1A:** **Can the above observations of the relative coverage loss be used as a baseline text for TR 38.875? If not, what aspects to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Panasonic | Y |  |
| vivo | N | As we commented in **[FL5] Question 2-1,** we have concern to draw observation solely based on Option 3 for FR2 indoor scenario. In particular, PDSCH and MSG4 coverage compensation is only needed in this scenario if Option 3 is solely considered. However, it would be a false issue if even we consider up to 100m ISD.  We would like to hear companies’ feedback about overcompensation issue. |
| ZTE |  | It seems the following highlighted parts are not aligned with the results shown in the tables.  *‘For RedCap UE with maximum 100MHz BW and 1Rx, an averaged coverage degradation of approximately 3.0 dB, 1.6 dB and 1.2 dB respectively, is observed for PDSCH, Msg2 and Msg4. It should be noted that for Msg2 results, some companies might have considered TBS scaling and some others have not.*  *For RedCap UE with maximum 50MHz BW and 2Rx, PDSCH needs to be compensated as seen from Table 9.1-14. A few sourcing companies also indicate coverage loss for Msg2 and Msg4, but on average no compensation is needed.’* |
| Qualcomm | Y |  |
| Futurewei |  | For FR2, there may not be enough observations as in not much companies have provided results and it could be reason why results seem inconsistent. In our views no special handling for FR2 should be needed that is FR2 should follow FR1 results. A 7.8 dB compensation for worst case scenario for PDCSH may still be achievable using legacy coverage recovery techniques. |
| InterDigital | Y |  |
| Ericsson |  | The numbers in the tables need to be doble-checked. For example, it appears that Ericsson results for Msg2 are based on no TBS scaling (see v015 or later for results with TBS scaling for Msg2). |
| Samsung |  | In “Note”, \* seems missing because all companies except only one company indicated no TBS scaling. |
| Intel | Y |  |
| OPPO | Y |  |
| FL5 | The TP above has been updated based on the received response. The PRACH format has been added in the Table 9.1-13 to Table 9.1-15. The note for Msg2 assumption has been updated to make it clearer. The typos on the numbers in the observations have been corrected.  **Proposal 3.4-1A:**   * Adopted the updated TP in section 3.4 of R1-2009660 as baseline text for TR clause 9.1 | |
| vivo | N | 1. The first sentence of the 3rd paragraph below should be deleted as we agree to only capture the observation about the coverage loss but not the conclusion on whether compensation is needed or not. We also added one sentence at the end of the section to state the concern about overcompensation issue according to the previous discussions. The changes are shown in red text below.   For RedCap UE with maximum 100MHz BW and 1Rx, an averaged coverage degradation of approximately 2.9 dB, 0.9 dB and 0.5 dB respectively, is observed for PDSCH, Msg2 and Msg4. It should be noted that for Msg2 results, some companies might have considered TBS scaling and some others have not.  By comparing Table 9.1-7 with Table 9.1-9, it can be seen a smaller maximum UE bandwidth may request a larger compensation. For example, the averaged coverage degradation for PDSCH is increased to 7.8 dB for RedCap UE with maximum 50MHz BW and 1Rx.  ~~For RedCap UE with maximum 50MHz BW and 2Rx, PDSCH needs to be compensated as seen from Table 9.1-14.~~ It should be noted that there may not be enough observations since not much sourcing companies have provided results.  For RedCap UE with maximum 50MHz BW and 1Rx, an averaged coverage degradation of approximately 7.8 dB, 1.8 dB and 1.9 dB respectively, is observed for PDSCH, Msg2 and Msg4. A coverage degradation of approximately 1.4 dB is also observed for PDCCH CSS. It should be noted that there may not be enough observations since not much sourcing companies have provided results.  For the indoor 28 GHz, although coverage degradation can be observed for PDSCH/PDCCH CSS/MSG2/MSG4 compared to the bottleneck channel of Reference UEs, the necessity of coverage compensation for these channels is questioned since the target ISD for this scenario (i.e. 20m as agreed in coverage enhancement SI, TR38.xxx) can already be fulfilled without coverage compensation.  2)We have agreed the following in the last GTW call   * + The representative value of a channel is used for identifying whether the channel needs coverage recovery     - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero     - The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc   Therefore the need and amount of coverage compensation should be discussed separately, not solely based on the coverage degradation. We should make the following change  The representative values in the last row of Table 9.1-2 and Table 9.1-3 are derived by taking the mean value (in dB domain) from all the companies results and excluding the highest and the lowest values when the number of samples is more than 3. A negative value of the representative value for a channel of the RedCap UE indicates the coverage of the channel is worse than that of the bottleneck channel of the reference NR UE ~~and coverage recovery is needed.~~ |
| Ericsson |  | We do not agree with this sentence “*It should be noted that there may not be enough observations since not much sourcing companies have provided results*.” ( 2 occurrences)  There are results from 5 sourcing companies. So we think this note is not needed. In comparison, there are approximately as many sourcing companies having provided the SLS results captured in the “Capacity impact” section. |
| Samsung |  | For the evaluation assumption on Msg 4, we noticed that some companies assume 18 PRBs with MCS 3, while some other companies used about 40 PRBs with MCS 0, and 66 PRBs are also used for Msg 4. The MCS/occupied PRB may impact on the coverage of Msg 4. Therefore, we suggest to add assumption especially for Table 9.1-12 where some companies observed bottleneck channel is Msg 4. We think if higher MCS (e.g., MCS 3) instead of MCS 0 was used, it should be noted in the TR.  If possible, some clarification on assumption for table 9.1-13-15 is needed.  In our simulation, MCS 3, 18PRBs, L=12 are used for Msg 4 with 1040bits. |
| **FL6** | The FL would propose to continue discuss the TP after the following two new questions are solved. | |
| Samsung |  | Add a note for Table with result of Msg 4 that:  *Most of the Msg4 results are based on MCS0. However, a few results are based on a higher MCS* |

One response has proposed to clarify the assumption for the maximum UE TX power, i.e. 23dBm or 12dBm. Based on the submitted evaluation results for indoor scenario, it seems two sourcing companies (Samsung and vivo) results are based on the 12 dBm and all the other sourcing companies use 23 dBm. Currently, when deriving the representation value there is no differentiation between 12 dBm and 23 dBm. That is, the coverage loss results are based on a mixed Tx power setting. The FL would like to check whether this approach is acceptable, or whether we need to have separate considerations for different Tx power setting.

* Approach 1 (currently): Single table for 12 dBm and 23 dBm and single observation is drawn based on the mixed Tx power setting.
* Approach 2: Separate tables for 12 dBm and 23 dBm. Separate observations may be drawn for the two different Tx power settings given that the available results for 12 dBm and 23 dBm can be derived one from the other by simple subtraction

**[FL6] Question 3.4-1B:** **Companies are invited to provide views for the above two approaches. The TP is to be updated if we decide to use approach #2.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Approach** | **Comments** |
| vivo |  | In the CE SI, the similar issue exists. It seems they decided to use simple subtraction method (the results of 23dBm Tx power is reduced by 11dB) to make it comparable for all results. It should be possible for us to use the same approach?   |  | | --- | | **FL’s Proposal 2 [Agreed online on 10/29]**  The amount of available results for UL channels in FR2 should be considered as given by the total number of results available results for both 23 dBm and 12 dBm, given that they can be derived one from the other by simple subtraction, and where each company is counted only once.  Therefore, it is noted that only results for 12 dBm TRP will be shown in the following charts, for simplicity. According to the corresponding agreement (cfr. Section 4), the aggregated value for UL channels has then been obtained by considering           results presented by companies assuming max TRP 12 dBm; and           results presented by companies assuming max TRP 23 dBm, where corresponding MCL/MIL/MPL values have been reduced by 11 dB, and each company is counted only once (no double value is considered, if any).  As discussed online, this approach has the merit of increasing the statistical relevance of the presented results, thanks to a larger overall number of samples, while preserving the validity/reliability of results presented for max TRP 23 dBm. | |
| ZTE | Approach 2 | The bottleneck channel of reference UE could be different by assuming different Tx power, i.e., 12 dBm and 23 dBm. It would end up with different observations respectively. Thus, Approach 2 is a clean solution and preferred. |
| Huawei, Hisilicon | Approach 2 | Approach 2 seems more reasonable as discussed in FR1 4GHz. |
| Futurewei | Approach 2 | No strong opinion prefer approach 2 |
| Qualcomm | Approach 2 | Provided that 12 dBm is adopted (23 dBm results can be scaled by 11 dB) |
| Ericsson | Approach 2 |  |
| Intel | Approach 2 |  |
|  |  |  |

The FL notes that a working assumption of 100 MHz maximum UE bandwidth for FR2 has been agreed in AI 8.6.1. In the current TP proposal, we draw observations for both 100 MHz and 50 MHz BW. The FL would like to invite companies to provide input whether we can remove 50 MHz BW from observations and include the coverage loss analysis only for 100 MHz BW.

**[FL6] Question 3.4-1C:** **Companies are invited to provide views for the need of observations for 50 MHz BW.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | No strong view. Slightly prefer to not draw observation for 50MHz. |
| ZTE |  | Ok to not draw observations for 50MHz BW. |
| Huawei, HiSilicon |  | Thanks for hard work. It is OK to keep the current observation for 50 MHz. But if companies need more time to debate on the numbers in the observations, then it is better to save time and have no observation. |
| Futurewei |  | OK to not draw observations for 50 MHz |
| Qualcomm |  | Support not drawing observations for 50 MHz BW |
| Ericsson |  | We suggest having observations based on 50 MHz. Since both 50 MHz and 100 MHz are studied, it is good to capture important observations for both options throughout the TR. These observations can be informative and support the recommendation of 100 MHz. |
| Intel |  | Fine to remove them for 50MHz BW |
| Samsung |  | OK to draw observations for 50MHz. |

## Conclusion

**[FL5] Based on the observations in previous sections, the following recommendation on coverage recovery can be considered.**

|  |
| --- |
| * Dependent on frequency bands, the channels to compensate and the amount of coverage recovery could be different. * For FR1, we may need coverage recovery for PUSCH and Msg3 when considering potential reduced antenna efficiency due to device size limitations. The amount of coverage recovery is up to 3 dB. * For carrier frequency of 4 GHz with DL PSD 24 dBm/MHz, considering RedCap UE with 1 Rx and reduced antenna efficiency, we need coverage recovery also for Msg2, Msg4 and PDCCH CSS. A small or moderate compensation can be considered, i.e. 1-2 dB for Msg4 and PDCCH CSS and 5-6 dB for Msg2. * For FR2, UL coverage is same as the reference NR UE due to no assumption of reduced antenna efficiency for the RedCap UE. Coverage recovery is needed for Msg2, Msg4 and PDSCH due to performance loss from reducing the number of receiver branches to 1 and the amount of coverage recovery is 2-3 dB. |

**[FL5] Question 3.5-1:** **Should TR 38.875 make recommendations on the channels to compensate and the amount of coverage recovery? If yes, companies are invited to provide views for the above text proposals.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Panasonic | Y |  |
| vivo | N | As we commented before, we have concern about drawing conclusion for FR2 indoor solely based on Option 3 without considering the actual deployment need. |
| ZTE |  | We would like to clarify that the compensation value in the proposed conclusion does not impose an limitation on techniques for enhancements. For instance, if 1-2 dB compensation is needed for Msg4, it doesn't imply that a technique which could provide 3 dB or even more performance gain cannot be considered, e.g., Msg4 PDSCH repetition.  So, we suggest to add a note like: ‘Note: the compensation value for a channel does not impose an limitation on potential techniques for enhancements of the channel’. |
| Qualcomm | N | We can wait for conclusion until the compensation value derivation approach is finally agreed |
| Futurewei |  | More work is needed in regards to FR2. Also recommend to have separate observations/bullets for 2rx and 1rx. |
| Ericsson |  | Some suggestion.   1. We can revise the 1st bullet to “Depending on frequency bands and deployment scenario, …” 2. The 3rd and 4th bullets need to be updated after double-checking the Msg2 results. We spotted the Ericsson results were based on no TBS scaling for Msg2. Our results with TBS scaling are included in v015 and later. |
| Samsung | Y |  |
| Intel |  | Regarding the third bullet, i.e.   * For carrier frequency of 4 GHz with DL PSD 24 dBm/MHz, considering RedCap UE with 1 Rx and reduced antenna efficiency, we need coverage recovery also for Msg2, Msg4 and PDCCH CSS. A small or moderate compensation can be considered, i.e. 1-2 dB for Msg4 and PDCCH CSS and 5-6 dB for Msg2.   This is not necessary for RedCap UE with 2 Rx and reduced antenna efficiency. Also, this bullet should perhaps be a sub-bullet of the second bullet.  Again, since the third bullet is talking about RedCap UE with 1RX, does it mean all other bullets are for RedCap UE with 2RX only or both 2RX and 1RX? Better to make this aspect clear.  Further, it might be better to also clarify the maximum UE TX power, i.e. 23dBm or 12dBm. |
| OPPO | Y |  |
| Lenovo, Motorola Mobility | Y | The observations are fine with us for now. We understand there might be updated results from companies. |
| LG | Y |  |
| CATT |  | We think at least the TR can recommend which channel should be compensated. |
| Nokia, NSB | Y |  |
| Samsung2 |  | In our comments for **3.4-1** and **3.4-1A**, we already asked the assumptions for Msg 4 should be clarified.  Regarding the number of symbols (L) for Msg 4, we assumed L =12, but in practical, it is not easy to find L =12 within CORESET 0, especially considering SSB, PDCCH, and also uplink transmission.  If L=12 cannot be easily found, smaller L has to be used. However, since occupied PRBs for Msg 4 is restricted within CORESET 0 given max. PRBs for CORESET 0 is 48 RBs for FR2 in Rel-16, it would be hard to increase the resource in frequency domain either.  So, we think it is hard to find enough DL resources for Msg 4 (and also Msg2, PDCCHs scheduling Msg2/4) to achieve required coverage in CORESET 0. Although not all the UEs need that amount of coverage, comparing 1 Redcap UE with 1 non-Redcap UE in the same location, more than double DL resource is needed to achieve its performance.  Therefore, we want to propose the following observations:  It is hard to find sufficient DL resources for Msg2/4 transmission to achieve coverage target in CSS within COREST 0 bandwidth, e.g., larger number of symbols in a slot and/or larger PRBs in CORESET 0. |
| FL6 | The FL supports the proposal for separate observation/conclusion for FR1/2 and 1Rx and 2 Rx.  Based on the received responses, the FL’s suggestion is as follows.  **Proposal 3.5-1A:**   * Capture the following observations for FR1 coverage recovery to the TR 38.875   + For FR1, under the consideration of potential reduced antenna efficiency due to device size limitations, coverage recovery is needed for PUSCH and Msg3. The amount of coverage recovery is up to 3 dB. Coverage recovery is not needed for other UL channels.   + For FR1 including both FDD and TDD bands and RedCap UE with 2 Rx and reduced antenna efficiency, the MIL of all the downlink channels is better than that of the bottleneck channel for the reference NR UE and coverage recovery is not needed.   + For RedCap UE with 1 Rx and reduced antenna efficiency, dependent on frequency bands and the assumption of DL PSD, the need for coverage recovery can be different     - For carrier frequency of 4 GHz with DL PSD 24 dBm/MHz, coverage recovery may be needed for the downlink channels of Msg2, Msg4 and PDCCH CSS. A small or moderate compensation can be considered, i.e. [1-2 dB] for Msg4 and PDCCH CSS and [5-6 dB] for Msg2     - For other carrier frequencies and DL PSD other than 24 dBm/MHz, coverage recovery is not needed for the downlink channels if the target for coverage recovery is based on the MIL of the bottleneck channel for the reference NR UE   **Proposal 3.5-1B:**   * Capture the following observations for FR2 coverage recovery to the TR 38.875   + For FR2, there is no assumption of reduced antenna efficiency for RedCap UE and the MIL of the UL channels is the same as the reference NR UE and coverage recovery for UL channels is not needed.   + For FR2, the MIL of the DL channels is degraded due to performance loss from reducing the number of Rx branches to 1. Coverage recovery may be needed for the DL channels of PDSCH data, Msg2 and Msg4 if the target for coverage recovery is based on the MIL of the bottleneck channel for the reference NR UE. The amount of coverage recovery is approximately [2-3 dB] for PDSCH data and [1-2 dB] for Msg2 and Msg4     - For PDSCH data, the tradeoff between data rate and coverage can be considered and the amount of coverage recovery may depend on this choice.   + The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the metric for coverage recovery     - E.g. coverage recovery may not be needed for FR2 indoor scenario when the metric is based on an MPL value from a target ISD of 20m     - E.g. a large amount of coverage recovery may be needed for the initial access channels if the metric is to achieve the same coverage for the initial access channels between RedCap UE and the reference NR UE | |
| vivo | Modificatinos | We propose the following changes. Basically, to clarify the what methodology we use for coverage recovery target determination that absolute ISD/MPL is not considered in this methodology. Also clarified for 24dBm/MHz and 1Rx @4GHz case, no TBS scaling is applied and what is expected with 1/4 TBS scaling.  **Proposal 3.5-1A:**   * Capture the following observations for FR1 coverage recovery to the TR 38.875   + For FR1, under the consideration of potential reduced antenna efficiency due to device size limitations, coverage recovery is needed for PUSCH and Msg3 since the MIL are worse than that of the bottleneck channel for the reference UE. The amount of coverage recovery is up to 3 dB. Coverage recovery is not needed for other UL channels.   + For FR1 including both FDD and TDD bands and RedCap UE with 2 Rx and reduced antenna efficiency, the MIL of all the downlink channels is better than that of the bottleneck channel for the reference NR UE and coverage recovery is not needed.   + For RedCap UE with 1 Rx and reduced antenna efficiency, dependent on frequency bands and the assumption of DL PSD, the need for coverage recovery can be different     - For carrier frequency of 4 GHz with DL PSD 24 dBm/MHz, coverage recovery may be needed for the downlink channels of Msg2, Msg4 and PDCCH CSS. A small or moderate compensation can be considered, i.e. [1-2 dB] for Msg4 and PDCCH CSS and [5-6 dB] for Msg2 without TBS scaling. It is expected that the coverage loss for Msg2 maybe compensated by applying 1/4 TBS scaling which is supported by current specification.     - For other carrier frequencies and DL PSD other than 24 dBm/MHz, coverage recovery is not needed for the downlink channels if the target for coverage recovery is based on the MIL of the bottleneck channel for the reference NR UE   + It is noted that in the methodology for RedCap UE coverage recovery target determination, absolute ISD/MPL targets are not considered.   **Proposal 3.5-1B:**   * Capture the following observations for FR2 coverage recovery to the TR 38.875   + For FR2, there is no assumption of reduced antenna efficiency for RedCap UE and the MIL of the UL channels is the same as the reference NR UE and coverage recovery for UL channels is not needed.   + For FR2 indoor, the MIL of the DL channels is degraded due to performance loss from reducing the number of Rx branches to 1. Coverage recovery may be needed for the DL channels of PDSCH data, Msg2 and Msg4 if the target for coverage recovery is determined based on the MIL of the bottleneck channel for the reference NR UE, without considering the absolute ISD/MPL targets. The amount of coverage recovery is approximately [2-3 dB] for PDSCH data and [1-2 dB] for Msg2 and Msg4     - For PDSCH data, the tradeoff between data rate and coverage can be considered and the amount of coverage recovery may depend on this choice.   + The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the metric for coverage recovery     - ~~E.g.~~ coverage recovery may not be needed for FR2 indoor scenario when the metric is based on an MPL value from a target ISD of 20m     - ~~E.g.~~ a large amount of coverage recovery may be needed for the initial access channels if the metric is to achieve the same coverage for the initial access channels between RedCap UE and the reference NR UE |
| Huawei, HiSilicon |  | We support the changes proposed by vivo for proposal 3.5-1A. Please note that the case of 4GHz with 33 dBm/MHz seems not covered, therefore, suggest additional small change in red to 3.5-1A  “   * + *For RedCap UE with 1 Rx and reduced antenna efficiency, dependent on frequency bands and the assumption of DL PSD, the need for coverage recovery can be different*     - *For carrier frequency of 4 GHz with DL PSD 24 dBm/MHz, coverage recovery may be needed for the downlink channels of Msg2, Msg4 and PDCCH CSS. A small or moderate compensation can be considered, i.e. [1-2 dB] for Msg4 and PDCCH CSS and [5-6 dB] for Msg2*     - *For other carrier frequencies and for DL PSD other than 24 dBm/MHz, coverage recovery is not needed for the downlink channels if the target for coverage recovery is based on the MIL of the bottleneck channel for the reference NR UE*   ”  We also feel the revised proposal 3.5-1B from vivo is better. |
| MediaTek | No | We agree with Vivo’s modifications. |
| Qualcomm |  | Fine with FL Proposal 3.5-1B.  For Proposal 3.5-1A, we propose adding the following (similar to FR2):   * The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the target for coverage recovery   + E.g. a large amount of coverage recovery may be needed for the initial access channels if the target is to achieve the same coverage for the initial access channels between RedCap UE and the reference NR UE |
| Ericsson |  | Suggest revising this sentence in Proposal 3.5-1B  “The amount of coverage recovery to be considered is approximately [2-3 dB] for PDSCH data and [1-2 dB] for Msg2 and Msg4” |
| Intel |  | We are supportive to vivo’s modification |

# Capacity impact

Based on the latest available evaluation results in [RedCapCapacity-v012-MTK2-vivo2](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Inbox/drafts/8.6/EvaluationResults/RedCapCapacity/RedCapCapacity-v012-MTK2-vivo2.xlsx), the SLS evaluation of complexity reduction to network capacity are summarized in Table 4-1 to Table 4-25 (Company please double check whether your results are correctly captured in these tables. The original format in the spreadsheet is not friendly for comparing results, so I use a different format in this summary).

**Table 4-1: Additional evaluation assumptions for capacity and spectral efficiency evaluation**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Traffic model | Scheduled BW | Modulation order | Options for UE modeling (Note) | Antenna efficiency loss for RedCap UE |
| Source 1  (Ericsson) | FTP mode 3 (0.5MB payload every 200ms) for eMBB UE  IM model (0.1 MB payload every 2s) for RedCap UE | Max 100MHz for eMBB UE and 20 MHz for RedCap UE | Max 256 QAM in DL and 64 QAM in UL for eMBB UE  Max 64QAM in DL and 16 QAM in UL for RedCap UE | Option 1 |  |
| Source 2 (Huawei) | FTP model 3 for both eMBB and RedCap UEs. Packet size is 0.125 Mbytes for DL and 0.05 MB for UL and mean inter-arrival time is 200 ms | Max 20MHz for both eMBB UE and RedCap UE | Max 256 QAM in DL and 64 QAM in UL for eMBB UE  Max 64QAM in DL and 16 QAM in UL for RedCap UE | Option 2  For DL, a total number of UEs per cell is 4 for low-loading and 8 for medium loading  For UL, a total number of UEs per cells is 2 for low-loading and 4 for medium loading |  |
| Source 3 (vivo) | FTP model 3 (0.5MB payload every 200ms) for eMBB UE  IM traffic (0.1 MB payload every 2s) for RedCap UE | Max 100MHz for eMBB UE and 20 MHz for RedCap UE | Max 256 QAM in DL and 64 QAM in UL for eMBB UE  Max 64QAM in DL and 16 QAM in UL for RedCap UE | Option 1  For DL, 8 eMBB UE and 0/3/8 RedCap UE based on ratios for low loading; 12 eMBB UE and 0/4/12 ReCap UE based on ratios for medium loading  For UL, 3 eMBB UE and 0/1/3 RedCap UE based on ratios for low loading; 5 eMBB UE and 0/2/5 ReCap UE based on ratios for medium loading |  |
| Source 4 (MTK) | FTP model 3 for both eMBB and RedCap UEs.  Packet size is 0.5 Mbytes and mean inter-arrival time 200 ms | Max 100MHz for eMBB UE and 20 MHz for RedCap UE | Max 256 QAM in DL for eMBB UE  Max 64QAM in DL for RedCap UE |  |  |
| Source 5 (Qualcomm) | FTP model 3 for eMBB UE (packet size is 0.5MB and the mean inter-arrival time changed with different RedCap UE ratios)  IM model (0.1 MB payload every 2s) for RedCap UE | Max 100MHz for eMBB UE and 20 MHz for RedCap UE | Max 256 QAM in DL for eMBB UE  Max 64QAM in DL for RedCap UE | Option 2 with a total 8 UEs per cell for DL |  |
| Source 6 (Nokia) | FTP model 3 for both eMBB and RedCap UEs | Max 100MHz for eMBB UE and 20 MHz for RedCap UE | Max 256 QAM in DL and 64 QAM in UL for eMBB UE  Max 64QAM in DL and 16 QAM in UL for RedCap UE | Total number of UEs per cell is 10 |  |
| Note: For burst traffic evaluation, the number of UEs including both eMBB and RedCap UEs can be based on the following options.   * Option 1: The number of UEs can be different for different RedCap UE ratios in the cell (e.g. using the target RU to determine the number of UEs for each RedCap UE ratio independently) * Option 2: With respect to a target RU, the total number of UEs is same for all the RedCap UE ratios in the cell (e.g. firstly determine the number of UEs assuming 0% RedCap UE ratio for a target RU and use the same total number to other RedCap UE ratios) | | | | | |

**Table 4-2: Downlink capacity evaluation for burst traffic (2.6GHz, low loading, 2Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.6GHz, DL, 2Rx RedCap, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 634.00 | 636.00 | 630.00 | \ | 317.00 | 315.00 | 313.00 | \ | 6.30 |  |  | \ |
| RedCap UE | \ | 86.00 | 85.00 | 83.00 | \ | 38.00 | 37.00 | 37.00 | \ |  |  | 4.10 |
| All UEs | 634.00 | 634.00 | 625.00 | 83.00 | 317.00 | 306.00 | 272.00 | 37.00 | 6.30 | 6.30 | 6.20 | 4.10 |
| Huawei | eMBB UE | 86.96 | 58.82 | 39.22 | \ | 33.33 | 21.98 | 16.95 | \ | 5.76 | 5.68 | 4.87 | \ |
| RedCap UE | \ | 29.41 | 30.77 | 46.51 | \ | 10.93 | 9.09 | 14.81 | \ | 3.20 | 3.17 | 2.87 |
| All UEs | 86.96 | 50.41 | 35.72 | 46.51 | 33.33 | 19.22 | 14.02 | 14.81 | 5.76 | 5.44 | 3.65 | 2.87 |
| vivo | eMBB UE | 464.86 | 470.23 | 465.56 |  | 164.03 | 162.74 | 164.62 |  | 5.47 | 5.49 | 5.49 |  |
| RedCap UE | \ | 39.00 | 38.13 |  | \ | 16.03 | 15.34 |  | \ | 2.64 | 2.61 |  |
| All UEs | 464.86 | 456.49 | 431.54 |  | 164.03 | 98.10 | 37.44 |  | 5.47 | 5.45 | 5.37 |  |
| MTK | eMBB UE | 365.00 |  |  | \ | 176.00 |  |  | \ | 6.15 |  |  | \ |
| RedCap UE | \ |  |  | 30.00 | \ |  |  | 1.00 | \ |  |  | 3.47 |
| All UEs | 365.00 |  |  | 30.00 | 176.00 |  |  | 1.00 | 6.15 |  |  | 3.47 |
| Qualcomm | eMBB UE | 168.12 | 176.74 | 204.66 | \ | 57.05 | 67.20 | 87.43 | \ | 8.98 | 9.22 | 9.70 | \ |
| RedCap UE | \ | 46.72 | 43.41 | 71.02 | \ | 4.04 | 2.14 | 5.68 | \ | 6.75 | 5.19 | 8.47 |
| All UEs | 168.12 | 134.86 | 84.85 | 71.02 | 57.05 | 14.64 | 5.31 | 5.68 | 8.98 | 8.60 | 7.44 | 8.47 |
| Nokia | eMBB UE | 402.48 | 447.58 | 569.93 | \ | 188.97 | 219.51 | 311.09 | \ | 4.79 | 5.31 | 6.43 | \ |
| RedCap UE | \ | 21.52 | 52.06 | 52.05 | \ | 3.94 | 19.81 | 18.97 | \ | 1.32 | 2.40 | 2.40 |
| All UEs | 402.48 | 377.15 | 133.94 | 52.05 | 188.97 | 9.80 | 26.79 | 18.97 | 4.79 | 4.31 | 4.42 | 2.40 |

**Table 4-3: Downlink capacity evaluation for burst traffic (2.6GHz, low loading, 1Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.6GHz, DL, 1Rx RedCap, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 634.00 | 634.00 | 632.00 | \ | 317.00 | 315.00 | 314.00 | \ | 6.30 |  |  | \ |
| RedCap UE | \ | 63.00 | 63.00 | 63.00 | \ | 30.00 | 29.00 | 27.00 | \ |  |  | 2.90 |
| All UEs | 634.00 | 632.00 | 627.00 | 63.00 | 317.00 | 302.00 | 268.00 | 27.00 | 6.30 | 5.90 | 6.10 | 2.90 |
| Huawei | eMBB UE | 86.96 | 42.55 | 25.98 | \ | 33.33 | 15.38 | 8.89 | \ | 5.76 | 5.22 | 4.99 | \ |
| RedCap UE | \ | 19.05 | 21.05 | 25.32 | \ | 7.41 | 7.38 | 7.25 | \ | 2.34 | 2.19 | 2.10 |
| All UEs | 86.96 | 36.00 | 23.31 | 25.32 | 33.33 | 13.59 | 8.24 | 7.25 | 5.76 | 4.25 | 2.98 | 2.10 |
| vivo | eMBB UE | 488.09 | 471.06 | 471.38 |  | 177.71 | 162.54 | 165.98 |  | 5.75 | 5.49 | 5.53 |  |
| RedCap UE | \ | 36.39 | 35.20 |  | \ | 13.54 | 13.80 |  | \ | 2.35 | 2.38 |  |
| All UEs | 488.09 | 456.73 | 436.73 |  | 177.71 | 95.10 | 34.73 |  | 5.75 | 5.43 | 5.39 |  |
| MTK | eMBB UE | 365.00 |  |  | \ | 176.00 |  |  | \ | 6.15 |  |  | \ |
| RedCap UE | \ |  |  | 16.00 | \ |  |  | 2.00 | \ |  |  | 2.50 |
| All UEs | 365.00 |  |  | 16.00 | 176.00 |  |  | 2.00 | 6.15 |  |  | 2.50 |
| Qualcomm | eMBB UE | 168.12 | 176.95 | 212.95 | \ | 57.05 | 71.71 | 98.93 | \ | 8.98 | 8.95 | 9.63 | \ |
| RedCap UE | \ | 36.20 | 31.15 | 41.79 | \ | 1.13 | 0.92 | 2.28 | \ | 3.95 | 3.13 | 3.98 |
| All UEs | 168.12 | 132.78 | 61.29 | 41.79 | 57.05 | 10.61 | 2.48 | 2.28 | 8.98 | 7.70 | 6.38 | 3.98 |
| Nokia | eMBB UE | 402.48 | 447.58 | 569.93 | \ | 188.97 | 219.51 | 311.09 | \ | 4.79 | 5.31 | 6.43 | \ |
| RedCap UE | \ | 18.93 | 41.51 | 41.51 | \ | 3.88 | 14.47 | 14.73 | \ | 1.19 | 1.72 | 1.72 |
| All UEs | 402.48 | 377.17 | 133.97 | 41.51 | 188.97 | 7.72 | 18.24 | 14.73 | 4.79 | 4.28 | 4.08 | 1.72 |

**Table 4-4: Downlink capacity evaluation for burst traffic (2.6GHz, medium loading, 2Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.6GHz, DL, 2Rx RedCap, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 512.00 | 518.00 | 521.00 | \ | 227.00 | 233.00 | 237.00 | \ | 6.00 |  |  | \ |
| RedCap UE | \ | 67.00 | 67.00 | 64.00 | \ | 29.00 | 28.00 | 27.00 | \ |  |  | 3.80 |
| All UEs | 512.00 | 516.00 | 515.00 | 64.00 | 227.00 | 224.00 | 206.00 | 27.00 | 6.00 | 5.90 | 5.80 | 3.80 |
| Huawei | eMBB UE | 64.52 | 41.67 | 28.57 | \ | 20.10 | 12.20 | 8.70 | \ | 5.33 | 5.45 | 4.90 | \ |
| RedCap UE | \ | 22.22 | 19.23 | 28.57 | \ | 6.92 | 4.38 | 7.25 | \ | 3.85 | 3.83 | 3.58 |
| All UEs | 64.52 | 38.61 | 26.23 | 28.57 | 20.10 | 10.88 | 4.66 | 7.25 | 5.33 | 4.64 | 4.34 | 3.58 |
| Vivo | eMBB UE | 388.54 | 392.09 | 397.28 |  | 97.68 | 94.44 | 97.61 |  | 5.13 | 5.09 | 5.14 |  |
| RedCap UE | \ | 27.10 | 27.56 |  | \ | 7.82 | 7.74 |  | \ | 2.53 | 2.61 |  |
| All UEs | 388.54 | 378.54 | 356.91 |  | 97.68 | 59.23 | 25.42 |  | 5.13 | 5.06 | 5.04 |  |
| MTK | eMBB UE | 258.00 |  |  | \ | 90.00 |  |  | \ | 5.80 |  |  | \ |
| RedCap UE | \ |  |  | 18.00 | \ |  |  | 0.50 | \ |  |  | 2.40 |
| All UEs | 258.00 |  |  | 18.00 | 90.00 |  |  | 0.50 | 5.80 |  |  | 2.40 |
| Qualcomm | eMBB UE | 139.30 | 152.74 | 187.06 | \ | 51.80 | 61.85 | 84.05 | \ | 7.99 | 8.26 | 9.09 | \ |
| RedCap UE | \ | 43.72 | 37.23 | 71.02 | \ | 1.75 | 1.71 | 5.68 | \ | 5.50 | 4.82 | 8.47 |
| All UEs | 139.30 | 117.80 | 80.72 | 71.02 | 51.80 | 11.51 | 4.08 | 5.68 | 7.99 | 7.57 | 6.95 | 8.47 |
| Nokia | eMBB UE | 300.05 | 407.42 | 413.37 | \ | 105.19 | 190.68 | 193.98 | \ | 3.68 | 4.79 | 4.79 | \ |
| RedCap UE | \ | 18.92 | 18.15 | 22.28 | \ | 2.73 | 2.34 | 3.83 | \ | 1.27 | 1.27 | 1.32 |
| All UEs | 300.05 | 330.63 | 106.32 | 22.28 | 105.19 | 7.50 | 3.77 | 3.83 | 3.68 | 3.91 | 3.03 | 1.32 |

**Table 4-5: Downlink capacity evaluation for burst traffic (2.6GHz, medium loading, 1Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.6GHz, DL, 1Rx RedCap, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 511.00 | 515.00 | 511.00 | \ | 227.00 | 236.00 | 231.00 | \ | 6.00 |  |  | \ |
| RedCap UE | \ | 52.00 | 52.00 | 51.00 | \ | 20.00 | 20.00 | 19.00 | \ |  |  | 2.80 |
| All UEs | 511.00 | 512.00 | 504.00 | 51.00 | 227.00 | 224.00 | 200.00 | 19.00 | 6.00 | 5.90 | 5.60 | 2.80 |
| Huawei | eMBB UE | 64.52 | 27.78 | 18.18 | \ | 20.10 | 7.25 | 4.52 | \ | 5.33 | 5.25 | 5.23 | \ |
| RedCap UE | \ | 14.49 | 13.70 | 16.13 | \ | 4.03 | 2.44 | 2.73 | \ | 2.41 | 2.72 | 2.96 |
| All UEs | 64.52 | 26.07 | 16.86 | 16.13 | 20.10 | 6.55 | 3.67 | 2.73 | 5.33 | 3.75 | 3.32 | 2.96 |
| vivo | eMBB UE | 396.74 | 392.38 | 387.63 |  | 102.39 | 97.20 | 95.89 |  | 5.22 | 5.13 | 5.09 |  |
| RedCap UE | \ | 25.54 | 24.37 |  | \ | 7.73 | 7.24 |  | \ | 2.36 | 2.31 |  |
| All UEs | 396.74 | 379.11 | 347.19 |  | 102.39 | 59.83 | 22.79 |  | 5.22 | 5.09 | 4.98 |  |
| MTK | eMBB UE | 258.00 |  |  | \ | 90.00 |  |  | \ | 5.80 |  |  | \ |
| RedCap UE | \ |  |  | 2.00 | \ |  |  | 0.30 | \ |  |  | 2.00 |
| All UEs | 258.00 |  |  | 2.00 | 90.00 |  |  | 0.30 | 5.80 |  |  | 2.00 |
| Qualcomm | eMBB UE | 139.30 | 154.16 | 186.99 | \ | 51.80 | 61.23 | 90.52 | \ | 7.99 | 8.07 | 8.86 | \ |
| RedCap UE | \ | 31.78 | 27.43 | 41.79 | \ | 0.79 | 0.78 | 2.28 | \ | 3.24 | 2.96 | 3.98 |
| All UEs | 139.30 | 112.21 | 61.16 | 41.79 | 51.80 | 8.90 | 1.80 | 2.28 | 7.99 | 6.86 | 5.91 | 3.98 |
| Nokia | eMBB UE | 300.05 | 407.42 | 413.37 | \ | 105.19 | 190.68 | 193.98 | \ | 3.68 | 4.79 | 4.79 | \ |
| RedCap UE | \ | 17.18 | 16.19 | 26.67 | \ | 2.70 | 2.55 | 5.84 | \ | 1.20 | 1.20 | 1.29 |
| All UEs | 300.05 | 330.64 | 77.96 | 26.67 | 105.19 | 6.01 | 3.60 | 5.84 | 3.68 | 3.89 | 2.99 | 1.29 |

**Table 4-6: Uplink capacity evaluation for burst traffic (2.6GHz, low loading)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.6GHz, UL, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 47.000 | 47.000 | 47.000 | \ | 3.000 | 3.000 | 3.000 | \ | 0.40 |  |  | \ |
| RedCap UE | \ | 12.000 | 12.000 | 11.000 | \ | 2.700 | 2.700 | 2.400 | \ |  |  | 0.40 |
| All UEs | 47.000 | 46.000 | 46.000 | 11.000 | 3.000 | 3.000 | 3.000 | 2.400 | 0.40 | 0.40 | 0.40 | 0.40 |
| Huawei | eMBB UE | 8.420 |  | 3.430 | \ | 0.220 |  | 0.220 | \ | 1.66 |  | 1.65 | \ |
| RedCap UE | \ |  | 1.940 | 4.300 | \ |  | 0.210 | 0.230 | \ |  | 0.84 | 0.82 |
| All UEs | 8.420 |  | 2.880 | 4.300 | 0.220 |  | 0.220 | 0.230 | 1.66 |  | 1.16 | 0.82 |
| vivo | eMBB UE | 21.400 | 22.811 | 23.444 |  | 0.063 | 0.061 | 0.059 |  | 1.01 | 1.01 | 1.01 |  |
| RedCap UE | \ | 0.556 | 0.473 |  | \ | 0.070 | 0.004 |  | \ | 0.24 | 0.24 |  |
| All UEs | 21.400 | 8.695 | 4.489 |  | 0.063 | 0.062 | 0.058 |  | 1.01 | 0.96 | 0.88 |  |
| MTK | eMBB UE | 82.000 |  |  | \ | 14.000 |  |  | \ | 0.60 |  |  | \ |
| RedCap UE | \ |  |  | 7.000 | \ |  |  | 4.000 | \ |  |  | 0.40 |
| All UEs | 82.000 |  |  | 7.000 | 14.000 |  |  | 4.000 | 0.60 |  |  | 0.40 |
| Nokia | eMBB UE | 45.974 | 46.240 | 46.967 | \ | 18.319 | 18.518 | 17.608 | \ | 0.52 | 0.52 | 0.52 | \ |
| RedCap UE | \ | 7.427 | 7.435 | 7.435 | \ | 4.991 | 5.008 | 5.000 | \ | 0.40 | 0.40 | 0.40 |
| All UEs | 45.974 | 36.354 | 11.072 | 7.435 | 18.319 | 6.946 | 6.025 | 5.000 | 0.52 | 0.49 | 0.46 | 0.40 |

**Table 4-7: Uplink capacity evaluation for burst traffic (2.6GHz, medium loading)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.6GHz, UL, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 37.000 | 37.000 | 37.000 | \ | 1.700 | 1.700 | 1.600 | \ | 0.40 |  |  | \ |
| RedCap UE | \ | 11.000 | 11.000 | 11.000 | \ | 1.500 | 1.600 | 1.400 | \ |  |  | 0.50 |
| All UEs | 37.000 | 37.000 | 36.000 | 11.000 | 1.700 | 1.700 | 1.600 | 1.400 | 0.40 | 0.40 | 0.40 | 0.50 |
| Huawei | eMBB UE | 7.340 | 5.230 | 3.400 | \ | 0.220 | 0.220 | 0.230 | \ | 2.04 | 2.20 | 2.22 | \ |
| RedCap UE | \ | 2.470 | 2.010 | 3.600 | \ | 0.190 | 0.220 | 0.240 | \ | 0.73 | 0.97 | 1.34 |
| All UEs | 7.340 | 4.410 | 2.900 | 3.600 | 0.220 | 0.200 | 0.220 | 0.240 | 2.04 | 1.82 | 1.59 | 1.34 |
| vivo | eMBB UE | 19.929 | 19.877 | 18.060 |  | 0.065 | 0.064 | 0.061 |  | 1.01 | 1.01 | 1.01 |  |
| RedCap UE | \ | 0.328 | 0.398 |  | \ | 0.034 | 0.032 |  | \ | 0.25 | 0.25 |  |
| All UEs | 19.929 | 14.120 | 2.791 |  | 0.065 | 0.062 | 0.056 |  | 1.01 | 0.96 | 0.90 |  |
| MTK | eMBB UE | 63.000 |  |  | \ | 9.000 |  |  | \ | 0.56 |  |  | \ |
| RedCap UE | \ |  |  | 7.000 | \ |  |  | 2.500 | \ |  |  | 0.40 |
| All UEs | 63.000 |  |  | 7.000 | 9.000 |  |  | 2.500 | 0.56 |  |  | 0.40 |
| Nokia | eMBB UE | 35.769 | 35.710 | 36.162 | \ | 11.898 | 11.898 | 11.163 | \ | 0.49 | 0.49 | 0.49 | \ |
| RedCap UE | \ | 6.968 | 7.079 | 7.150 | \ | 3.514 | 3.289 | 3.313 | \ | 0.39 | 0.39 | 0.39 |
| All UEs | 35.769 | 29.122 | 7.783 | 7.150 | 11.898 | 5.171 | 4.040 | 3.313 | 0.49 | 0.47 | 0.44 | 0.39 |

**Table 4-8: Downlink capacity evaluation for burst traffic (4GHz, low loading, 2Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **4 GHz, DL, 2Rx RedCap, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 506.00 | 507.00 | 504.00 | \ | 152.00 | 153.00 | 153.00 | \ | 3.80 |  |  | \ |
| RedCap UE | \ | 64.00 | 63.00 | 64.00 | \ | 16.00 | 15.00 | 15.00 | \ |  |  | 2.30 |
| All UEs | 506.00 | 506.00 | 497.00 | 64.00 | 152.00 | 129.00 | 98.00 | 15.00 | 3.80 | 3.80 | 3.70 | 2.30 |
| Huawei | eMBB UE | 62.50 | 41.17 | 27.56 | \ | 19.05 | 12.09 | 9.63 | \ | 5.02 | 4.95 | 4.63 | \ |
| RedCap UE | \ | 19.16 | 16.93 | 30.57 | \ | 6.01 | 5.09 | 8.77 | \ | 3.85 | 2.96 | 3.15 |
| All UEs | 62.50 | 35.29 | 23.35 | 30.57 | 19.05 | 10.27 | 7.58 | 8.77 | 5.02 | 4.63 | 3.86 | 3.15 |
| vivo | eMBB UE | 419.32 | 426.57 | 422.85 |  | 143.05 | 149.96 | 152.43 |  | 4.35 | 4.54 | 4.68 |  |
| RedCap UE | \ | 33.70 | 33.33 |  | \ | 9.71 | 12.22 |  | \ | 1.86 | 1.95 |  |
| All UEs | 419.32 | 415.80 | 393.03 |  | 143.05 | 99.24 | 33.11 |  | 4.35 | 4.50 | 4.55 |  |
| Qualcomm | eMBB UE | 118.95 | 155.56 | 189.03 | \ | 44.27 | 52.85 | 77.25 | \ | 7.62 | 8.54 | 9.30 | \ |
| RedCap UE | \ | 20.64 | 28.90 | 34.61 | \ | 1.63 | 1.51 | 1.81 | \ | 5.55 | 5.19 | 8.47 |
| All UEs | 118.95 | 118.55 | 82.69 | 34.61 | 44.27 | 5.85 | 2.29 | 1.81 | 7.62 | 7.46 | 7.02 | 8.47 |
| Nokia | eMBB UE | 371.06 | 488.87 | 494.21 | \ | 173.15 | 255.53 | 273.74 | \ | 4.34 | 5.50 | 5.50 | \ |
| RedCap UE | \ | 44.28 | 44.76 | 44.36 | \ | 15.36 | 17.94 | 16.79 | \ | 2.07 | 2.07 | 2.07 |
| All UEs | 371.06 | 431.70 | 95.22 | 44.36 | 173.15 | 28.19 | 22.97 | 16.79 | 4.34 | 4.64 | 3.79 | 2.07 |

**Table 4-9: Downlink capacity evaluation for burst traffic (4GHz, low loading, 1Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **4 GHz, DL, 1Rx RedCap, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 507.00 | 505.00 | 516.00 | \ | 151.00 | 154.00 | 156.00 | \ | 3.80 |  |  | \ |
| RedCap UE | \ | 49.00 | 50.00 | 50.00 | \ | 10.00 | 11.00 | 11.00 | \ |  |  | 1.60 |
| All UEs | 507.00 | 503.00 | 511.00 | 50.00 | 151.00 | 132.00 | 95.00 | 11.00 | 3.80 | 3.80 | 3.70 | 1.60 |
| Huawei | eMBB UE | 62.50 | 30.85 | 18.67 | \ | 19.05 | 8.71 | 5.08 | \ | 5.02 | 4.56 | 4.34 | \ |
| RedCap UE | \ | 9.59 | 10.59 | 12.74 | \ | 2.54 | 2.53 | 2.49 | \ | 2.24 | 1.94 | 1.86 |
| All UEs | 62.50 | 25.65 | 14.82 | 12.74 | 19.05 | 7.26 | 3.95 | 2.49 | 5.02 | 3.98 | 3.19 | 1.86 |
| vivo | eMBB UE | 422.64 | 420.15 | 413.95 |  | 146.07 | 141.29 | 150.78 |  | 4.51 | 4.50 | 4.45 |  |
| RedCap UE | \ | 31.52 | 30.67 |  | \ | 10.15 | 10.62 |  | \ | 1.75 | 1.70 |  |
| All UEs | 422.64 | 409.41 | 383.94 |  | 146.07 | 84.44 | 29.75 |  | 4.51 | 4.45 | 4.31 |  |
| Qualcomm | eMBB UE | 118.95 | 167.35 | 197.97 | \ | 44.27 | 60.54 | 80.16 | \ | 7.62 | 8.69 | 9.53 | \ |
| RedCap UE | \ | 15.22 | 15.84 | 19.22 | \ | 0.62 | 0.66 | 0.76 | \ | 2.59 | 2.74 | 3.07 |
| All UEs | 118.95 | 120.11 | 58.11 | 19.22 | 44.27 | 2.45 | 1.05 | 0.76 | 7.62 | 7.16 | 6.14 | 3.07 |
| Nokia | eMBB UE | 371.06 | 488.87 | 494.21 | \ | 173.15 | 255.53 | 273.74 | \ | 4.34 | 5.50 | 5.50 | \ |
| RedCap UE | \ | 35.20 | 34.83 | 34.78 | \ | 11.57 | 11.57 | 11.94 | \ | 1.48 | 1.48 | 1.48 |
| All UEs | 371.06 | 431.72 | 47.61 | 34.78 | 173.15 | 20.44 | 14.92 | 11.94 | 4.34 | 4.49 | 3.49 | 1.48 |

**Table 4-10: Downlink capacity evaluation for burst traffic (4GHz, medium loading, 2Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **4 GHz, DL, 2Rx RedCap, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 404.00 | 393.00 | 417.00 | \ | 109.00 | 114.00 | 116.00 | \ | 3.80 |  |  | \ |
| RedCap UE | \ | 49.00 | 50.00 | 48.00 | \ | 11.00 | 12.00 | 9.00 | \ |  |  | 2.10 |
| All UEs | 404.00 | 409.00 | 414.00 | 48.00 | 109.00 | 104.00 | 84.00 | 9.00 | 3.80 | 3.70 | 3.60 | 2.10 |
| Huawei | eMBB UE | 43.48 | 50.00 | 20.13 | \ | 11.30 | 6.81 | 4.88 | \ | 5.14 | 5.04 | 4.61 | \ |
| RedCap UE | \ | 407.00 | 13.57 | 18.69 | \ | 3.81 | 2.51 | 3.88 | \ | 3.57 | 3.60 | 3.86 |
| All UEs | 43.48 | 26.43 | 16.93 | 18.69 | 11.30 | 6.25 | 3.75 | 3.88 | 5.14 | 4.58 | 4.12 | 3.86 |
| vivo | eMBB UE | 336.94 | 337.24 | 339.47 |  | 78.86 | 82.85 | 82.10 |  | 4.12 | 4.24 | 4.25 |  |
| RedCap UE | \ | 22.91 | 21.69 |  | \ | 5.95 | 5.59 |  | \ | 1.95 | 1.82 |  |
| All UEs | 336.94 | 323.63 | 305.21 |  | 78.86 | 45.98 | 20.18 |  | 4.12 | 4.20 | 4.14 |  |
| Qualcomm | eMBB UE |  | 132.23 | 166.67 | \ |  | 46.88 | 67.67 | \ |  | 7.61 | 8.24 | \ |
| RedCap UE |  | 16.41 | 22.80 | 34.61 |  | 1.21 | 1.20 | 1.81 |  | 3.81 | 4.23 | 8.47 |
| All UEs |  | 100.31 | 74.07 | 34.61 |  | 3.97 | 1.87 | 1.81 |  | 6.66 | 6.24 | 8.47 |
| Nokia | eMBB UE | 159.15 | 319.16 | 371.27 | \ | 28.26 | 137.36 | 174.61 | \ | 2.68 | 3.82 | 4.34 | \ |
| RedCap UE | \ | 15.60 | 18.75 | 19.66 | \ | 2.32 | 3.15 | 3.35 | \ | 1.21 | 1.25 | 1.25 |
| All UEs | 159.15 | 249.19 | 95.10 | 19.66 | 28.26 | 6.38 | 4.97 | 3.35 | 2.68 | 3.17 | 2.80 | 1.25 |

**Table 4-11: Downlink capacity evaluation for burst traffic (4GHz, medium loading, 1Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **4 GHz, DL, 1Rx RedCap, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 404.00 | 408.00 | 412.00 | \ | 109.00 | 112.00 | 110.00 | \ | 3.80 |  |  | \ |
| RedCap UE | \ | 39.00 | 39.00 | 38.00 | \ | 7.00 | 8.00 | 7.00 | \ |  |  | 1.70 |
| All UEs | 404.00 | 407.00 | 406.00 | 38.00 | 109.00 | 102.00 | 74.00 | 7.00 | 3.80 | 3.60 | 3.50 | 1.70 |
| Huawei | eMBB UE | 43.48 | 18.72 | 12.25 | \ | 11.30 | 4.08 | 2.54 | \ | 5.14 | 5.06 | 5.04 | \ |
| RedCap UE | \ | 9.82 | 9.28 | 10.93 | \ | 2.45 | 1.48 | 1.66 | \ | 2.33 | 2.96 | 3.22 |
| All UEs | 43.48 | 16.60 | 10.51 | 10.93 | 11.30 | 3.68 | 1.90 | 1.66 | 5.14 | 4.20 | 3.67 | 3.22 |
| vivo | eMBB UE | 343.43 | 337.71 | 341.72 |  | 83.67 | 79.37 | 81.73 |  | 4.32 | 4.15 | 4.25 |  |
| RedCap UE | \ | 20.95 | 20.12 |  | \ | 4.64 | 4.73 |  | \ | 1.59 | 1.67 |  |
| All UEs | 343.43 | 324.09 | 306.91 |  | 83.67 | 42.09 | 18.41 |  | 4.32 | 4.09 | 4.13 |  |
| Qualcomm | eMBB UE |  | 137.93 | 170.21 | \ |  | 52.77 | 69.00 | \ |  | 7.59 | 8.42 | \ |
| RedCap UE |  | 12.64 | 13.12 | 19.22 |  | 0.58 | 0.59 | 0.76 |  | 2.45 | 2.53 | 3.07 |
| All UEs |  | 102.89 | 55.35 | 19.22 |  | 1.75 | 0.67 | 0.76 |  | 6.31 | 5.47 | 3.07 |
| Nokia | eMBB UE | 159.15 | 319.16 | 371.27 | \ | 28.26 | 137.36 | 174.61 | \ | 2.68 | 3.82 | 4.34 | \ |
| RedCap UE | \ | 13.51 | 17.46 | 22.20 | \ | 1.89 | 2.92 | 4.73 | \ | 1.12 | 1.12 | 1.16 |
| All UEs | 159.15 | 249.20 | 95.10 | 22.20 | 28.26 | 4.36 | 4.04 | 4.73 | 2.68 | 3.15 | 2.73 | 1.16 |

**Table 4-12: Uplink capacity evaluation for burst traffic (4GHz, low loading)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **4 GHz, UL, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 52.000 | 52.000 | 52.000 | \ | 0.900 | 0.900 | 0.900 | \ | 0.40 |  |  | \ |
| RedCap UE | \ | 16.000 | 16.000 | 16.000 | \ | 0.800 | 0.900 | 0.700 | \ |  |  | 0.50 |
| All UEs | 52.000 | 52.000 | 51.000 | 16.000 | 0.900 | 0.900 | 0.900 | 0.700 | 0.40 | 0.40 | 0.40 | 0.50 |
| Huawei | eMBB UE | 9.850 |  | 4.240 | \ | 0.210 |  | 0.240 | \ | 1.48 |  | 1.45 | \ |
| RedCap UE | \ |  | 2.330 | 5.110 | \ |  | 0.200 | 0.240 | \ |  | 0.75 | 0.78 |
| All UEs | 9.850 |  | 3.290 | 5.110 | 0.210 |  | 0.200 | 0.240 | 1.48 |  | 1.07 | 0.78 |
| vivo | eMBB UE | 12.845 | 12.574 | 12.369 |  | 0.058 | 0.057 | 0.057 |  | 1.34 | 1.34 | 1.34 |  |
| RedCap UE | \ | 0.582 | 0.635 |  | \ | 0.065 | 0.070 |  | \ | 0.32 | 0.32 |  |
| All UEs | 12.845 | 1.325 | 2.544 |  | 0.058 | 0.057 | 0.058 |  | 1.34 | 1.26 | 1.16 |  |
| Nokia | eMBB UE | 63.987 | 61.527 | 63.484 | \ | 11.134 | 27.863 | 28.981 | \ | 0.73 | 0.72 | 0.73 | \ |
| RedCap UE | \ | 11.065 | 11.141 | 9.399 | \ | 7.803 | 8.291 | 7.987 | \ | 0.58 | 0.59 | 0.59 |
| All UEs | 63.987 | 51.601 | 13.084 | 9.399 | 11.134 | 9.623 | 8.852 | 7.987 | 0.73 | 0.69 | 0.66 | 0.59 |

**Table 4-13: Uplink capacity evaluation for burst traffic (4GHz, medium loading)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **4 GHz, UL, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 43.000 | 43.000 | 43.000 | \ | 0.600 | 0.600 | 0.600 | \ | 0.60 |  |  | \ |
| RedCap UE | \ | 15.000 | 15.000 | 15.000 | \ | 0.500 | 0.500 | 0.500 | \ |  |  | 0.60 |
| All UEs | 43.000 | 42.000 | 41.000 | 15.000 | 0.600 | 0.600 | 0.600 | 0.500 | 0.60 | 0.60 | 0.60 | 0.60 |
| Huawei | eMBB UE | 8.450 | 6.110 | 4.070 | \ | 0.200 | 0.220 | 0.220 | \ | 1.86 | 2.20 | 2.05 | \ |
| RedCap UE | \ | 2.840 | 2.410 | 3.790 | \ | 0.200 | 0.200 | 0.220 | \ | 0.73 | 0.89 | 1.25 |
| All UEs | 8.450 | 5.220 | 3.260 | 3.790 | 0.200 | 0.200 | 0.200 | 0.220 | 1.86 | 1.67 | 1.42 | 1.25 |
| vivo | eMBB UE | 5.265 | 5.894 | 4.805 |  | 0.058 | 0.058 | 0.058 |  | 1.34 | 1.34 | 1.32 |  |
| RedCap UE | \ | 0.505 | 0.513 |  | \ | 0.034 | 0.037 |  | \ | 0.32 | 0.32 |  |
| All UEs | 5.265 | 2.976 | 1.217 |  | 0.058 | 0.057 | 0.056 |  | 1.34 | 1.27 | 1.17 |  |
| Nokia | eMBB UE | 54.438 | 54.020 | 53.324 | \ | 22.083 | 20.970 | 20.970 | \ | 0.70 | 0.70 | 0.70 | \ |
| RedCap UE | \ | 10.469 | 10.527 | 10.538 | \ | 5.873 | 6.004 | 5.873 | \ | 0.58 | 0.58 | 0.58 |
| All UEs | 54.438 | 42.751 | 12.042 | 10.538 | 22.083 | 8.429 | 7.260 | 5.873 | 0.70 | 0.67 | 0.64 | 0.58 |

**Table 4-14: Downlink capacity evaluation for burst traffic (28 GHz, low loading, 2Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **28 GHz, DL, 2Rx RedCap, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 441.00 | 444.00 | 442.00 | \ | 192.00 | 199.00 | 198.00 | \ | 8.80 |  |  | \ |
| RedCap UE | \ | 338.00 | 336.00 | 356.00 | \ | 153.00 | 146.00 | 155.00 | \ |  |  | 7.00 |
| All UEs | 441.00 | 442.00 | 440.00 | 356.00 | 192.00 | 199.00 | 195.00 | 155.00 | 8.80 | 8.70 | 8.60 | 7.00 |
| MTK | eMBB UE | 103 |  |  | \ | 51 |  |  | \ | 4.14 |  |  | \ |
| RedCap UE | \ |  |  | 64.00 | \ |  |  | 44.00 | \ |  |  | 2.70 |
| All UEs | 103 |  |  | 64.00 | 51 |  |  | 44.00 | 4.14 |  |  | 2.70 |
| Qualcomm | eMBB UE | 322.50 | 334.80 | 323.00 | \ | 286.30 | 313.20 | 290.30 | 318.60 | 6.90 | 6.90 | 6.90 | \ |
| RedCap UE | \ | 312.90 | 306.80 | 328.70 | \ | 267.50 | 266.00 | \ | \ | 6.80 | 6.90 | 6.90 |
| All UEs | 322.50 | 327.30 | 316.50 | 328.70 | 286.30 | 285.70 | 277.40 | 318.60 | 6.90 | 6.90 | 6.90 | 6.90 |

**Table 4-15: Downlink capacity evaluation for burst traffic (28 GHz, low loading, 1Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **28 GHz, DL, 1Rx RedCap, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 441.00 | 445.00 | 437.00 | \ | 192.00 | 202.00 | 196.00 | \ | 8.80 |  |  | \ |
| RedCap UE | \ | 215.00 | 213.00 | 213.00 | \ | 103.00 | 100.00 | 98.00 | \ |  |  | 4.40 |
| All UEs | 441.00 | 444.00 | 434.00 | 213.00 | 192.00 | 199.00 | 189.00 | 98.00 | 8.80 | 8.70 | 8.40 | 4.40 |
| MTK | eMBB UE | 103.00 |  |  | \ | 51.00 |  |  | \ | 4.14 |  |  | \ |
| RedCap UE | \ |  |  | 48.00 | \ |  |  | 22.00 | \ |  |  | 2.2 |
| All UEs | 103.00 |  |  | 48.00 | 51.00 |  |  | 22.00 | 4.14 |  |  | 2.2 |
| Qualcomm | eMBB UE |  |  |  | \ |  |  |  | \ |  |  |  | \ |
| RedCap UE |  |  |  | 177.30 |  |  |  | 172.00 |  |  |  | 3.50 |
| All UEs |  |  |  | 177.30 |  |  |  | 172.00 |  |  |  | 3.50 |

**Table 4-16: Downlink capacity evaluation for burst traffic (28 GHz, medium loading, 2Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **28 GHz, DL, 2Rx RedCap, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 322.00 | 344.00 | 347.00 | \ | 109.00 | 133.00 | 134.00 | \ | 8.60 |  |  | \ |
| RedCap UE | \ | 244.00 | 244.00 | 238.00 | \ | 89.00 | 91.00 | 79.00 | \ |  |  | 6.30 |
| All UEs | 322.00 | 344.00 | 344.00 | 238.00 | 109.00 | 133.00 | 133.00 | 79.00 | 8.60 | 8.50 | 8.20 | 6.30 |
| MTK | eMBB UE | 84 |  |  | \ | 38.00 |  |  | \ | 3.75 |  |  | \ |
| RedCap UE | \ |  |  | 54.00 | \ |  |  | 32.00 | \ |  |  | 2.60 |
| All UEs | 84 |  |  | 54.00 | 38.00 |  |  | 32.00 | 3.75 |  |  | 2.60 |
| Qualcomm | eMBB UE | 249.50 | 284.00 | 237.80 |  | 207.70 | 238.10 | 189.00 |  | 6.80 | 6.80 | 6.70 |  |
| RedCap UE | \ | 272.20 | 228.60 |  | \ | 237.00 | 156.90 |  | \ | 6.80 | 6.60 |  |
| All UEs | 249.50 | 283.00 | 234.80 |  | 207.70 | 238.60 | 167.40 |  | 6.80 | 6.80 | 6.60 |  |

**Table 4-17: Downlink capacity evaluation for burst traffic (28 GHz, medium loading, 1Rx RedCap UE)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **28 GHz, DL, 1Rx RedCap, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 322.00 | 343.00 | 346.00 | \ | 109.00 | 130.00 | 132.00 | \ | 8.60 |  |  | \ |
| RedCap UE | \ | 172.00 | 171.00 | 173.00 | \ | 64.00 | 63.00 | 65.00 | \ |  |  | 4.40 |
| All UEs | 322.00 | 342.00 | 342.00 | 173.00 | 109.00 | 128.00 | 128.00 | 65.00 | 8.60 | 8.40 | 8.00 | 4.40 |
| MTK | eMBB UE | 84.00 |  |  | \ | 38.00 |  |  | \ | 3.75 |  |  | \ |
| RedCap UE | \ |  |  | 35.00 | \ |  |  | 11.00 | \ |  |  | 1.90 |
| All UEs | 84.00 |  |  | 35.00 | 38.00 |  |  | 11.00 | 3.75 |  |  | 1.90 |

**Table 4-18: Uplink capacity evaluation for burst traffic (28 GHz, low loading)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **28 GHz, UL, low loading (RU<30%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 62.00 | 62.00 | 61.00 | \ | 16.00 | 16.00 | 16.00 | \ | 1.10 |  |  | \ |
| RedCap UE | \ | 54.00 | 53.00 | 49.00 | \ | 14.00 | 14.00 | 10.00 | \ |  |  | 0.90 |
| All UEs | 62.00 | 62.00 | 61.00 | 49.00 | 16.00 | 16.00 | 16.00 | 10.00 | 1.10 | 1.10 | 1.00 | 0.90 |
| MTK | eMBB UE | 72.00 |  |  | \ | 47.00 |  |  | \ | 0.82 |  |  | \ |
| RedCap UE | \ |  |  | 31.00 | \ |  |  | 20.00 | \ |  |  | 0.40 |
| All UEs | 72.00 |  |  | 31.00 | 47.00 |  |  | 20.00 | 0.82 |  |  | 0.40 |

**Table 4-19: Uplink capacity evaluation for burst traffic (28 GHz, medium loading)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **28 GHz, UL, medium loading (30%<RU<50%)** | | | | | | | | | | | | | |
|  |  | 50% UPT (Mbps) | | | | 5% UPT (Mbps) | | | | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% | 0 | 25% | 50% | 100% |
| Ericsson | eMBB UE | 31.00 | 31.00 | 31.00 | \ | 0.60 | 0.60 | 0.60 | \ | 1.10 |  |  | \ |
| RedCap UE | \ | 27.00 | 27.00 | 18.00 | \ | 0.50 | 0.50 | 0.10 | \ |  |  | 0.80 |
| All UEs | 31.00 | 31.00 | 31.00 | 18.00 | 0.60 | 0.60 | 0.60 | 0.10 | 1.10 | 1.00 | 1.00 | 0.80 |
| MTK | eMBB UE | 53.00 |  |  | \ | 38.00 |  |  | \ | 0.80 |  |  | \ |
| RedCap UE | \ |  |  | 22.50 | \ |  |  | 8.50 | \ |  |  | 0.40 |
| All UEs | 53.00 |  |  | 22.50 | 38.00 |  |  | 8.50 | 0.80 |  |  | 0.40 |

**Table 4-20: Downlink capacity evaluation for full buffer traffic (2.6 GHz, 2Rx RedCap UE)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **2.6GHz, DL, 2Rx RedCap, full buffer, total 10 UEs/cell** | | | | | |
|  |  | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 20% | 50% | 100% |
| Huawei | eMBB UE | 15.10 | 14.92 | 14.48 | \ |
| RedCap UE | \ | 9.63 | 9.84 | 10.50 |
| All UEs | 15.10 | 14.18 | 12.80 | 10.50 |
| Nokia | eMBB UE | 4.49 | 4.47 | 4.43 | \ |
| RedCap UE | \ | 2.67 | 2.77 | 2.84 |
| All UEs | 4.49 | 4.11 | 3.60 | 2.84 |

**Table 4-21: Downlink capacity evaluation for full buffer traffic (2.6 GHz, 1Rx RedCap UE)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **2.6 GHz, DL, 1Rx RedCap, full buffer, total 10 UEs/cell** | | | | | |
|  |  | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 20% | 50% | 100% |
| Huawei | eMBB UE | 15.10 | 15.03 | 14.87 | \ |
| RedCap UE | \ | 7.68 | 7.80 | 7.87 |
| All UEs | 15.10 | 13.65 | 11.49 | 7.87 |
| Nokia | eMBB UE | 4.49 | 4.47 | 4.43 | \ |
| RedCap UE | \ | 2.09 | 2.17 | 2.21 |
| All UEs | 4.49 | 3.99 | 3.30 | 2.21 |

**Table 4-22: Uplink capacity evaluation for full buffer traffic (2.6 GHz)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **2.6 GHz, UL, full buffer, total 10 UEs/cell** | | | | | |
|  |  | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 20% | 50% | 100% |
| Huawei | eMBB UE | 2.73 | 2.70 | 2.61 | \ |
| RedCap UE | \ | 1.41 | 1.49 | 1.54 |
| All UEs | 2.73 | 2.47 | 2.14 | 1.54 |
| Nokia | eMBB UE | 2.03 | 2.01 | 2.00 | \ |
| RedCap UE | \ | 1.79 | 1.78 | 1.79 |
| All UEs | 2.03 | 1.97 | 1.89 | 1.79 |

**Table 4-23: Downlink capacity evaluation for full buffer traffic (4 GHz, 2Rx RedCap UE)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **4 GHz, DL, 2Rx RedCap, full buffer, total 10 UEs/cell** | | | | | |
|  |  | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 20% | 50% | 100% |
| Huawei | eMBB UE | 14.02 | 13.96 | 13.66 | \ |
| RedCap UE | \ | 9.14 | 9.43 | 9.68 |
| All UEs | 14.02 | 14.18 | 12.80 | 9.68 |
| Nokia | eMBB UE | 4.74 | 4.73 | 4.75 | \ |
| RedCap UE | \ | 2.98 | 2.89 | 2.89 |
| All UEs | 4.74 | 4.38 | 3.82 | 2.89 |

**Table 4-24: Downlink capacity evaluation for full buffer traffic (4 GHz, 1Rx RedCap UE)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **2.6GHz, DL, 1Rx RedCap, full buffer, total 10 UEs/cell** | | | | | |
|  |  | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 20% | 50% | 100% |
| Huawei | eMBB UE | 14.02 | 13.88 | 13.65 | \ |
| RedCap UE | \ | 6.76 | 6.92 | 7.14 |
| All UEs | 14.02 | 12.91 | 10.75 | 7.14 |
| Nokia | eMBB UE | 4.74 | 4.73 | 4.75 | \ |
| RedCap UE | \ | 2.25 | 2.20 | 2.21 |
| All UEs | 4.74 | 4.23 | 3.47 | 2.21 |

**Table 4-25: Uplink capacity evaluation for full buffer traffic (4 GHz)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **2.6GHz, UL, full buffer, total 10 UEs/cell** | | | | | |
|  |  | Cell avg. SE (bps/Hz) | | | |
|  | RedCap UE ratio | 0 | 20% | 50% | 100% |
| Huawei | eMBB UE | 2.54 | 2.49 | 2.41 | \ |
| RedCap UE | \ | 1.35 | 1.41 | 1.47 |
| All UEs | 2.54 | 2.47 | 2.14 | 1.47 |
| Nokia | eMBB UE | 1.94 | 1.93 | 1.93 | \ |
| RedCap UE | \ | 1.76 | 1.76 | 1.75 |
| All UEs | 1.94 | 1.90 | 1.84 | 1.75 |

**Question 4-1: Can the SLS evaluation results in Table 4-1 to Table 4-24 be captured to TR 38.875? (Companies are invited for check the results and if any modification is needed, please also indicate here.)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | We would like to have some discussion on the different simulation assumptions used in the evaluation first.  For example, we found that some agreed evaluation assumption were not followed by companies   1. For traffic model, it was agreed to use IM traffic model (TR38.840) for RedCap UEs, however, different traffic model were used, e.g. in Huawei’s evaluation 2. For simulated BW, it was agreed to simulate 100MHz for eMBB UEs and 20MHz for RedCap UEs in FR1, however, different BW assumptions were used, e.g. in Huawei’s evaluation, 20MHz was used for both eMBB and RedCap UEs. |
| Futurewei | Y | It is important to capture the results to address the operator concerns. |
| Ericsson |  | We think we can give more time for companies to update the results. Ericsson plans to update our results based on more sufficient collection of statistics.  We note that in the 50% UPT (Mbps) results reported by most companies are quite low for the eMBB UEs. Note that in FR1 the eMBB UEs has 100 MHz BW, 256QAM and MIMO so that the peak data rate is > 1 Gbps.  In the tables “Redap” should be changed to “RedCap”.  It might be better to have separate tables for different traffic assumptions (or add a clarifying note on this). |
| Samsung |  | It should be clearly stated if simulation assumptions different than what was agreed are used for some simulation results. |
| Huawei, Hisilicon |  | In response to Vivo’s comments on our evaluation assumption, firstly, we encourage all companies to share more their SLS assumptions that have not been covered by agreements and we confirmed that our traffic model and scheduled bandwidth assumptions are in line with current agreements. Please find more details below,   1. For the traffic model   Instant message traffic model is only agreed for power saving evaluation, while for Capacity impact evaluation, it was agreed that both FTP 3 and Instant message can be considered for RedCap UEs.  The related agreements are provided as following:  *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*   *Agreements:*   * *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* | *500m* | *20m* | | *Scenario and frequency* | *Dense Urban:*  *2.6 GHz (TDD) (primary choice)*  *4 GHz (TDD) (secondary choice)*  *Other scenarios (e.g. Rural 700MHz) are not precluded.* | *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* | *Full buffer (Optional)*  *Non-full buffer traffic, e.g. FTP traffic model 3 for the reference NR UEs and the IM traffic model from TR 38.840 for RedCap UEs* | | | *Traffic load* | *Full buffer traffic (Optional):*  *10 users per cell including both RedCap and reference NR UEs*  *Non-full buffer traffic:*  *Low (e.g. <30%) and medium (e.g. 30%-50%) loading (resource utilization)* | | | *Percentage of RedCap UEs among total number of UEs*  *Note: Other UEs are the reference NR UEs* | *Full buffer traffic (Optional):*  *0, 20%, 50% (i.e. 0, 2 or 5 RedCap UEs per cell), 100% (as applicable)*  *Non-full buffer traffic:*  *0, 25%, 50%, ~~[100%]~~ 100% (optional, as applicable)* | |  1. For the scheduled bandwidths   The following agreements have been made in RedCapCapacity template’s general note, where the scheduled BW is up to 100MHz, not fixed 100MHz. More importantly, the traffic data rate for non-full buffer is not agreed yet, neither the way to scattering out 20MHz REDCAP within 100MHz bandwidth. To complete the assumptions, the following assumptions are used,   * The DL traffic data rate is proportional to UE bandwidth: 25Mbps DL@100MHz for reference UE, 5Mbps DL@20MHz for RedCap UE, with 5:1 ratio between two kinds of UEs. * No frequency hopping for RedCap UE: every RedCap UE is fixed to one of five 20MHz frequency blocks within 100MHz bandwidth. Different RedCap UEs are scattered out within 100MHz bandwidth. As a result, RedCap UEs in different frequency blocks do not compete each other for raido resources but compete only with RedCap UEs and Reference UEs scheduled in the same frequency blocks. * RU is the same for all 20MHz frequency blocks as RU definition.   Since the UPT of a RedCap UEs in one frequency block are impacted by reference UEs only when reference UE’s traffic falls into the frequency block, we call that the scheduled bandwidth for reference UE is 20Mhz and its equivalent DL traffic data rate of reference UEs within the 20MHz frequency block is also 5Mbps.  *Agreements:*  *8. The total system bandwidth in the SLS can be 100 MHz for both FR1 and FR2 (aligned with the LLS assumption).*  *In FR1, the scheduled bandwidths for eMBB and RedCap UEs can be up to 100 MHz and 20 MHz, respectively. In FR2, the scheduled bandwidths for eMBB UEs can be up to 100 MHz, and up to 100 MHz or 50 MHz for RedCap UEs.*  Secondly, we also provide SLS results of SE and RU for non-full buffer traffic. Our above assumptions obviously have no impact on SE and RU evaluation.  Thirdly, in our view, the key in Capacity evaluation is the traffic model.The use cases discussed in SID include Video surveillance, wearables and IWSN. So Video is a more typical traffic than Instant message, while we have noted that in some companies’ assumption, such as Vivo, FTP3 and IM are considered for reference UEs and RedCap UEs, which means the traffic contribution by RedCap UEs and reference UEs is no more than 1:50. With such low traffic contribution from RedCap UEs, the impact from RedCap UEs is obviously hard to be observed. It would be no surprise if no impact were observed.  Again, we would like to encourage all companies to share more their SLS assumptions that have not been covered by agreements, e.g. how to scatter out UEs, scheduling constraint. |
| FL4 | It is noted that companies have different assumptions on the traffic model and the simulation bandwidth resulting in very different observations.  As seen from capacity evaluation spreadsheet, three companies (vivo, Ericsson, Qualcomm) use the IM model for RedCap and FTP3 for the eMBB UE, and other companies (Huawei, MTK, Nokia) use the FTP3 for both RedCap and eMBB UEs. It is also noted that even with FTP3, the assumptions for packet size and mean inter-arrival time are different by companies.  In case of FTP3 for both RedCap and eMBB UEs, we also note different observations from companies’ evaluation results for the impact to eMBB UE UPT with presence of RedCap UE.  Therefore, the FL would like to encourage companies to share more on the SLS assumptions, e.g. packet size and mean inter-arrival time for FTP3 and IM model, scheduling bandwidth, the number of eMBB and RedCap UEs, etc. Also, companies are invited to provide input whether and how to use the evaluation results for making summary observation | |
| vivo |  | Our simulation assumptions  Traffic model: (according to RAN1#102e agreement)   * FTP traffic model 3 from TR38.840 for eMBB UEs * IM traffic model from TR 38.840 for RedCap Ues   Scheduling BW: (according to RAN1 agreement made in post RAN1#102e email discussion)   * 100MHz for eMBB UE (FR1) * 20MHz for RedCap UE(FR1)   Number of UEs: reported in the excel sheet |
| Ericsson |  | * Regarding traffic model we assume the following:   + [FTP3](ftp://FTP3): 0.5 MB payload every 200ms. => 2e7 bits/s per MBB UE   + IM: 0.1 MB payload every 2s. => 4e5 bits/s per RedCap UE. * For both RedCap and reference MBB UEs the number of MIMO layers in DL is assumed to be same the number of Rx antennas. * Power control is used in the uplink. * No carrier-aggregation is used. * MU MIMO scheduling is used for DL. * Option 1 is used, i.e. constant RU is compared for the different RedCap user fractions. That is, 30% RU for 100% MBB corresponds to a larger offered load than 30% RU for RedCap since RedCap transmission is less efficient. * Traffic assumed to be symmetric in UL and DL. * Simulation parameters:  |  |  |  | | --- | --- | --- | | **Case:** | 2.6 GHz | 28 GHz | | **System BW:** | 100 MHz | 100 MHz | | **Ref UE:** | 100 MHz  4Rx  Max 256QAM in DL  Max 64QAM in UL | 100 MHz  2Rx  Max 64QAM in DL  Max 64QAM in UL | | **RedCap UE:** | 20 MHz  1Rx or 2Rx  Max 64QAM in DL  Max 16QAM in UL | 100 MHz  1Rx or 2Rx  Max 16QAM in DL  Max 16QAM in UL | |
| **FL5** | FL note: The clarification notes on evaluation assumptions have been added to some tables of low-loading and medium-loading. The numbers in the tables have been updated also based on the latest evaluation results in the version v012.  Based on the received response, the FL’s updated suggestion is as following.  **[FL5] Updated Proposal 4-1:**   * Capture the SLS evaluation results in Table 4-1 to Table 4-24 to TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of evaluation assumption   + Up to editor to decide whether to include evaluation assumption notes to all the tables. | |
| vivo |  | Fine in general. Regarding the Notes (detailed assumptions), we propose to clarify if the agreed evaluation assumption (e.g. traffic model, schedulable BW) are followed or not. Otherwise, it seems difficult to directly compare the results from companies. |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y | Some minor comments   1. Notes 1 and 3 in tables 4-1 and 4-3 can be merged. They say the same thing. 2. This note may from the 1st tab of the excel sheet may be added.   “*For burst traffic evaluation, the number of UEs including both eMBB and RedCap UEs can be based on the following options.*  *Option 1: The number of UEs can be different for different RedCap UE ratios in the cell (e.g. using the target RU to determine the number of UEs for each RedCap UE ratio independently)*  *Option 2: With respect to a target RU, the total number of UEs is same for all the RedCap UE ratios in the cell (e.g. firstly determine the number of UEs assuming 0% RedCap UE ratio for a target RU and use the same total number to other RedCap UE ratios)*  *Companies are encouraged to report how the number of UEs are determined and how the impact to network capacity is evaluated.*”  The option that is used in the SLS can be added to the notes in Tables 4-1 and 4-3. |
| Nokia, NSB | Y |  |
| **FL6** | Based on the received response, a new table has been added for the additional evaluation assumptions. In the new table, the last column is for the assumption for reduced antenna efficiency for RedCap UE to companies to input. This is because that the objective of evaluating the impact to network capacity and spectral efficiency should include the impact from the potential UE complexity reduction techniques AND the potential antenna inefficiencies AND the potential coverage recovery techniques.  However, it is unclear whether the submitted SLS results have accounted for the antenna efficiency loss. If there is no SLS result accounting for antenna efficiency loss, it would be good to know it.  **Therefore, the FL would like to encourage companies to share their assumptions on the reduced antenna efficiency.** | |
| vivo |  | In our evaluation, 3dB antenna efficiency loss is modelled for all FR1 scenarios. |
| MediaTek |  | In our evaluation, 3dB antenna efficiency loss is modelled for all FR1 scenarios, DL/UL. |
| Qualcomm |  | In our SLS results, 3 dB antenna efficiency loss was not modeled for RedCap UE in FR1 |
| Ericsson |  | Our SLS results do not account for antenna efficiency loss. |

***Summary of observations:***

For burst traffic evaluation, the assumed traffic model for RedCap UE is different by companies. In contributions [1, 4, 24], the IM model as defined in TR 38.840 is used and the averaged traffic ratio between the reference eMBB and RedCap UEs is relatively small, e.g. less than 2%. The very low data volume in the downlink is corresponding to some RedCap use cases with UL dominant traffic, e.g. video surveillance and industrial wireless sensor. In contribution [3], FTP model 3 is used for both eMBB and RedCap UEs by considering some video applications for wearable and video surveillance use cases.

With different assumption of traffic model for RedCap, the impact of UE complexity reduction on network capacity and spectrum efficiency could be different. The contributions [1, 4] have noted that RedCap UE may experience degraded performance due to cost reduction features, but there is little impact on the reference eMBB UE performance. The contribution [1] stated that the spectral efficiency in DL has a minor degradation with the introduction of small RedCap data volume even with a 50% fraction of RedCap users, and the spectral efficiency in UL is essentially unchanged. The contribution [4] noted that the introduction of RedCap UEs has little impact to the co-existing eMBB UEs in the system and the cell capacity (cell served throughput) is increased due to the introduction of RedCap UEs to the system. The contributions [1, 24] also noted that for the impact of UE complexity reduction, the 1 Rx antenna does not make an appreciable change on the user throughput performance of the eMBB UE compared to the 2 Rx antenna.

With FTP model 3 for RedCap UE, the contribution [3] stated that the loss of downlink SE is about 54% and RU is increased by 104% for 2 Rx RedCap UE and the SE loss will be up to 70% and RU will be increased by 166% if UE Rx antenna is further reduced to 1Rx for the assumption of 100% RedCap UE in network.

Based on the SLS evaluation results in Table 4-1 to Table 4-24 and companies’ observations, the following observations are proposed for discussion for the TP drafting for TR 38.875.

**Moderator’s observation**

* P1: When the RedCap traffic volume is low (e.g. under the assumption of the IM model as defined in TR 38.840), there is little impact on eMBB UE performance and little impact on cell-average spectral efficiency
* P2: When the RedCap traffic volume is high (e.g. under the assumption of FTP model 3), there is a considerable degradation of cell-average spectral efficiency in downlink, especially for 1 Rx antenna
* P3: The loss of uplink capacity performance is much lower than in the downlink

**Question 4-2: Can the above list (P1-P3) be used as a baseline text for TR 38.875? If not, what other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | As commented before, there are discrepancies in some key simulation parameters, e.g. traffic, BW, etc, which lead to different observations. We should address them first. |
| Futurewei | Y | It is important to capture the results to address the operator concerns. We are not OK to only capture P1 without P2 |
| Ericsson |  | P1: okay  P2: It should be clarified that the assumption is that a RedCap UE generates as much traffic as an eMBB UE. Then, in our view the degradation shown in the results is also due to the system load has increased when more and more RedCap UEs are added to the system. In our view, this is the main cause of the degradation.  P3: okay |
| Samsung |  | The comment in Q 4-1 should be addressed before agreeing it. |
| Huawei, Hisilicon |  | It is good to discuss traffic load and include its conclusion into the observation, e.g. the traffic contribution ratio of RedCap UEs, and the traffic load ratio of reference UE over RedCap UE. |

**[FL5] Based on the received response, the FL’s updated text proposals is as following.**

|  |
| --- |
| The SLS evaluations for the impacts of UE complexity reduction and antenna inefficiency to network capacity and spectrum efficiency are summarized in Table 4-1 to 4-25. Burst traffic model and optional full buffer traffic are considered.  The impact from potential coverage recovery techniques is reflected in the SLS results in the sense that we allow the PDSCH/PUSCH spectral efficiency to go lower due to, e.g. repetitions and/or HARQ transmissions (i.e. trading data rate for coverage).  For burst traffic evaluation, FTP model 3 is assumed for eMBB users. The assumption of traffic model for RedCap users varies across the sourcing companies. The instant message (IM) traffic model which in average generates an offered load of 400 kbps/s (0.1 MB payload every 2 s) is assumed for RedCap users by some sourcing companies. Compared to the assumed traffic model for the eMBB users which have an offered load of 20 Mbps (0.5 MB payload every 200 ms), the RedCap users will produce a very low data volume even with a 50-50 split of eMBB and RedCap users. The use of IM traffic for downlink capacity evaluation corresponds to video surveillance and industrial wireless sensor use cases for which traffic pattern is dominated by UL transmissions. In addition, the IM traffic may also be possible for some low data rate wearable use cases.  Some companies have considered to reuse the same FTP model 3 for RedCap users by assuming wearable use cases have DL heavy traffic and the traffic pattern is the same for RedCap users and eMBB users. It should be noted that among the companies assuming FTP3 traffic model for RedCap, there may be differences in the average traffic volume assumption. Such a difference may contribute to different conclusion.  For burst traffic evaluation with IM traffic model for RedCap users:   * 3 sources observed that the RedCap users have minor or no impact on spectral efficiency and capacity, and little impact to the performance of co-existing eMBB users in the system * It is further noted that the 1 Rx RedCap users do not make an appreciable change on the user throughput performance of the eMBB users compared to the 2 Rx RedCap users   For burst traffic evaluation with FTP model 3 for RedCap users:   * One source reported the user throughput performance of the eMBB users is not degraded with the presence of the RedCap users in the system. * One source reported the impact on spectral efficiency will be substantial. It is further observed substantial cell spectral efficiency loss about 30% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 50% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1 * One possible reason for the above different observations is due to different schedulable BW assumption. When both eMBB user and RedCap user are scheduled in the same 20MHz bandwidth, most of the reduction in spectral efficiency may come from higher interference due to increased RU   For optional full buffer traffic evaluation:   * One source reported a minor degradation of the spectral efficiency for the eMBB users and the degree of spectral efficiency loss is irrespective of the number of Rx antennas for RedCap users * One source reported the impact on spectral efficiency will be substantial. It is further observed substantial cell spectral efficiency loss about 54% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 70% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1 * One possible reason for the above different observations is due to different schedulable BW assumption. When both eMBB user and RedCap user are scheduled in the same 20MHz bandwidth, most of the reduction in spectral efficiency may come from higher interference due to increased RU |

**[FL5] Question 4-1A:** **Can the above observations of the impact to network capacity be used as a baseline text for TR 38.875? If not, what aspects to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | Propose some revisions as below   1. Regarding traffic models   The instant message (IM) traffic model which in average generates an offered load of 4x105 bits/s (0.1 MB payload every 2 s) is assumed for RedCap users by some sourcing companies according to RAN1 agreement.  …  The use of IM traffic for downlink capacity evaluation corresponds to video surveillance and industrial wireless sensor use cases for which traffic pattern is dominated by UL transmissions. In addition, IM traffic may also be possible for some low data rate wearable use cases.   1. Regarding evaluation results, the following highlighted observation is based on the different schedulable BW assumption (20MHz for both eMBB and RedCap) compared to the RAN1 agreement (20MHz for RedCap, 100MHz for eMBB), we should clearly highlight such discrepancy from the agreed simulation assumption since that might be the true reason for the different observation compared to other sources. In addition, the fact that RAN1 agreed full buffer traffic evaluation being optional should also be captured.   For burst traffic evaluation with FTP model 3 for RedCap users:   * One source reported the user throughput performance of the eMBB users is not degraded with the presence of the RedCap users in the system. * One source reported the impact on spectral efficiency will be substantial. It is further observed substantial cell spectral efficiency loss about 30% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 50% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1   For full buffer traffic evaluation:   * One source reported a minor degradation of the spectral efficiency for the eMBB users and the degree of spectral efficiency loss is irrespective of the number of Rx antennas for RedCap users * One source reported the impact on spectral efficiency will be substantial. It is further observed substantial cell spectral efficiency loss about 54% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 70% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1 |
| ZTE | Y | Fine with the observations. |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson |  | Regarding “burst traffic evaluation with FTP model 3 for RedCap users”, explanations regarding why the observations are very different are needed.  Regarding “full buffer traffic evaluation”, explanations on why the impacts on SE are more significant are needed.  Some minor comments.   1. Change “4x105 bits/s” to “400 kb/s” and “2x107 bits/s” to “20 Mb/s”. 2. Change “user cases” to “use cases” |
| Nokia, NSB | Y |  |
| **FL6** | Based on the received responses, the TP above has been updated. Please note that some text is added for clarifying the impact from the potential coverage recovery techniques.  **Proposal 4-1A:**   * Adopt the updated TP in section 4 as baseline text for TR clause 10 | |
| vivo | modifications | We have following comments and provided revisions in red text.  1. We are not sure about the following paragraph, what is the basis for that. In particular, we do not think repetitions are modeled in the SLS results  The impact from potential coverage recovery techniques is reflected in the SLS results in the sense that we allow the PDSCH/PUSCH spectral efficiency to go lower due to, e.g. repetitions and/or HARQ transmissions (i.e. trading data rate for coverage).  2.We should capture the fact that IM traffic model is the agreed traffic model in RAN1 for RedCap  For burst traffic evaluation, FTP model 3 is assumed for eMBB users. The assumption of traffic model for RedCap users varies across the sourcing companies. The instant message (IM) traffic model which in average generates an offered load of 400 kbps/s (0.1 MB payload every 2 s) is assumed for RedCap users by some sourcing companies. Compared to the assumed traffic model for the eMBB users which have an offered load of 20 Mbps (0.5 MB payload every 200 ms), the RedCap users will produce a very low data volume even with a 50-50 split of eMBB and RedCap users. The use of IM traffic for downlink capacity evaluation corresponds to video surveillance and industrial wireless sensor use cases for which traffic pattern is dominated by UL transmissions. In addition, the IM traffic may also be possible for some low data rate wearable use cases. RAN1 agreed to use IM traffic model for RedCap UEs.  3.We should capture the fact that the source indicates substantial SE impact is based on the assumption of 20MHz schedulable BW for both eMBB and RedCap UEs in FR1. Also we should also capture what is the agreed BW assumption for FR1.  For burst traffic evaluation with FTP model 3 for RedCap users:   * One source reported the user throughput performance of the eMBB users is not degraded with the presence of the RedCap users in the system. * One source reported the impact on spectral efficiency will be substantial based on the assumption of that eMBB and RedCap UEs are scheduled on the same frequency bandwidth of 20MHz in FR1. It is further observed substantial cell spectral efficiency loss about 30% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 50% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1 * One possible reason for the above different observations is due to different schedulable BW assumption. When both eMBB user and RedCap user are scheduled in the same 20MHz bandwidth, most of the reduction in spectral efficiency may come from higher interference due to increased RU. However, it is noted that RAN1 agreed that for FR1, the scheduled bandwidths for eMBB and RedCap UEs can be up to 100 MHz and 20 MHz, respectively   For optional full buffer traffic evaluation:   * One source reported a minor degradation of the spectral efficiency for the eMBB users and the degree of spectral efficiency loss is irrespective of the number of Rx antennas for RedCap users * One source reported the impact on spectral efficiency will be substantial based on the assumption of that eMBB and RedCap UEs are scheduled on the same frequency bandwidth of 20MHz in FR1. It is further observed substantial cell spectral efficiency loss about 54% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 70% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1 * One possible reason for the above different observations is due to different schedulable BW assumption. When both eMBB user and RedCap user are scheduled in the same 20MHz bandwidth, most of the reduction in spectral efficiency may come from higher interference due to increased RU. However, it is noted that RAN1 agreed that for FR1, the scheduled bandwidths for eMBB and RedCap UEs can be up to 100 MHz and 20 MHz, respectively |
| Huawei, HiSilicon |  | As explained in our previous replies on simulation assumptions, we have different view on the reason behind the different observations. It is not because of schedulable BW assumption but because of the the extent of traffic load contribution from REDCAP UEs. 1/50 ratio of REDCAP traffic does not represent the real network application. We suggest to capture this perspective.  In addition, we did not agree with vivo on adding “RAN1 agreed to use IM traffic model for RedCap UEs.”. It is obviously not true. Please refer to the agreements we copied before. |
| MediaTek | Support FL6 proposal | We do not agree with Vivo’s comments. We also observe 40%-60% degradation in RedCap UE average SE at 30-50% resource utilization at 2.6GHz using FTP3 20 Mbps traffic. The root causes may be the loss in antenna efficiency and antenna number, the lower maximum modulation order and the reduced bandwidth.  Furthermore, we observe 40% loss in efficiency in UL at 2.6GHz. The causes may be the reduced bandwidth and modulation order and the loss in antenna efficiency. |
| Ericsson |  | Regarding Vivo’s question about the below paragraph, we would like to confirm that the description matches our SLS setup. In our SLS, we never set a target data rate for the data channels. Instead, the MCS is chosen based on (1) channel condition, (2) amount of payload to be delivered, (3) UE bandwidth limitation, and (4) availability of radio resources. When the PDSCH/PUSCH transmissions are in error, we rely on HARQ retransmissions to fix the errors.  “The impact from potential coverage recovery techniques is reflected in the SLS results in the sense that we allow the PDSCH/PUSCH spectral efficiency to go lower due to, e.g. repetitions and/or HARQ transmissions (i.e. trading data rate for coverage).” |

# Potential techniques

In this section, we summarize the proposals on potential techniques to enhance the performance for RedCap UE in various contributions under AI 8.6.3.

## UL coverage recovery

Based on the initial observation, three UL channels, PUSCH, Msg3 and PUCCH format 3 with 22 bits may be coverage limited for RedCap and need for coverage recovery. Contributions [4][9] proposed that some solutions for UL channels introduced in the Rel-17 coverage enhancement SI can be reused or tailored for RedCap UE and the enhancement of UL channel could be deprioritized in RedCap SI. One contribution [3] indicated some additional UL enhancements outside Rel-17 CE SI could also be considered considering the further loss of uplink coverage for RedCap UE due to the loss of antenna efficiency.

**Observation #1**

* The solutions for UL channels introduced in the Rel-17 CE SI could be reused for coverage recovery for RedCap UE.

**Observation #2**

* Additional UL enhancements outside Rel-17 CE SI could also be considered for RedCap
  + [1, 5, 8, 11, 13, 18, 20, 22, 23, 24] proposed frequency hopping enhancement to increase frequency diversity for RedCap UE with a reduction on the maximum channel bandwidth.
  + [3] observed that SUL can achieve 10 ~ 13 dB coverage gain and maximum cell range can be increased by 80% ~ 120%
  + [24] proposed to consider techniques to reduce the payload size for the L1 measurement report by taking advantage of the stationary conditions of the UEs in some RedCap use cases.

Based on companies’ observations, the following observations are proposed for discussion for the TP drafting for TR 38.875.

**Moderator’s observation**

* P1: The solutions for UL coverage enhancements introduced in the Rel-17 CE SI could be reused for compensating the coverage loss due to complexity reduction and the solutions includes at least
  + Cross-slot or cross-repetition channel estimation. [The potential specification impacts are phase continuity and power consistency]
  + Lower DM-RSM density in time domain. [The potential specification impacts include DM-RS pattern and configuration, power consistency and phase continuity]
  + Repetition for Msg3 initial and/or retransmission. [The potential specification impact includes signalling indication of the number of repetitions and early indication of UE capability for Msg3 repetition]
* P2: Additional UL enhancements outside Rel-17 CE SI could also be considered for RedCap including at least
  + Supplement uplink carrier
  + L1 measurement payload reduction. [The potential specification impacts include CSI reporting configuration]
  + Hopping across a larger system bandwidth. [The potential specification impact includes definition of RF retuning time and UL transmission interruption during RF retuning time.]

**Question 5.1-1: Can the above list (P1-P2) be used as a baseline text for TR 38.875? If not, what other aspects need to be added? The proponent companies are invited to provide the input for the potential specification impact and the analysis of coexistence with legacy UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | We think the following techniques are commonly applicable for both eMBB and RedCap coverage enhancements and should be captured under the first main bullet   * + Supplement uplink carrier   + L1 measurement payload reduction. [The potential specification impacts include CSI reporting configuration]   And does L1 measurement payload reduction more related to PUCCH? However, from the representative values captured in section 3, PUCCH does not seem to require coverage recovery.  For P1, since the solutions to be study in CE SI is not clearly provided, we suggest not to capture the detailed solutions in P1. |
| ZTE |  | For RedCap UE, we don’t think SUL is a good approach considering it would increase UE supported BW and capability. In case it would be added here, please also add CA as the candidate solution for UL coverage enhancement. |
| Nokia, NSB |  | On P2, we are not sure if SUL is valid as this can depend on deployment. Also, L1 measurement payload reduction has other specification impact and may not be necessary (for PUCCH). |
| Futurewei |  | OK for existing techniques (including SUL for some deployment) + Rel 17 CE SI |
| NTT DOCOMO |  | We support to follow the solutions for UL coverage enhancements introduced in the Rel-17 CE SI, and extension of Type A and B repetitions may be one of the solutions. |
| Ericsson |  | In principle we are fine with P1.  The 2nd subbullet should be about lower “DM-RS” density.  For PUSCH data, the tradeoff between data rate and coverage can be considered. For example, HARQ retransmission and slot aggregation can be used for improving the coverage of PUSCH.  P2: no need to capture this now. |
| CATT |  | We do not think all solutions for UL coverage enhancements introduced in the Rel-17 CE SI could be reused. Considering that RedCap UE is aiming at low complexity/cost, simple methods with low implementation requirement and less specification impact are preferred. For example, we agree that repetition is recommended to Msg3 (P1 with sub-bullet1&3). |
| Samsung |  | Although likely, solutions listed in P1 are not agreed in the CE SI, it can be used “potentially introduced in the Rel-17 CE SI…”.  Not sure about SUL for RedCap and also L1 measurement payload reduction which seems related to PUCCH coverage recovery. In addition, SUL may not be mandatory for RedCap UE, and it may increase UE complexity. We should focus on the techniques can apply for most of UE with limited complexity. |
| LG |  | We are fine with main bullet in P1, but it would be better to discuss details after CE SI decision. |
| Convida Wireless |  | We agree in principle, but we have inquiry on the sub-bullet regarding Msg3 repetition. If the coverage of Msg3 needs to be compensated, the coverage of MsgA-PUSCH will require coverage enhancement as well. Please note that in AI 8.6.5, MsgA-PUSCH is one of the candidates for early UE identification. Therefore, we want to clarify whether MsgA-PUSCH should be included in the proposed baseline text for the TR or not. |
| Huawei, Hisilicon |  | We are fine with P1 and P2. For SUL, we would like to clarify that SUL does not increase UE supported BW and cost because there is no aggregated carrier bandwidth nor concurrent UL transmission between SUL carrier and NUL carrier, allowing UE hardware sharing among carriers, which is very different from CA. Additionally, in real markets, RedCap UEs will support multi bands naturally, SUL can fully utilize those UE hardware in those bands. |
| OPPO |  | Generally we are fine with the bullets in P1. Details can be further discussed according to CE SI conclusion. |
| **FL5** | Most responses seem fine with P1. However, a few responses have indicated that not all the solutions for UL coverage enhancements introduced in the Rel-17 CE SI could be reused for RedCap users and proposed to discuss details after CE SI decision.  Several responses have raised concern on the SUL and L1 measurement payload reduction since SUL is dependent on deployment and L1 measurement payload reduction is more related to PUCCH.  One response wants to clarify whether MsgA-PUSCH should be included in the proposed baseline text for the TR or not.  Based on the received response, the following updated proposals can be considered.  (FL note: for techniques that have been studied in the Rel-17 CE SI, potential specification impacts can follow the agreement in the Rel-17 CE SI and therefore not included here. **The FL intention here is to firstly summarize a list of potential techniques for coverage recovery, and the recommendation for techniques for the WI can be further discussed after drawing conclusion for coverage recovery or probably even not needed**)  **[FL5] Proposal 5.1-1A:**   * Capture the following to the TR 38.875   + Coverage recovery for PUSCH was studied from several aspects, including cross-slot or cross-repetition channel estimation, lower DM-RS density in time domain, enhancements on PUSCH repetition Type A and/or Type B, frequency hopping or BWP switching across a larger system bandwidth   + Some techniques, such as cross-slot or cross-repetition channel estimation, lower DM-RS density in time domain, enhancements on PUSCH repetition Type A and/or Type B have been studied also in the Rel-17 coverage enhancement SI   + Potential specification impacts of frequency hopping or BWP switching across a larger system bandwidth include:     - Frequency domain hopping offsets/positions     - Relaxed BWP switching time or RF retuning time     - Transmission/reception interruption during RF retuning time   **[FL5] Proposal 5.1-1B:**   * Capture the following to the TR 38.875   + Coverage recovery for Msg3 [and MsgA] was studied including repetition for Msg3 PUSCH initial and/or retransmission   + It is noted that enhancements on Msg3 PUSCH repetition have been studied also in the Rel-17 coverage enhancement SI | |
| Panasonic |  | We are generally fine with [FL5] Proposal 5.1-1A. However, we slightly prefer to highlight the recommendation of techniques or technical aspects for RedCap based on Rel-15 CE SI agreements. Otherwise, it seems there is no need to further discuss on techniques for coverage recovery for RedCap because all potential aspects can be discussed therein CE SI. |
| vivo |  | We have concern on “frequency hopping or BWP switching across a larger system bandwidth” as it clearly increases the UE complexity.  We think MSGA should not be captured as there has been no explicit evaluation/study on it. |
| ZTE | Y | Support the proposal. |
| Qualcomm | Y | Support the FL’s proposal not to include SUL since it is not supported for all the deployments. The PUSCH loss is due to reduced antenna efficiency and applies to all the bands in FR1. |
| Futurewei |  | Given the amount of compensation that is needed for Msg3 which is minimal for all scenarios, prefer to keep it simple in sense there is no need to include *enhancements* frequency hopping or BWP switching across a larger system bandwidth that may result in unnecessary specification impacts. |
| Convida |  | We are okay with FL5 proposals 5.1-1A and 5.1-1B |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Samsung | Y |  |
| Intel |  | Further discussions are necessary before capturing these.  For instance, the techniques in the first sub-bullet may have been mentioned in company contributions but have not really been studied/evaluated. So, the wording needs to reflect that.  Similarly, the third bullet on “frequency hopping across a larger system BW” needs further discussions before we can get to spec impact. |
| OPPO | Y | Fine with FL5 proposals 5.1-1A and 5.1-1B |
| Lenovo, Motorola Mobility | Y |  |
| LG | Y |  |
| CATT | Y | Fine to capture them as potential techniques, but we think not all of them are well studied sufficiently. |
| Nokia, NSB | Y |  |
| **FL6** | The FL’s understanding is although there is no performance evaluation provided for RedCap, some sourcing companies have provided evaluation results to the Rel-17 CE SI. Since almost same techniques have been also proposed here, probably we don’t need to say that techniques have not been studied and evaluated.  To address concerns on “hopping or BWP switching”, a bracket is added so that it can be further discussed whether to support it.  For MsgA, it has been removed from the updated TP.  **Updated proposal 5.1-1A:**   * Capture the following to the TR 38.875   + Coverage recovery for PUSCH was studied from several aspects, including cross-slot or cross-repetition channel estimation, lower DM-RS density in time domain, enhancements on PUSCH repetition Type A and/or Type B, [frequency hopping or BWP switching across a larger system bandwidth]   + Some techniques, such as cross-slot or cross-repetition channel estimation, lower DM-RS density in time domain, enhancements on PUSCH repetition Type A and/or Type B have been studied also in the Rel-17 coverage enhancement SI   + Potential specification impacts of frequency hopping or BWP switching across a larger system bandwidth (if supported) include:     - Frequency domain hopping offsets/positions     - Faster switching/RF retuning time     - Transmission/reception interruption during RF retuning time   **Updated proposal 5.1-1B:**   * Capture the following to the TR 38.875   + Coverage recovery for Msg3 ~~[and MsgA]~~ was studied including repetition for Msg3 PUSCH initial and/or retransmission   + It is noted that enhancements on Msg3 PUSCH repetition have been studied also in the Rel-17 coverage enhancement SI | |
| vivo |  | We still have concern on capturing the “frequency hopping or BWP switching across a larger system bandwidth” and its spec impact, due to following reasons   * + - 1. The only case that PDSCH may be considered for coverage recovery is FR2 indoor, based on the methodology of Option3. However, if we consider the target ISD/MPL as agreed in CE SI, there is no issue for PDSCH.       2. There is no feasibility study of fast BWP switching across wide carrier bandwidth. If a long gap is required for switching, potential coverage loss can be expected due to the loss of resources       3. The fast BWP switching across wide carrier bandwidth increase UE complexity and is not even supported by baseline reference UEs. |
| Futurewei |  | Given the amount of compensation that is needed for Msg3 which is minimal for all scenarios, prefer to keep it simple in sense there is no need to include *enhancements* frequency hopping or BWP switching across a larger system bandwidth that may result in unnecessary specification impacts. We can say that existing techniques Rel-15 Rel-16 are sufficient for compensation. Prefer to just list the **existing** techniques |
| Qualcomm |  | Fine with both FL proposals. We support considering switching across larger BW due to following reasons:   * We agreed on option 3 and coverage recovery may be needed for PDSCH * For FR2, we need to consider that as one of the techniques. The reason is that delay spreads and directivity of FR2 beams make the coherence BW larger and to get freq diversity gains, we need to hop across larger BW |
| Ericsson |  | We suggest revising the sentence below to:  “If frequency hopping or BWP switching across a larger system bandwidth is supported, the potential specification impacts include:” |
| CMCC |  | Fine with FL proposals. |
| Intel |  | Fine with FL proposals |

## PDSCH coverage recovery

**Observation #1:**

* The existing Rel-15/16 coverage enhancement techniques are sufficient in compensating for coverage loss from complexity reduction
  + [2] has observed a 1.5dB gain with the use of the lower MCS table Table 5.1.3.1-3 while achieving the target data rates for DL 2Mbps.
  + According to [12], repetition cannot improve the data rate, and instead by a lower MCS, 1-2dB gain can be achieved.

**Observation #2:**

* Further extension of the existing techniques, such as slot aggregation enhancements can be considered if larger coverage recovery is necessary
  + [5, 8, 14] proposed a larger aggregation factor, e.g. 16 or more can be used for PDSCH for RedCap UE, and extension of RRC signalling for larger aggregation factor may be needed
  + [8] also proposed to consider indicating the number of repetitions dynamically to RedCap UEs

**Observation #3:**

* Frequency domain-based solutions can be considered to increase frequency diversity for RedCap UE
  + [1, 5, 8, 11, 13, 18, 20, 22, 23, 24] indicated that hopping across a larger bandwidth is beneficial for achieving frequency diversity gain
  + [2] observed that 1-2 dB PDSCH performance loss for fixed 20MHz BW location over flexible 20MHz with a 100MHz system bandwidth and proposed to consider BWP switching in a larger system bandwidth for achieving frequency scheduling gain and load balancing.

**Observation #4:**

* Improvement on channel estimation is also useful for improving the efficiency of coverage recovery
  + [13] observed that cross-repetition channel estimation additionally can provide about 0.5-1.3dB gain over the repetition without DM-RS bundling
  + [8] indicated that the increase of the granularity of PRB bundling in channel estimation could be beneficial for a flat channel

Based on companies’ observations, the following observations are proposed for discussion for the TP drafting for TR 38.875.

**Moderator’s observation**

* P1: The existing Rel-15/16 coverage enhancement techniques (e.g. low-MCS table) are sufficient in compensating for the coverage loss from complexity reduction when the required coverage recovery is small
* P2: Further extension of the existing techniques, such as slot aggregation enhancements can be considered
  + A larger aggregation factor, e.g. 16 or more for PDSCH. The potential specification impacts are RRC signalling enhancement.
  + Dynamic indication of the number of repetitions. The potential specification impacts are DCI design for indicating the number of repetitions.
* P3: Hopping or BWP switching across a larger system bandwidth is beneficial for achieving frequency diversity gain
  + The potential specification impacts include hopping configuration for PDSCH, latency reduction for BWP switching time or RF retuning time across a larger BW
* P4: Improvement on channel estimation is also useful for improving the efficiency of coverage recovery
  + Cross-slot or cross-repetition channel estimation. The potential specification impacts include precoder cycling in time domain.
  + Increasing the granularity of PRB bundling. The potential specification impacts are new PRG size configuration.

**Question 5.2-1: Can the above list (P1-P4) be used as a baseline text for TR 38.875? If not, what other aspects need to be added? The proponent companies are invited to provide the input for the potential specification impact and the analysis of coexistence with legacy UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | P3 requires RedCap UEs to support dynamic BWP switching with reduced delay, however, those are not assumed for reference UEs. This will definitely increase the RedCap UE complexity.  For Dynamic indication of the number of repetitions for PDSCH, it is already supported in Rel-16, such enhancements are not needed. |
| Futurewei |  | P1 is OK and may not be limited to small but may also include moderate. P2-P4 may depend on the observed CE SI. |
| Ericsson |  | We prefer to come back to this after we have a clearer view on coverage compensation needed for PDSCH. For example, P2 might not be needed if the need for PDSCH coverage compensation is not huge.  For PDSCH data, the tradeoff between data rate and coverage can be considered. (For example, HARQ retransmission and slot aggregation can be used for improving the coverage of PDSCH.) |
| CATT |  | Similar to the Question 5.1-1, simple methods with low implementation requirement and less specification impact are preferred. We think at least P1, P2 (1st bullet) are fine. |
| Samsung | Y |  |
| Convida Wireless |  | We agree in principle, but we have a question for clarification on whether PDSCH in FL’s proposals refers to PDSCH transmitted when UE is in RRC-connected mode or PDSCH transmitted when UE is in RRC-idle/inactive state, e.g. such RMSI-PDSCH and paging message. We note that there is a dedicate discussion for PDSCH of Msg2 and Msg4 in the next section. |
| OPPO | Y |  |
| **FL5** | Two responses are fine with the FL’s proposal. A few responses have suggested to further discuss after CE SI decision or having a clear view on coverage compensation needed for PDSCH. One response indicated that a tradeoff between data rate and coverage can be considered for PDSCH. One response has raised concern on P3 considering potentially UE complexity increase.  One response proposes to clarify whether PDSCH includes also PDSCH transmitted in RRC-idle and inactive states, such as such RMSI-PDSCH and paging message.  The FL’s understanding is that PDSCH for coverage evaluation is assumed with a target data rate and therefore mainly for PDSCH transmitted when UE is in RRC-connected mode. However, some enhancements are not limited to PDSCH unicast and can also be used for broadcast PDSCH. These can be further discussed during the WI phase.  Based on the received response, the following updated proposals can be considered.  (FL note: Rel-17 CE SI has not made any decision on PDSCH unicast coverage enhancement. Based on link budget analysis in section 3, coverage recovery for PDSCH unicast is needed at least for FR2 with single Rx. **The FL intention here is to firstly summarize a list of potential techniques for coverage recovery, and the recommendation for techniques for the WI can be further discussed after drawing conclusion for coverage recovery or probably even not needed**)  **[FL5] Proposal 5.2-1:**   * Capture the following to the TR 38.875   + Coverage recovery for PDSCH was studied from several aspects, including the use of the lower-MCS table, larger aggregation factor for PDSCH reception, cross-slot or cross-repetition channel estimation, increasing the granularity of PRB bundling, frequency hopping or BWP switching across a larger system bandwidth.   + Some techniques, such as the lower-MCS table and larger aggregation factor for PDSCH reception are existing techniques with optional UE capability signaling   + Potential specification impacts of cross-slot or cross-repetition channel estimation include:     - Time-domain precoder cycling and DM-RS configuration   + Potential specification impacts of frequency hopping or BWP switching across a larger system bandwidth include     - PDSCH hopping configuration     - Relaxed BWP switching time or RF retuning time     - Transmission/reception interruption during RF retuning time   + Potential specification impacts of increasing the granularity of PRB bundling include     - Related signaling design | |
| Panasonic | Y |  |
| vivo | N | Based on our understanding, the non-initial acess PDSCH coverage issue (except MSG 2 and MSG4) is only seen in FR2 indoor based on option3. However, as we commented before, we have concern on such approach to identify the coverage problem without considering the actual deployment need. |
| ZTE |  | If the intention of ‘ lower-MCS table, larger aggregation factor for PDSCH reception’ is to reuse Rel-15/16 features, we don’t see the need to capture into TR. If it is for additional enhancements, the second sub-bullet would be not accurate by saying it is existing techniques. |
| Qualcomm | Y |  |
| Futurewei |  | Yes for use of existing techniques such as low MCS table. But no for unnecessary enhancements that result in specification impacts such as those related to frequency hopping and increasing granularity of PRB and the associated signaling. According to simulation results and LB results the existing techniques are enough. |
| Convida | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Samsung | Y |  |
| Intel |  | Further discussions are necessary before capturing these.  For instance, the techniques in the first sub-bullet may have been mentioned in company contributions but have not really been studied/evaluated. So, the wording needs to reflect that.  Similarly, the spec impact bullets need further analyses and discussions before agreeing, including correlation to CE studies. |
| OPPO | Y |  |
| Lenovo, Motorola Mobility | Y |  |
| LG | Y |  |
| CATT | Y | Fine to capture them as potential techniques, but we think not all of them are well studied sufficiently. |
| Nokia, NSB | Y |  |
| **FL6** | Only one response indicated not to capture PDSCH enhancement to the TR. The FL understanding is that for the TR completeness we need to include solutions for PDSCH. However, the necessity of coverage recovery for PDSCH is not the purpose of the proposal, and should be discussed in the section 3.5  One response proposed not to include some existing techniques. The FL’s understanding is that coverage recovery for PDSCH (if supported) is mainly required for FR2, and it is not clear how these techniques are useful unless we consider a trade-off between data rate and coverage.  Based on the received response, the following updated proposal can be considered  **Updated proposal 5.2-1:**   * Capture the following to the TR 38.875 (if coverage recovery for PDSCH is supported)   + Coverage recovery for PDSCH was studied from several aspects, including ~~the use of the lower-MCS table, larger aggregation factor for PDSCH reception,~~ cross-slot or cross-repetition channel estimation, increasing the granularity of PRB bundling, frequency hopping or BWP switching across a larger system bandwidth.   + ~~Some techniques, such as the lower-MCS table and larger aggregation factor for PDSCH reception are existing techniques with optional UE capability signaling~~   + Potential specification impacts of cross-slot or cross-repetition channel estimation include:     - Time-domain precoder cycling and DM-RS configuration   + Potential specification impacts of frequency hopping or BWP switching across a larger system bandwidth include     - PDSCH hopping configuration     - Faster switching/RF retuning time     - Transmission/reception interruption during RF retuning time   + Potential specification impacts of increasing the granularity of PRB bundling include     - Related signaling design | |
| vivo |  | Based on the current evaluation and methodology, we do not agree to conclude that coverage recovery is needed since the only scenario we found PDSCH may be an issue is FR2 indoor based on option3. However, there is no coverage issue if the target ISD as agreed in CE SI for this scenario. Therefore we suggest we either remove the section regarding PDSCH coverage recovery technique, or add a note that there is no conclusion in RAN1 on whether coverage recovery for PDSCH is needed.  In addition, we have same concern regarding “frequency hopping or BWP switching across a larger system bandwidth” |
| Futurewei |  | As listed here it may seem that PDSCH requires a lot of compensation which is not the case. It may be that PDSCH FR2 requires compensation but even with that a small compensation may be needed. As such we propose to simply say that existing techniques from Rel-15, Rel-16 are sufficient to compensate for the loss for completeness. We think the removing the list of existing techniques is NOT OK. It should still be there as we indeed have studied them. |
| Qualcomm |  | Fine with FL proposal.  May be we need to add time domain PDSCH repetition as one of the techniques explicitly in the proposal |
| Ericsson |  | Similar comment as what we have for “Updated proposal 5.1-1A”, we suggest revising the all the statements on specification impact to  “If XXX is introduced, the potential specification impacts include …” |
| CMCC |  | Fine with FL proposal. |
| Intel |  | Fine with FL proposal |

## Msg2 and Msg4 coverage recovery

**Observation #1:**

* Slot aggregation or repetition can be used for broadcast PDSCH enhancement for RedCap UE [2, 4, 5, 23]
  + [13] showed time domain repetition by 8 transmissions for 1Rx UE can achieve the same performance as 4Rx UE at 10% BLER;
  + [25] observed a PDSCH loss of about 6dB from reducing the number of Rx antennas from 4 to 1 and it can be recovered by about 8 repetitions

**Observation #2:**

* The existing TBS scaling technique for Msg2 can achieve a coverage improvement of 3-6 dB
  + [24] also observed a restriction on Msg2 payload size with TBS scaling for RedCap UE

**Observation #3:**

* The use of lower MCS table before the RRC configuration can be used for coverage enhancement of Msg4 [2, 24]

**Observation #4:**

* The recovery schemes for PDSCH such as frequency hopping enhancement and DM-RS enhancement can be also suitable for Msg2/Msg4 [5]

Based on companies’ observations, the following observations are proposed for discussion for the TP drafting for TR 38.875.

**Moderator’s observation**

* P1: The existing TBS scaling can be used for coverage enhancement of Msg2, and slot-aggregation or repetition can be considered if a larger coverage recovery (e.g. more than 6 dB) is necessary
* P2: The use of lower MCS table before the RRC configuration can be used for coverage enhancement of channels such as Msg4, and slot-aggregation or repetition can also be considered
* P3: The recovery schemes for PDSCH such as frequency hopping enhancement and DM-RS enhancement can be also suitable for Msg2 and Msg4

**Question 5.3-1: Can the above list (P1-P3) be used as a baseline text for TR 38.875? If not, what other aspects need to be added? The proponent companies are invited to provide the input for the potential specification impact and the analysis of coexistence with legacy UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | For P3, it is not clear how to apply the enhancements to RedCap UEs, and gNB may not fully aware of UE capability before RRC connection. |
| Futurewei |  | P2 is OK and preferable, P1 is OK as existing techniques |
| Ericsson | Y |  |
| CATT |  | We think at least P1 is fine. |
| Samsung |  | We think P1 has already been supported by Rel-15 spec. and with P1, it may not need any other enhancements for Msg 2. In addition, some analysis is needed for the evaluation results of DL channels with a big gap between companies before drawing observations. |
| Convida Wireless | Y |  |
| Huawei, Hisilicon | N | We feel that existing TBS scaling is sufficient for Msg.2, don’t see the need to consider slot-aggregation or repetition.  It should be more careful to draw a feasible conclusion on some potential enhancement for Msg4 and Msg2. Because they may be optional UE feature and gNB has no sufficient knowledge whether a UE has supported it during initial access procedure.  More investigations are needed for P1-P3. |
| OPPO | Y |  |
| **FL5** | Three responses are fine with the FL’s proposal. One response suggests having more investigation. Another three responses indicate the support for P1.  Based on the received response, the following updated proposals can be considered.  (FL note: for techniques that have been studied in the Rel-17 CE SI, potential specification impacts can follow the agreement in the Rel-17 CE SI and therefore not included here. **The FL intention here is to firstly summarize a list of potential techniques for coverage recovery, and the recommendation for techniques for the WI can be further discussed after drawing conclusion for coverage recovery or probably even not needed**)  **[FL5] Proposal 5.3-1A:**   * Capture the following to the TR 38.875   + Coverage recovery for Msg2 PDSCH was studied from several aspects, including TBS scaling and time domain repetition   + It is noted that TBS scaling is an existing technique mandatory for Rel-15 UE   + Potential specification impacts of Msg2 PDSCH repetition include     - Msg2 PDSCH repetition configuration     - Mechanism to differentiate enhanced UE and legacy UE, e.g., separate PRACH configurations (e.g, separate PRACH occasions or preambles)   **[FL5] Proposal 5.3-1B:**   * Capture the following to the TR 38.875   + Coverage recovery for Msg4 PDSCH was studied from several aspects, including early CSI on Msg3 PUSCH for early link adaptation, scaling factor for TBS determination, PDSCH repetition and the use of the lower-MCS table.   + Some techniques, such as early CSI on Msg3 PUSCH for early link adaptation, scaling factor for TBS determination and PDSCH repetition have been studied also in the Rel-17 coverage enhancement SI   + Potential specification impacts of using the lower-MCS table for Msg4 PDSCH include     - Related signaling design | |
| Panasonic | Y |  |
| vivo |  | For MSG4, we think “early CSI on Msg3 PUSCH for early link adaptation” is a scheduling efficiency improvement technique, rather than a coverage enhancement technique, we suggest to not capture it. |
| ZTE |  | For “early CSI on Msg3 PUSCH for early link adaptation”, we prefer to keep it as agreed in CE SI. Because it could provide more accurate scheduling information, e.g., MCS or PRB location, which could improve the coverage. |
| Qualcomm | Y |  |
| Futurewei | Y |  |
| Convida | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Samsung | Y |  |
| Intel |  | Here, only TBS scaling can be considered for the first Proposal, but again, same general comments as previous Proposals in Section 5 apply. Further discussions are necessary before capturing any of these above details considering lack of evaluations/analysis establishing exact needs so far. |
| OPPO | Y |  |
| Lenovo, Motorola Mobility |  | For the first bullet for Msg2,   * + Coverage recovery for Msg2 PDSCH was studied from several aspects, including TBS scaling and time domain repetition   We suggest revising “time domain repetition” to be “time/frequency domain repetition”. |
| LG | Y |  |
| CATT | Y | Fine to capture them as potential techniques, though we are skeptical to the benefit of some methods. |
| FL5 | The FL would like to repeat that the intention of the proposals is to list the potential techniques for coverage recovery that have been studied by companies, and the recommendation of techniques for the following WI will be down-selected from the list based on the outcome of the amount of coverage recovery in section 3.5.  Based on the received responses, the FL’s updated suggestion is as following.  **Updated Proposal 5.3-1A:**   * Capture the following to the TR 38.875   + Coverage recovery for Msg2 PDSCH was studied from several aspects, including TBS scaling [and Msg2 PDSCH repetition]   + It is noted that TBS scaling is an existing technique mandatory for Rel-15 UE   + Potential specification impacts of Msg2 PDSCH repetition (if considered) include     - Msg2 PDSCH repetition configuration     - Mechanism to differentiate enhanced UE and legacy UE, e.g., separate PRACH configurations (e.g, separate PRACH occasions or preambles)   **Updated Proposal 5.3-1B:**   * Capture the following to the TR 38.875   + Coverage recovery for Msg4 PDSCH was studied from several aspects, including [early CSI on Msg3 PUSCH for early link adaptation], scaling factor for TBS determination, PDSCH repetition and the use of the lower-MCS table.   + Some techniques, such as [early CSI on Msg3 PUSCH for early link adaptation], scaling factor for TBS determination and PDSCH repetition have been studied also in the Rel-17 coverage enhancement SI   + Potential specification impacts of using the lower-MCS table for Msg4 PDSCH include     - Related signaling design | |
| FL5 | **Agreements:** (in 11/10 GTW session)   * Capture the following to the TR 38.875   + Coverage recovery for Msg2 PDSCH was studied from several aspects, including TBS scaling [and Msg2 PDSCH repetition]   + It is noted that TBS scaling is an existing technique mandatory for Rel-15 UE   + Potential specification impacts of Msg2 PDSCH repetition (if supported) include     - Msg2 PDSCH repetition configuration     - Mechanism to differentiate enhanced UE and legacy UE, e.g., separate PRACH configurations (e.g, separate PRACH occasions or preambles)   Agreements: (in 11/10 GTW session)   * Capture the following to the TR 38.875   + Coverage recovery for Msg4 PDSCH was studied from several aspects, including scaling factor for TBS determination, PDSCH repetition and the use of the lower-MCS table.   + Some techniques, such as scaling factor for TBS determination and PDSCH repetition have been studied also in the Rel-17 coverage enhancement SI   + Potential specification impacts of using the lower-MCS table for Msg4 PDSCH include     - Related signaling design | |

## PDCCH coverage recovery

**Observation #1:**

* Repetition can compensate the coverage loss of PDCCH due to complexity reduction
  + [17] observed a loss of 8dB for AL=4 and 2Rx RedCap UE, w.r.t. AL=16 and 4Rx reference UE, and the loss was increased to more than 10dB for AL=4 and 1Rx
  + [21] indicated that with AL16 and a target PDCCH BLER of 1%, there was about 2.72dB performance loss by reducing #Rx antennas from 4 to 2, and about 6dB by reducing #Rx antennas from 4 to 1
  + [4, 24] observed that PDCCH repetition can generally provide 2 dB gain by repeating twice in time domain
  + [17, 24, 25] stated that PDCCH repetitions can be performed both within a slot and across slots.
  + [21] proposed to consider only UE-transparent PDCCH repetition scheme and UE-aware PDCCH repetition schemes are not considered for RedCap UE.
  + [12] indicated that repetition can be applied in time or frequency, effectively creating an extended CORESET

**Observation #2:**

* Compact DCI is useful for improving PDCCH coverage when the required coverage recovery is small [1, 3, 5, 8, 11, 12, 23, 26, 27]
  + [5] stated that about 1dB gain can be achieved for AL=16 at 1e-5 or 1e-6 target BLER with 10~16 bits size reduction by DCI format 0\_2/1\_2 (similar observation for target BLER 1e-2);

**Observation #3:**

* Increasing the CCE number for PDCCH transmission is another effective way to enhance PDCCH coverage [1, 4, 5, 12, 13, 17, 26]
  + [1] stated the higher aggregation level can be achieved by repetition
  + [12, 13] stated that higher aggregation level in conjunction with an extended CORESET may impact codeword generation and mapping to CCEs and may have an overall high specification impact
  + [4] indicated CORESET bundling is another scheme to increase the CCE number for PDCCH transmission. In such case, the CCE of a PDCCH is distributed across multiple CORESETs in a bundle to efficiently achieve a larger aggregation level.

**Observation #5:**

* Combination of different techniques can also be considered for PDCCH
  + [4] indicated that cross-slot channel estimation can be considered together with CORESET bundling
  + [1] proposed to consider frequency hopped CORESET for RedCap UE, and [17] proposed that frequency hopping in a wide bandwidth region can be considered for inter-slot PDCCH repetition

**Observation #6:**

* Compatibility with normal UE should be considered for broadcast PDCCH enhancement
  + [4] indicated there could be compatibility issue if RedCap and normal UEs share the same initial DL BWP
  + [19] noted it is not possible to use consecutive time resources for PDCCH repetition for CORESET0 since these resources are reserved for other SS/PBCH blocks in Rel-15/16
  + [15] stated that PDCCH coverage recovery should consider PDCCH overhead reduction and the congestion of CORESET 0 and initial BWP.

Based on companies’ observations, the following observations are proposed for discussion for the TP drafting for TR 38.875.

**Moderator’s observation**

* P1: There could be multiple candidate techniques that can be considered for coverage recovery of PDCCH, with some techniques being useful with relatively low specification impact
* P2: Dependent on the amount of coverage recovery, different solutions could be considered
  + Compact DCI is useful when the required coverage recovery is small, e.g. approximately 1dB
  + Repetition and/or increasing the CCE number for PDCCH transmission can be considered when the required coverage recovery is larger, e.g. more than 1 dB
* P3: The recovery schemes for PDCCH should consider compatibility with normal UE if RedCap and normal UEs share the same initial DL BWP

**Question 5.4-1: Can the above list (P1-P3) be used as a baseline text for TR 38.875? If not, what other aspects need to be added? The proponent companies are invited to provide the input for the potential specification impact and the analysis of coexistence with legacy UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | Seems OK  It would be necessary to clarify that for repetition and/or increasing the CCE number for PDCCH transmission, one or more than more CORESETs may be used for PDCCH transmission. |
| Futurewei |  | Looks OK |
| Ericsson |  | P2: The meaning of “*Repetition and/or increasing the CCE number*” is not clear. Does it mean increasing the maximum supported AL in the CORESET configured for RedCap? |
| CATT |  | Generally OK. Some of the solutions may have impact on AI8.6.2 where PDCCH monitoring reduction is under discussion. May come back later. |
| Samsung | Y |  |
| LG |  | We are generally OK with P1 and P3.  Meanwhile, the meaning of candidate methods captured in sub-bullets of P2 are not clear. Also, pros and cons of various methods proposed by several companies have not been discussed in detail. So we prefer to discuss further on P2. |
| Convida Wireless |  | We agree in the principle, but we would like to clarify whether PDCCH in FL’s proposals includes RMSI-PDCCH and PDCCH that schedules Msg2/Msg4 or not. |
| Huawei, Hisilicon |  | For the perspective of coverage, it is still unclear that PDCCH enhancement is necessary.  To draw a conclusion to claim some PDCCH technique beneficial, we suggest to take into account the perspectives of network efficiency and capacity. Compact DCI can be considered to compensate the performance loss caused by UE RX antennas reduction. However, other PDCCH enhancement techniques seems not good for network efficiency and capacity, such as, repetition and/or increasing the CCE number for PDCCH transmission. Therefore, we don’t feel they are beneficial. |
| OPPO | Y | Further down-selection can be done in WI stage. |
| **FL5** | Most responses seem okay with the FL’s proposal although a few responses want to clarify and further discuss P2.  (**FL note:** **The FL intention here is to firstly summarize a list of potential techniques for coverage recovery, and the recommendation for techniques for the WI can be further discussed after drawing conclusion for coverage recovery or probably even not needed)**  Based on the received response, the following updated proposals can be considered.  **[FL5] Proposal 5.4-1:**   * Capture the following to the TR 38.875   + Coverage recovery for broadcast PDCCH (including RMSI PDCCH and PDCCH that schedules Msg2/Msg4/paging) was studied from several aspects, including PDCCH repetition, compact DCI, AL greater than 16 in conjunction with an extended CORESET, and increasing the CCE number for a PDCCH transmission via CORESET bundling   + Potential specification impacts of PDCCH repetition include     - Repetition configuration (e.g. intra-slot or inter-slot)     - DMRS design among PDCCH repetitions   + Potential specification impacts of compact DCI include     - DCI overhead reduction   + Potential specification impacts of AL greater than 16 in conjunction with an extended CORESET include     - Mechanism for codeword generation and mapping to CCEs   + Potential specification impacts of increasing the CCE number for a PDCCH transmission via CORESET bundling include     - CORESET bundling configuration     - DMRS design among CORESET bundling   + It is noted that all these techniques may have compatibility issue if RedCap and normal UEs share the same initial DL BWP | |
| Panasonic | Y |  |
| vivo | Y |  |
| ZTE |  | For broadcast PDCCH, RMSI seems not a terminology used in the specification. It seems more accurate to say it is a PDCCH monitored in a Type0/0A/1/2-PDCCH CSS set as agreed in CE SI.  In addition, we suggest to add PDCCH-less mechanism which is also discussing in CE SI. The reasoning and spec impacts are provided below.   * PDCCH-less mechanism has already been supported for SIB message transmission in LTE MTC which also targets for coverage enhancement. In brief, for SIB1 transmission, the time/frequency resources are predefined, and the TBS and repetiton times are indicated in MIB. For other SIBs transmission, all scheduling information are indicated in SIB1. * Potential specification impacts of PDCCH-less include the mechanism to indicate the scheduling information for broadcast PDCCH carrying SIB messages. |
| Qualcomm | Y |  |
| Futurewei |  | Avoid introducing newer techniques that result in new specification impacts, that is PDCCH does not require much compensation according to section 3 results. Existing techniques should be sufficient. |
| Convida | Y |  |
| InterDigital | Y |  |
| Ericsson |  | Regarding AL for broadcast PDCCH, one issue with 100 MHz UE bandwidth in FR2 is that 1-symbol CORESET with120 kHz SCS can not support AL 16. In this case, perhaps one can consider introducing AL 12, instead of stepping down the AL to 8.  Regarding “Potential specification impacts of AL greater than 16 in conjunction with an extended CORESET include”, there is also an impact on the RRC specs. |
| Samsung | Y |  |
| Intel |  | Similar comments as above. Too early and no discussions yet to capture these observations. |
| OPPO | Y |  |
| Lenovo, Motorola Mobility |  | For “Potential specification impacts of PDCCH repetition”, we suggest including PDCCH search space design. Note the PDCCH search space design for PDCCH repetition in LTE-M can be taken as a reference here. |
| LG |  | Regarding Potential specification impacts of compact DCI, we would like to clarify the meaning of “DCI overhead reduction”. It should be noted that DCI format 1\_0 is used in the PDCCH CSS to schedule the PDSCH. From a backward compatibility point of view, introducing new DCI format for PDCCH CSS is not preferred. Also, in our contribution, we suggest to consider fixing some DCI bits with predefined value by restricting scheduling flexibility. The intention is to take advantage of the strategy of compact DCI while ensuring a coexistence with legacy PDCCH. To capture the consideration of coexistence property while containing the compact DCI property, we prefer to modify the proposal regarding the compact DCI as follow:   * Potential specification impacts of compact DCI include   Modify the existing DCI format for lower code rate |
| CATT | Y | Fine to capture them as potential techniques, though we are skeptical to the benefit of some methods. |
| FL6 | Based on the received response, the following updated proposal can be considered.  **Updated proposal 5.4-1:**   * Capture the following to the TR 38.875   + Coverage recovery for broadcast PDCCH (PDCCH monitored in a Type0/0A/1/2-PDCCH CSS) was studied from several aspects, including PDCCH repetition, compact DCI, AL greater than 16 in conjunction with an extended CORESET, increasing the CCE number for a PDCCH transmission via CORESET bundling, PDCCH-less mechanism for SIB1 and/or SI message, AL12 for 1-symbol CORESET   + Potential specification impacts of PDCCH repetition include     - Repetition configuration (e.g. intra-slot or inter-slot)     - DMRS design among PDCCH repetitions     - Search space design for PDCCH repetition   + Potential specification impacts of compact DCI include     - New DCI format with a small payload size     - Reuse existing format by fixing some DCI bits   + Potential specification impacts of AL greater than 16 in conjunction with an extended CORESET and AL12 for 1-symbol CORESET include     - Mechanism for codeword generation and mapping to CCEs     - New RRC signaling   + Potential specification impacts of increasing the CCE number for a PDCCH transmission via CORESET bundling include     - CORESET bundling configuration     - DMRS design among CORESET bundling   + Potential specification impacts of PDCCH-less include     - Mechanism for indicating scheduling information for SIB1 and/or SI message   + It is noted that some of the techniques may have compatibility issue if RedCap and normal UEs share the same initial DL BWP | |
|  |  |  |
| Xiaomi |  | * + - 1. Regarding the supported AL, AL=12 does not only exist in the case of 1 OFDM symbol case. For example, when the BW of one CORESET is 24 PRB and the OFDM duration is 3 symbols, then the maximum supported AL is 12 as well. And furthermore, considering AL=12 and AL larger than 16 are all new AL, So would like to use more general description to cover these two cases, for example, to update the description like “support new aggregation level”       2. For the description of “AL greater than 16 in conjunction with an extended CORESET, and increasing the CCE number for a PDCCH transmission via CORESET bundling”, if we understand correctly, increasing the AL is essential solution to improve coverage, while CORESET extension or CCE increasing via CORESET bundling is just the spec impact it may cause.   Thus, considering the bullet 2 and 3, we suggest the following update   * Capture the following to the TR 38.875   + Coverage recovery for broadcast PDCCH (PDCCH monitored in a Type0/0A/1/2-PDCCH CSS) was studied from several aspects, including PDCCH repetition, compact DCI, new AL ~~AL greater than 16 in conjunction with an extended CORESET, increasing the CCE number for a PDCCH transmission via CORESET bundling,~~ PDCCH-less mechanism for SIB1 and/or SI message, ~~AL12 for 1-symbol CORESET~~   + Potential specification impacts of PDCCH repetition include     - Repetition configuration (e.g. intra-slot or inter-slot)     - DMRS design among PDCCH repetitions     - Search space design for PDCCH repetition   + Potential specification impacts of compact DCI include     - New DCI format with a small payload size     - Reuse existing format by fixing some DCI bits   + Potential specification impacts of new AL ~~AL greater than 16 in conjunction with an extended CORESET and AL12 for 1-symbol CORESET include~~     - Mechanism for codeword generation and mapping to CCEs     - New RRC signaling     - Extended CORESET     - CORESET bundling   + ~~Potential specification impacts of increasing the CCE number for a PDCCH transmission via CORESET bundling include~~     - ~~CORESET bundling configuration~~     - ~~DMRS design among CORESET bundling~~   + Potential specification impacts of PDCCH-less include     - Mechanism for indicating scheduling information for SIB1 and/or SI message   It is noted that some of the techniques may have compatibility issue if RedCap and normal UEs share the same initial DL BWP |
| vivo | modifications | For broadcast PDCCH, we think the type-3 CSS can also be included, as type-3 CSS has the same issue if broadcast/group beam is used.  For “PDCCH-less mechanism for SIB1 and/or SI message” we prefer not to capture as it has been no discussion about its feasibility. For example, in LTE MTC, the indication is based on MIB but NR has much less spare bits (1bit available in FR2) than LTE, so it seems the LTE solution cannot be applied here. Secondly, there will be RAN2 impact for this proposal, it is not clear if RAN1 can consider it as feasible without RAN2 input. |
| ZTE |  | Regarding vivo’s concern on PDCCH less mechanism, we are fine to limit it only for FR1.  In Rel-13 MTC, 5 bits of the reserved bits in MIB are used to indicate {one TBS and one repetition factor} for SIB1-BR from the 6 candidates for TBS and 3 candidates for repetition factor, i.e., totally 18 combinations. Other scheduling information can be obtained implicitly. In NR Rel-15, reserved number of bits in MIB is 3bits for FR1 and 1bit for FR2. However, considering NR CE doesn’t require 15-20dB coverage enhancement in MTC, different repetition factors may be not needed for NR SIB1.Then, it would be feasible to use the 3 reserved bits in FR1 for TBS indication only. In FR2, only 1 bit could be used and more scheduling information should be determined implicitly. Though we think it is still feasible, we are also fine to leave it for FR2. |
| Futurewei | N | There are a number of ways that PDCCH coverage can be improved, as discussed, but based on the coverage results none of these may be needed.is not clear why we are proposing all these enhancements even though LB have shown not much is needed. If LB has shown that a lot of enhancements are needed then we may propose all these enhancements |
| Qualcomm |  | Fine with FL proposal |
| Ericsson |  | We are fine with Xiaomi’s suggestion of using “new AL” in the proposal.  Similar comment as what we have for “Updated proposal 5.1-1A”, we suggest revising the all the statements on specification impact to  “If XXX is introduced, the potential specification impacts include …” |
| CMCC |  | Fine with FL proposal. |
| Intel |  | Fine with FL proposal |
| Samsung |  | We suggest the following change due to:   * We don’t need to agree to define a new DCI format, a compact DCI might be enough. * RRC signaling is very general, and may not available before broadcast PDCCH. No need to explicitly mention it. We suggest to change it as “mechanism for indicating additional configuration(s) of the extended CORESET” * Agree to delete “COREST bundling” since COREST is frequency domain resource. But we think it can be further discuss on CORESET duration extension in time domain or search space bundling in time domain. * Need some clarification for how to achieve PDCCH-less.   + Potential specification impacts of PDCCH repetition include     - Repetition configuration (e.g. intra-slot or inter-slot)     - DMRS design among PDCCH repetitions     - Search space design for PDCCH repetition   + Potential specification impacts of compact DCI include     - ~~New~~ DCI format with a compact small payload size     - Reuse existing format by fixing some DCI bits   + Potential specification impacts of new AL ~~AL greater than 16 in conjunction with an extended CORESET and AL12 for 1-symbol CORESET include~~     - Mechanism for codeword generation and mapping to CCEs     - ~~New RRC signaling~~     - ~~Extended~~ CORESET duration extension     - [Search space bundling]     - ~~CORESET bundling~~   + ~~Potential specification impacts of increasing the CCE number for a PDCCH transmission via CORESET bundling include~~     - ~~CORESET bundling configuration~~     - ~~DMRS design among CORESET bundling~~   + Potential specification impacts of PDCCH-less include     - Mechanism or resource allocations for indicating scheduling information for SIB1 and/or SI message in L1 signal(s)/channel(s) other than PDCCH.   + It is noted that some of the techniques may have compatibility issue if RedCap and normal UEs share the same initial DL BWP |

## SSB and PRACH coverage recovery

Two contributions [14][21] proposed a shorter SSB period of 5ms or 10ms can be considered for coverage recovery. One contribution [1] stated that the “keep trying” method can be used for improving the coverage of SSB. The contribution [12] noted that PBCH repetition design for coverage recovery must consider SSB structure for different sub-carrier spacings and different RF frequency ranges.

One contribution [1] indicated that coverage recovery for PRACH can be supported by repeating random access attempts and using longer PRACH preambles, which may not require specification enhancements.

Since majority of companies do not observe the need of coverage recovery for PRACH and SSB, the moderator’s proposal is not to capture the candidate recovery solutions for PRACH and SSB

**Question 5.5-1: Companies are invited to provide views on whether to capture the candidate recovery solutions for PRACH and SSB. The proponent companies are invited to provide the input for the potential specification impact and the analysis of coexistence with legacy UE.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | From the representative values captured in section 3, there is no issue identified for SSB and PRACH. |
| Futurewei |  | No coverage recovery needed |
| Ericsson |  | No need to capture any candidate recovery solutions for PRACH and SSB. These two channels do not need coverage compensation. |
| CATT |  | No need for SSB and PRACH coverage recovery. |
| Samsung |  | We don’t see a need of coverage recovery for SSB and PRACH |
| LG |  | No need to capture the candidate solutions. |
| Huawei, Hisilicon |  | No coverage recovery needed. |
| **FL5** | No further proposal regarding coverage recovery for SSB and PRACH | |
| **vivo** | It would be useful to draw a conclusion, i.e. no coverage compensation for SSB and PRACH is needed for RedCap UEs, and capture it in the TR. | |
| **Futurewei** | Agree | |
| Ericsson | Agree | |
| Samsung | Y | |
| Intel | Y | |
| OPPO | Y | |
| LG | Y | |
| CATT | Y | |
| Nokia, NSB | Y | |
| FL6 | It will be concluded in section 3.5 | |

# Possible proposals for endorsement

**Proposals for capturing link budget evaluation results to the TR:**

|  |
| --- |
| **Further updated Proposal 3.1-1:**   * Capture the link budget evaluation results (Urban 2.6 GHz) in Table 3.1-1 to Table 3.1-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables   **Further updated Proposal 3.2-1:**   * Capture the link budget evaluation results (rural 0.7 GHz) in Table 3.2-1 to Table 3.2-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.   + MPL results to be included also. Up to editor to use the same or different tables.   **Further updated Proposal 3.3-1:**   * Capture the link budget evaluation results (Urban 4 GHz) in Table 3.3-1 to Table 3.3-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2, PRACH and DL PSD.   + MPL results to be included also. Up to editor to use the same or different tables.   **Further updated Proposal 3.4-1:**   * Capture the link budget evaluation results (indoor 28 GHz) in Table 3.4-1 to Table 3.4-3 in R1-2009660 to the Appendix of TR 38.875   + The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2, PRACH and UE maximum Tx power.   + MPL results to be included also. Up to editor to use the same or different tables |

**Proposals for capturing observations of coverage loss based on Option 3 to the TR:**

|  |
| --- |
| **Updated proposal 3.1-1A:**   * Adopted the updated TP in section 3.1 of R1-2009660 as baseline text for TR clause 9.1   + Remove “and coverage recovery is needed” from the TP   **Updated proposal 3.2-1A:**   * Adopted the updated TP in section 3.2 of R1-2009660 as baseline text for TR clause 9.1   + Remove “and coverage recovery is needed” from the TP   **Updated proposal 3.3-1A:**   * Adopted the updated TP in section 3.3 of R1-2009660 as baseline text for TR clause 9.1   + Remove “and coverage recovery is needed” from the TP   + Add the following sentence to the last paragraph of the TP     - It should be noted that for DL PSD 24 dBm/MHz and 1 Rx RedCap UE case Msg2 results are based on no TBS scaling |

# References

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

# Appendix –

## RAN1 agreements in 101e and 102

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| **RAN1 #101e**  Agreements: If/when coverage evaluations outside the CE SI are needed,   * The basic evaluation methodology is based on link-level simulation for FR1.   + ­Step 1: Obtain the required SINR for the physical channels under target scenarios and service/reliability requirements.   + ­Step 2: Obtain the baseline performance based on required SINR and link budget template.   + ­Note: aspects related to identifying target performance and coverage bottlenecks based on target performance metric is to be handled separately * The evaluation methodology for FR2 is the same as FR1.   Agreements: If/when link-level coverage evaluations outside the CE SI are needed,   * The CE SI link-level simulation assumptions can be used as a starting point. * For calibration purposes, the following settings can be used:  |  |  |  | | --- | --- | --- | | **Parameters** | **FR1 values** | **FR2 values** | | Scenario and frequency | Urban:  2.6 GHz (TDD) (primary choice)  4 GHz (TDD) (secondary choice)  Rural:  700 MHz (FDD) | 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 | TDL-C | TDL-A | | UE velocity | 3 km/h | 3 km/h | |  |  |  |   **RAN1 #102 e:**  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 [revised, see below]   Agreements: For link budget evaluation, the antenna gain loss due to the small form factor can be applied to all the FR1 bands   * For RedCap coverage analysis, the agreements in the Rel-17 CE SI regarding link budget template and antenna array gain are reused.   + Continue to discuss and decide the performance metric in RAN1-103 e-meeting   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, adopt 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   Agreements: For RedCap coverage evaluation, the Rel-17 CE SI agreements on gNB antenna configuration, # gNB Tx/Rx chains, 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  CDL-A(optional) | | Delay spread | 300ns | 30ns | | UE velocity | 3 km/h | 3 km/h | | Antenna correlation | Low | Low | | # gNB Tx chains | 2 or 4 | 2 | | # gNB Rx chains | 2 or 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.   * + Other UE BWs are not precluded  |  |  |  | | --- | --- | --- | | **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) |   Agreements: 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 (except for Msg2)/PUSCH for the RedCap UE are based on the agreed target data rates or message sizes and reported by companies   + Adopt the following table for Msg2 evaluation     - Note: the TBS scaling is not precluded in the table entry “PRBs/TBS/MCS”  |  |  | | --- | --- | | **Parameters** | **Values** | | PRBs/TBS/MCS | MCS is fixed to zero. Companies to report the used number of PRBs and corresponding TBS value | | PDSCH duration | 12 OS | | DMRS configuration | Type I, 3 DMRS symbol, no multiplexing with data | | Waveform | CP-OFDM | | HARQ configuration | No retransmission |   Agreements:   * 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 | 500m | 20m | | Scenario and frequency | Dense Urban:  2.6 GHz (TDD) (primary choice)  4 GHz (TDD) (secondary choice)  Other scenarios (e.g. Rural 700MHz) are not precluded. | 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 | Full buffer (Optional)  Non-full buffer traffic, e.g. FTP traffic model 3 for the reference NR UEs and the IM traffic model from TR 38.840 for RedCap UEs | | | Traffic load | Full buffer traffic (Optional):  10 users per cell including both RedCap and reference NR UEs  Non-full buffer traffic:  Low (e.g. <30%) and medium (e.g. 30%-50%) loading (resource utilization) | | | Percentage of RedCap UEs among total number of UEs  Note: Other UEs are the reference NR UEs | Full buffer traffic (Optional):  0, 20%, 50% (i.e. 0, 2 or 5 RedCap UEs per cell), 100% (as applicable)  Non-full buffer traffic:  0, 25%, 50%, 100% (optional, as applicable) | | |

## RAN1 agreements in 103e

Agreements**:**

* If coverage recovery target ~~performance requirement~~ is based on Option 1
  + Maximum pathloss loss (MPL) is used as the coverage evaluation metric
* If coverage recovery target ~~performance requirement~~ is based on Option 3
  + Maximum isotropic loss (MIL) is used as the coverage evaluation metric

Agreements:

* For Option 3, down-selection on the following alternatives for coverage recovery
  + Alt 1: A single coverage recovery target based on the same bottleneck channel is used for initial access channels and non-initial access channels of RedCap UE
  + Alt 2: Identify 2 coverage recovery targets for the RedCap UE initial access channels and non-initial access channels, respectively:
  + The 1st target is based on the bottleneck channel among the initial access channels of the reference NR UE
  + The 2nd target is based on the bottleneck channel among all the channels of the reference NR UE
  + Note: The initial access channels include at least PBCH, PRACH, Msg2, Msg3, Msg4 and PDCCH CSS

Agreements:

* Agree in principle using Option 3 for determining the coverage recovery target
  + Option 3: The coverage recovery target for each channel of RedCap UE corresponds to the link budget of the bottleneck channel(s) for the reference NR UE within the same deployment scenario
  + Note: The reference UE is a Rel-15/16 NR UE with mandatory features only
* FFS For Option 3, companies report their individual observations of the amount of compensation for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)
  + A representative value of the amount of compensation is derived by taking the mean value (in dB domain) from all the compensation values including both negative and non-negative values
    - Excluding the highest & the lowest values when the number of samples is more than 3
    - If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification
    - In this case, observations may still be drawn
  + The representative value of a channel is used for identifying whether the channel needs coverage recovery
    - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero

Agreements**:**

* For Option 3, companies report their individual observations of the amount of coverage loss for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)
  + A representative value of the amount of coverage loss is derived by taking the mean value (in dB domain) from all the compensation values including both negative and non-negative values
    - Excluding the highest & the lowest values when the number of samples is more than 3
    - If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification
    - In this case, observations may still be drawn
  + The representative value of a channel is used for identifying whether the channel needs coverage recovery
    - Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero
    - The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc

**Agreements:**

* Capture the following to the TR 38.875
  + Coverage recovery for Msg2 PDSCH was studied from several aspects, including TBS scaling [and Msg2 PDSCH repetition]
  + It is noted that TBS scaling is an existing technique mandatory for Rel-15 UE
  + Potential specification impacts of Msg2 PDSCH repetition (if supported) include
    - Msg2 PDSCH repetition configuration
    - Mechanism to differentiate enhanced UE and legacy UE, e.g., separate PRACH configurations (e.g, separate PRACH occasions or preambles)

Agreements:

* Capture the following to the TR 38.875
  + Coverage recovery for Msg4 PDSCH was studied from several aspects, including scaling factor for TBS determination, PDSCH repetition and the use of the lower-MCS table.
  + Some techniques, such as scaling factor for TBS determination and PDSCH repetition have been studied also in the Rel-17 coverage enhancement SI
  + Potential specification impacts of using the lower-MCS table for Msg4 PDSCH include
    - Related signaling design