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

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

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

**Title: Feature lead summary #6 on reduced PDCCH monitoring**

**Agenda item:** **8.6.2**

**Document for:** **Discussion and Decision**

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# 1 Introduction

Contributions made under the “reduced PDCCH monitoring” agenda item of the Rel-17 study item on “Study on support of reduced capability NR devices” as well as initial evaluation results in [29] were summarized in FL summary #1 (FLS1) in R1-2008471.

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

|  |
| --- |
| [103-e-NR-RedCap-03] Email discussion for reduced PDCCH monitoring– Hong (Apple)   * 1st check point: 10/29 * 2nd check point: 11/4 * 3rd check point: 11/10 * Last check point 11/12 |

This summary was organized based on the structure of latest TR 38.875 [1] to document the evaluation results of reduced PDCCH monitoring provided in Phase-2 post-102-e-meeting email thread [102-e-Post-NR-RedCap-01] into section 2. In addition, section 3 intends to discuss potential conclusions for this study item based on the finding in section 2.

Follow the naming convention in this example:

* RedCapPDCCHFLS2-v000.docx
* RedCapPDCCHFLS2-v001-CompanyA.docx
* RedCapPDCCHFLS2-v002-CompanyA-CompanyB.docx
* RedCapPDCCHFLS2-v003-CompanyB-CompanyC.docx

This version of document contains updated proposal tagged FL6.

# 8.2 Reduced PDCCH monitoring

## 8.2.1 Description of feature

In the Wednesday GTW session, the following was agreed for capturing the feature description

|  |
| --- |
| Agreements:   * To include description of the evaluated schemes #1/#2/#3 as in R1-2009370 to the TR   + Further discussion the detailed text proposal for these schemes   + Note: the description for scheme #1 is taken as a higher priority than #2/#3 |

One of concerns raised during GTW session is lack of the detail to achieve reduced maximum number of BD per slot by reducing the DCI size budget since the maximum number of BDs can still be configured even with reducing DCI size budget from ‘3+1’ to “2+1”. The revised proposals intend to address the concerns and to be added into TR for feature description.

**[FL4] Proposal 8.2.1-1**: **Capture the following feature descriptions into the TR 38.875**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| The following three reduced PDCCH monitoring schemes were studied and evaluated:  **Scheme #1: Reduced maximum number of Blind Decoding (BD) per slot**   * In Rel-15 and Rel-16 NR, the limits on maximum number of BDs per slot are defined for different SCS configurations, as summarized in Table 1. Scheme #1 is to reduce the maximum number of BDs in a slot. In Rel-15 and Rel-16 specifications, the total number of different DCI sizes configured to monitor is up to 4 with 3 for DCI sizes with C-RNTI and 1 for other RNTIs. Two options were studied under Scheme #1 with reduced number of DCI size (Scheme #1a) and without reduced number of DCI size (Scheme #1b) to achieve a same reduced number of BDs per slot.   Table 1: Blind decoding limits in NR.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **SCS [kHz]** | **15** | **30** | **60** | **120** | | **Max # BD per slot (in NR)** | 44 | 36 | 22 | 20 |   **Scheme #2: Extending the PDCCH monitoring span gap to X slots (X>1)**   * In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to limit the minimum PDCCH monitoring periodicity value to be X slots, where and keep the same maximum number of BDs in a slot as that in Rel-15/16.   **Scheme #3**: **Dynamic adaptation of PDCCH monitoring parameters**   * In Rel-15/16, the parameters of PDCCH monitoring is configured by RRC signaling on a per search space set basis. Scheme #3 is to dynamically adapt PDCCH monitoring parameters e.g. number of PDCCH candidates and time separation between two consecutive spans. |

**Please comments “Yes or no” per Scheme e.g. Scheme 1 or Scheme 2, …, or simply ‘Yes’ means ‘all’. If a particular scheme is generally ok but need some modifications on the exact wording, please provide modified wording in the ‘comments’ column.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | OK in general | For scheme#1, we prefer not to further split into 1a and 1b, since both of them are targeting BD reduction. Suggest the following revisions  **Scheme #1: Reduced maximum number of Blind Decoding (BD) per slot**   * In Rel-15 and Rel-16 NR, the limits on maximum number of BDs per slot are defined for different SCS configurations, as summarized in Table 1. Scheme #1 is to reduce the maximum number of BDs in a slot. In Rel-15 and Rel-16 specifications, the total number of different DCI sizes configured to monitor is up to 4 with 3 for DCI sizes with C-RNTI and 1 for other RNTIs. Two options were studied under Scheme #1, with reduced number of DCI sizes ~~(Scheme #1a)~~ and without reduced number of DCI sizes ~~(Scheme #1b)~~ to achieve a ~~same~~ reduced number of BDs per slot. |
| LG | Scheme #1 No  The others Yes | We don’t think it is essential to reduce the number of DCI sizes for the purpose of reducing the maximum number of BD per slot. There is no need to separate Scheme #1a and #1b. We think only Scheme #1b is Scheme #1 and there is no need to reduce the number of DCI sizes. |
| CATT | Y with some modification | For scheme#1, we are supportive to FL’s version except the wording ‘reduced number of DCI sizes’. It is a little bit confusing as the reduced number of DCI sizes can be put some restriction on the search space configuration, e.g. excluding some DCI formats or configure same payload size for different DCI formats. The intention here should be reduce the DCI budget. To be specific, we propose the following modification: Two options were studied under Scheme #1 with reduced ~~number of~~ DCI size budget (Scheme #1a) and without reduced ~~number of~~ DCI size budget (Scheme #1b) to achieve a same reduced number of BDs per slot.  For scheme#2, the corresponding description for scheme#2, i.e. the last sentence, is more like a restriction on the periodicity configuration. Furthermore, if URLLC PDCCH monitoring capability is supported, the total number of BD/CCE is defined per span. In the other words, the maximum number of BD/CCE per slot may be much larger than Rel-15. If the intention is to follow the per slot limit, Rel-15 limit is sufficient. |
| ZTE,sanechips | OK to scheme1  OK to scheme2  OK to scheme3 | Generally OK with scheme1. For scheme1, the total candidates under the AL distribution is an approximate value after 25% or 50% BDs reduction, which means the reduced number of BDs per slot may be different from each company,it is not the same. Therefore, we suggest to remove the “to achieve a same reduced number of BDs per slot” or adopt vivo’s modification.  Generally OK with scheme2, but we do think the  the maximum number of BDs should be defined in X slots instead of a slot. So, we suggest modify “and keep the same maximum number of BDs in a slot as that in Rel-15/16. ” as “and keep the same maximum number of BDs in X slots as that in Rel-15/16. ”  Generally OK with scheme3, but “time separation between two consecutive spans” is not clear and clarification is needed here. |
| Spreadtrum | OK in general | For scheme 1, there is no need to further split into Scheme1a and Scheme1b.  For scheme 3, it is more suitable for power saving WI. |
| Huawei, HiSilicon | Yes for Scheme#1;  Generally yes on Scheme#2 with slight revision;  Modification needed on Scheme#3; | 1. Scheme#1: We are fine with VIVO’s revision on scheme#1. 2. Scheme#2: We are generally fine with the description of Scheme#2, but we don’t need to mention the concept of ‘span’ here. Actually, we are not sure whether RedCap UE needs to support the concept of ‘span’. Let’s remove the word of ‘span’. Also, we think the Scheme#2 should be semi-statically configure the X slots for monitoring. Therefore, we suggest the change of “Scheme#2 is to ~~limit~~ configure the minimum PDCCH monitoring periodicity value to be X slots”.   Scheme#3: As we agreed in the last week, it would be fine to capture the description of Scheme#3 proposed/evaluated by companies. However, the current description of Scheme#3 is too general and can cover almost all Rel-16/Rel-17 power saving adaptation enhancements, which may be even not relevant with BD reduction. We should give clear description of the solutions for the TP. |
| Samsung | Yes with modifications | For scheme 1, we don’t think text regarding the two options are needed. For the evaluation results provided companies, the power saving gain is from BD scaling factor determined by PDCCH BD reduction rate only. It doesn’t matter how many DCI sizes are configured. The assumption of DCI sizes is just one configuration parameter, which is no different from the configured PDCCH candidates per AL.  Therefore, we suggest the following modification.  **Scheme #1: Reduced maximum number of Blind Decoding (BD) per slot**   * In Rel-15 and Rel-16 NR, the limits on maximum number of BDs per slot are defined for different SCS configurations, as summarized in Table 1. Scheme #1 is to reduce the maximum number of BDs in a slot. In Rel-15 and Rel-16 specifications, the total number of different DCI sizes configured to monitor is up to 4 with 3 for DCI sizes with C-RNTI and 1 for other RNTIs. The number of PDCCH candidates per AL and number of DCI sizes to monitor are restricted by the maximum number of BD per slot. ~~Two options were studied under Scheme #1 with reduced number of DCI size (Scheme #1a) and without reduced number of DCI size (Scheme #1b) to achieve a same reduced number of BDs per slot.~~   For Scheme #2, the PDCCH monitoring span gap is the separation between two PDCCH monitoring occasions regardless of SS set configuration. But, PDCCH periodicity is configuration parameter per SS set. The PDCCH monitoring periodicity is restricted by UE capability of minimum span gap. In addition, it’s not necessary to keep the same maximum BD numbers as Rel15/16. The maximum BD numbers can be same as Rel-17 values from Scheme #1.  Therefore, we suggest the following modifications.  **Scheme #2: Extending the PDCCH monitoring span gap to X slots (X>1)**   * In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to limit the span gap, i.e. the minimum separation between two consecutive ~~of~~ PDCCH monitoring ~~periodicity value~~ occasions, to be X slots, where and determine ~~keep~~ the ~~same~~ maximum number of BDs in a span ~~in a slot as that in Rel-15/16.~~   For Scheme #3, similar as Scheme #1 and Scheme 3, we think it should be focus on explicit adaptation on BD limit. And it is also necessary to avoid overlapping with the Rel-17 PS enhancement agenda.  Therefore, we suggest to clarify the applicable adaptive parameter as following:  **Scheme #3**: **Dynamic adaptation of PDCCH monitoring parameters**   * In Rel-15/16, the parameters of PDCCH monitoring is configured by RRC signaling on a per search space set basis. Scheme #3 is to dynamically adapt PDCCH monitoring parameters e.g. maximum number of PDCCH candidates per PDCCH monitoring occasion and minimum time separation between two consecutive ~~spans~~ PDCCH monitoring occasions. |
| Qualcomm | Yes | vivo and CAT’s modifications to scheme #1 make the wording more clear. |
| Ericsson | Scheme #1: Yes (partially)  Schemes #2, #3: No | Scheme #1 should be updated as follows:  **Scheme #1: Reduced maximum number of Blind Decoding (BD) per slot in connected mode**   * In Rel-15 and Rel-16 NR, the limits on maximum number of BDs per slot are defined for different SCS configurations, as summarized in Table 1. Scheme #1 is to reduce the maximum number of BDs in a slot. In Rel-15 and Rel-16 specifications, the total number of different DCI sizes configured to monitor is up to 4 with up to 3 for different DCI sizes with C-RNTI ~~and 1 for other RNTIs~~. Two options were studied under Scheme #1 with reduced number of DCI size (Scheme #1a) and without reduced number of DCI size (Scheme #1b) to achieve a same reduced number of BDs per slot. Note that the BD reduction can already be achieved by using existing Rel-15/16 mechanisms, for instance, by configuration of the number of PDCCH candidates per aggregation level and the number of DCI sizes to monitor.   The last sentence can be common for both Scheme #1 and Scheme #2, if Scheme #2 were to be captured in the feature description.  We also support LG’s and Spreadtrum’s views on reduced number of DCI sizes for Scheme #1.  In our view, we should prioritize capturing Scheme #1, in line with the agreements during the GTW session. |
| InterDigital | Y | We prefer to keep Scheme 3 in RedCap SI. |
| Nokia, NSB | Scheme #1: Yes Scheme #2: Yes  Scheme #3: No | For scheme 1, we support the removal of the text regarding the two sub-options as suggested by Samsung.  Scheme 3 needs rewording to justify why it is studied here rather than the Power Savings WI. |
| Intel | Scheme # 2, 3 Yes Scheme # 1 needs revision | We prefer CATT version.  We do not think the added note by Ericsson that by configuration BD reduction can be done is relevant here, since here we are only capturing description of schemes that can be different from Rel15/16. |
| Sharp | Scheme #1: Yes Scheme #2: Yes  Scheme #3: No | For Scheme #2, we agree with Samsung. |

**Summary of 4th round email discussions**

**On Scheme #1**, two responses indicated to remove the text regarding the two options. However, the feature description in technical report of study item targets to provide necessary information of each studied scheme so as to carefully justify the benefit, figure out the corresponding specification impacts of each scheme and facilitate the recommendation in conclusion section. This rule supposed to be followed by not only scheme 1, but also scheme 2 and 3. One response indicates to add one note at the end of scheme as “Note that the BD reduction can already be achieved by using existing Rel-15/16 mechanisms, for instance, by configuration of the number of PDCCH candidates per aggregation level and the number of DCI sizes to monitor”, which was against by another response. It is FL understanding that the scheme is to reduce the “maximum” number of BD, which cannot be achieved by Rel-15/Rel-16 signaling as it is hard-encoded in spec as upper bound.

In addition, Vivo/CATT revision is preferred by at least four responses [ZTE, Huawei, Qualcomm, Intel]. FL updated the proposal for scheme#1 based on vivo/CATT version, taking into account all other responses.

**[FL5]** **Proposal 8.2.1-1: Capture the following feature description for Scheme #1 in the TR:**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scheme #1: Reduced maximum number of Blind Decoding (BD) per slot**  In Rel-15 and Rel-16 NR, the limits on maximum number of BDs per slot are defined for different SCS configurations, as summarized in Table 1. Scheme #1 is to reduce the maximum number of BDs in a slot. In Rel-15 and Rel-16 specifications, the total number of different DCI sizes configured to monitor is up to 4 with up to 3 for different DCI sizes with C-RNTI ~~and 1 for other RNTIs~~. Two options were studied under Scheme #1 with reduced DCI size budget and without reduced DCI size budget to achieve a reduced number of BDs per slot.  Table 1: Blind decoding limits in NR.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **SCS [kHz]** | **15** | **30** | **60** | **120** | | **Max # BD per slot (in NR)** | 44 | 36 | 22 | 20 | |

**Is the proposed note by one response can be added for Scheme #1? i.e. “Note that the BD reduction can already be achieved by using existing Rel-15/16 mechanisms, for instance, by configuration of the number of PDCCH candidates per aggregation level and the number of DCI sizes to monitor”**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| OPPO | Y(partially) | We are open for capturing the 2 alternative of Scheme #1. But definitely do not want to mix them. The newly proposed text seems to be a bit vague.  Please note for the BD reduction, we are considering fixed limitation for RedCap UE capability. The BD limit is not done by the gNB configuration, one reason is the power saving is purely out of control of UE, another reason is the UE have to prepare “Higher” processing power as Normal UE. In the end there is no reason for special benefit by always looking at this configurability way.  For DCI budget reduction, it is not a capability definition. We assume this would be more reasonable to be configured. If we going to introduce DCI budget limit in to RedCap capability, special procedure should be defined in 38.212 7.3.1.0 DCI size alignment. The condition will be changed to like “different DCI sizes configured to monitor is up to 3 with up to 2 for different DCI sizes with C-RNTI”.  Thus, we consider the last sentence to be:  Two alternatives were studied under Scheme #1:  1a. Reduced UE capability of BD limits.  1b. Reduced UE DCI size budget by gNB configuration.  Then, in this sense, the additional notes proposed would be applicable for 1b.  **“Note that the DCI size budget reduction can already be achieved by using existing Rel-15/16 mechanisms, for instance, by configuration of the number of PDCCH candidates per aggregation level and the number of DCI sizes to monitor”** |
| Samsung | N | The note is about RRC reconfiguration of search space sets, which is not relevant to Scheme #1. Scheme #1 focus on the **maximum** number of BDs that limits the actual number of PDCCH candidates per aggregation level and the number of DCI sizes to monitor.  Also, we still have concern about the two options. The DCI size budget only limits the configured DCI sizes rather than maximum BDs. We understand it may be necessary to help reduce PDCCH blocking rate. It can be captured or discussed in PDCCH blocking observations if necessary. However, we don’t think it’s an option to reduce the maximum BDs per slot. |
| Huawei, HiSilicon | Y | We are OK with Moderator’s proposal, which is already as a compromise.  Some response to OPPO’s comment, we cannot agree the argument that BD reduction is UE capability but DCI size budget is not. DCI size budget is also a UE capability specified in 38.212: UE is not expected to handle a configuration that, after applying the above steps, results in the total number of different DCI sizes configured to monitor is more than 4 for the cell. DCI size budget cannot be configured, and it is hard coded in specification 38.212.  Some reply to Samsung regarding the DCI size budget reduction, the current description does not mean DCI size budget reduction is a replacement of BD reduction. There are two options, one is BD reduction without DCI size budget reduction and the other one is BD reduction with DCI size budget reduction to minimize the impact on PDCCH blocking rate. We don’t see any reason to block companies to capture the technical description of options. Otherwise, there is nothing meaningful compared with SID description. |
| Intel | Y, with some revision | The word “same” seems to be missing. This is to ensure that both schemes are targeting a common reduced BD numbers per slot.  Two options were studied under Scheme #1 with reduced DCI size budget and without reduced DCI size budget to achieve a same reduced number of BDs per slot |
| vivo | Y | We support the proposal. There is no essential need to further split scheme 1 into 1a and 1b.  Regarding the “same”, we think it would be too restrictive, as it is not necessary that the two options has to provide exact the same BD number. |
| Sharp | Y |  |
| Nokia, NSB | Y |  |
| CATT | Y |  |
| LG | Y | We are fine with adding the note.  On the other hand, we have a similar view with Samsung regarding reduced DCI size budget. The DCI size budget is not directly related to maximum BDs. Only a few companies brought the results with reduced DCI size budget and it even show negligible power saving gain compared to the results without reduced DCI size budget. Thus, Scheme #1 should be reduced maximum BD limit without reduced DCI size budget. DCI size budget reduction can only be an additional condition to reduce blocking probability if necessary. |
| Spreadtrum | Y | We are OK with Moderator’s proposal. |
| ZTE,sanechips | Partially Yes | Generally, Yes to capture feature description and No to add the note.   1. The note should not be added, since the maximum limit can not be configured by RRC, which means the maximum limit can not be achieved by configuration of the number of PDCCH candidates per aggregation level and the number of DCI sizes to monitor 2. It is better to modify the sentence “the total number of different DCI sizes configured to monitor is up to 4 with up to 3 for different DCI sizes with C-RNTI” as “the total number of different DCI sizes configured to monitor is up to 4 with up to 3 different DCI sizes with C-RNTI”. 3. Regarding the two options, we do not think there is a necessity to further limit the reduction method, e.g.,by gNB configuration, UE capability or others, since the actual simulation does not indicate the method details which can be discussed in the WI stage. |
| Qualcomm | Y |  |
| InterDigital | Y |  |
| Futurewei | Y |  |
| Ericsson | Y | In our view it is important to emphasize that the BD reduction can already be achieved by existing network configurations. We also think that the note fits well in the above description as it also captures different options for BD reduction.  It can also be clarified that the feature is a connected mode feature by updating the heading as “Reduced maximum number of Blind Decoding (BD) per slot in connected mode”. |
| MediaTek | Y with the note | It is essential to have the note as it reflects the existing approach for controlling the BDs.  We also agree with Samsung’s comment that the DCI size budget only limits the configured DCI sizes rather than maximum BDs. |

**[FL6]** **Proposal 8.2.1-1: Capture the following feature description for Scheme #1 in the TR:**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scheme #1: Reduced maximum number of Blind Decoding (BD) per slot in connected mode**  In Rel-15 and Rel-16 NR, the limits on maximum number of BDs per slot are defined for different SCS configurations, as summarized in Table 1. Scheme #1 is to reduce the maximum number of BDs in a slot. In Rel-15 and Rel-16 specifications, the total number of different DCI sizes configured to monitor is up to 4 with up to 3 different DCI sizes with C-RNTI. Two alternatives were studied under Scheme #1, which includes reduced maximum number of BDs per slot with additionally reduced DCI size budget (Alt.1a) and reduced maximum number of BDs per slot without reduced DCI size budget (Alt.1b).  Table 1: Blind decoding limits in NR.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **SCS [kHz]** | **15** | **30** | **60** | **120** | | **Max # BD per slot (in NR)** | 44 | 36 | 22 | 20 | |

**When commenting, please provide details about what modification is needed in order to add it into TR to make progress, instead of only raising your concerns. Thanks!!**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y | We prefer not to explicitly separate alt.1a/1b, but can accept if there is majority view to separate them. |
| Qualcomm | Y |  |
| Intel | Y | We are Ok to accept this for sake of progress if there is majority support/interest. In our view, Scheme 1 just targets to achieve a reduced maximum number of BDs per slot which can be obtained either with Rel15 DCI format size budget (a.k.a without reduced DCI format size budget) or with a reduced DCI format size budget, but we can accept this version in light of the fact that reducing DCI format size budget would be helpful in reducing *the need for larger numbers of BDs*, in addition to reducing UE complexity. |
| Samsung | Y | Although we think reduced DCI size budget helps mitigating PDCCH blocking, and the benefit is common to Scheme #1, #2, and #3, we are fine if the majority prefer to capture it under Scheme #1. |
| Futurewei | Y | Minor editorial comment: “Scheme #1 reduces the maximum number of BDs in a slot.” |
| InterDigital | Y |  |
| Ericsson | With modifications | We are fine with capturing the above description, if the following sentence is added at the end: “These two alternatives can be enabled by using existing Rel-15/16 mechanisms, for instance, by configuration of the number of PDCCH candidates per aggregation level and/or the number of DCI sizes to monitor”. |
| Lenovo, Motorola Mobility | Y | Fine with the proposal. |
| CATT | Y |  |
| LG | Y with modifications | We think Scheme #1 should not be separated into Alt.1a and Alt.1b, however, we are okay if the majority prefer to separate them.  We agreed with Ericsson’s modification. |
| Huawei, HiSilicon | Y | We are fine with the description. |

**[FL5]** **Proposal 8.2.1-2: Capture the following feature description for Scheme #2 in the TR:**

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| **Scheme #2: Extending the PDCCH monitoring gap to X slots (X>1)**   * In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to configure the gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasions) to be X slots, where and reduce the maximum number of BDs in X slots. |

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| OPPO | Y(patrially) | Now we looked the Scheme #2 as also a BD reduction of Scheme #1. The gap can be configurable. But seems the UE still need to support like 1 slot mini gap(for initial access or so). The only different is when the gap increase the capability of BD should have corresponding different.  I suggest to clarify: “reduce the maximum capable number of BDs in X slots” |
| Samsung | Y with modification | The last sentence, “reduce the maximum number of BDs in X slot”, is not clear and also confusing. If we follow the principle in Rel-16, the maximum number of BDs is defined per span, i.e. PDCCH monitoring occasion, not span gap. So we suggest modification below.  **Scheme #2: Extending the PDCCH monitoring gap to X slots (X>1)**  In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to configure the gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasions) to be X slots, where and ~~reduce~~ the maximum number of BDs ~~in X slots~~ in a PDCCH monitoring occasion is reduced. |
| Huawei, HiSilicon | Y(partially) | For the last sentence, we don’t think there is a definition of “maximum number of BDs in X slots, X>1”. The maximum number of BDs is defined for a slot in current specification. Therefore, for the last sentence of “reduce the maximum number of BDs in X slots.”, we think the description in FL4 is better and clearer:  “**and keep the same maximum number of BDs in a slot as that in Rel-15/16**” |
| Intel | Neutral | We are not sure this scheme is within scope |
| vivo | Y with modifications | Our understanding of scheme #2 is to increase the minimum configurable gap for PDCCH monitoring, we suggest a slightly change as the following  **Scheme #2: Extending the PDCCH monitoring gap to X slots (X>1)**   * In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to increase the minimum configurable ~~the~~ gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasions) to be X slots, where and reduce the maximum number of BDs in X slots. |
| Sharp | Y | Agree as it is. |
| Nokia, NSB | Y |  |
| CATT | Y with modifications | Share the similar with Samsung and HW that the last sentence is confusing. HW’s revision is preferred. Furthermore, gap is pretty confusing as it is currently defined for span, which is in terms of several symbols. From our perspective, PDCCH monitoring periodicity instead of gap is more accurate. |
| LG | Y, partially | Agreed with Samsung, Huawei and CATT.  The maximum number of BDs in X slots is unclear. |
| ZTE,sanechips | Yes | We are fine with the FL proposal.  From our understanding, the word “configurable” actually contains the increased gap, so we don’t think we need to add the redundant “increase the minimum”.  Additionally, X slots actually means the difference with scheme1, which is just based on one slot. And we don’t need to replace “X slots” as “a PDCCH occasion”, because whether to define the PDCCH on X slots can be discussed in the WI stage. Therefore, the last sentence “and reduce the maximum number of BDs in X slots” is fine. |
| Qualcomm | Y |  |
| InterDigital | Y |  |
| Futurewei | Y | Agree with the suggested changes |
| Ericsson | Y, partially | We think “reduce the maximum number of BDs in X slots” can be further clarified, assuming the intention here is to capture that maximum number of BDs per slot, on average, reduces in X slots. We also support the adding the sentence mentioned in the response from Huawei/HiSilicon.  In our view, a similar note to Scheme #1 can be captured here as well: “Extending the PDCCH monitoring gap to X slots can be achieved by using existing Rel-15/16 mechanisms”.  We also suggest adding “in connected mode” in the title of Scheme #2. |
| MediaTek | With changes | A note should be captured as well similar to scheme#1. The UE can be configured with PDCCH monitoring periodicity that is larger than 1 slot. |

In FL understanding, one of alternative of scheme 2 is to specify maximum number of BDs over X slots, e.g. 2 slots, which is smaller than that in Rel-15. For example, maximum number of BDs over 2 slot maybe reduced to 72 from Rel-15 88 BDs (=44 per slot x 2 slots). FL tries to reflect this in the last sentence to keep ‘X slots’ and ‘on average’.

**[FL6]** **Proposal 8.2.1-2: Capture the following feature description for Scheme #2 in the TR:**

|  |
| --- |
| **Scheme #2: Extending the PDCCH monitoring gap to X slots (X>1) in connected mode**   * In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to increase the minimum configurable gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasions) to be X slots, where . The maximum capable number of BDs in a PDCCH monitoring occasion on average is reduced in X slots compared to Rel-15. |

**When commenting, please provide details about what modification is needed in order to add it into TR to make progress, instead of only raising your concerns. Thanks!!**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y with modifications | For the last sentence, we think there is no need to mention PDCCH monitoring occasion, we agree with the comment from Ericsson and FL before about the interpretation of scheme#2. A hopefully clearer version for the last sentence is suggested as below for consideration:  On top of Rel-15 BD limit M per slot, a maximum capable number of BDs per X slot is defined as N, and N<M\*X to achieve average BD reduction across X slots. |
| Qualcomm | Y | This essentially configures a sparse PDCCH monitoring. Whether additional BD limit per multiple slots is defined should be FFS and hence should not be captured in TR. Our preference is not to define the additional BD limit per multiple slots. |
| Intel |  | The current last sentence is not clear. Vivo’s version for the last sentence seems clearer, although the phrase “capable number of BDs” does not seem very appropriate. If we pursue this scheme, the requirements will be updated accordingly, and thus, what is implied by use of “capable” is not clear. This could simply say “max number of BDs per X > 1 slots”. |
| Samsung | Y with modification | We think “minimum configurable gap” is not needed. For some example, the minimum gap could be UE reported PDCCH monitoring capability, which is not configurable. Also, it’s better to use “extend” instead of “increase”, to keep same wording as the title.  So, we suggest the following modifications.  In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to increase extend the minimum configurable gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasions) to be X slots, |
| Futurewei | Y | Same minor editorial as first comment: “Scheme#2 increases…”  Capture in a note that scheme#2 may not be within the scope of WID |
| InterDigital | Y |  |
| Ericsson | With modifications | In our view, the following statement should be captured: “Extending the PDCCH monitoring gap to X slots can be achieved by using existing Rel-15/16 mechanisms”. |
| CATT | Y with modifications | The last sentence is not clear to us. The maximum number of BD is defined within the basic time-domain transmission unit, i.e. per slot or per span. The proposed sentence seems to introduce a more advanced capability for UE which is against the objectives in SID, which is shown below:  Reduced PDCCH monitoring by smaller numbers of blind decodes and CCE limits  It should be noted that the blind decodes and CCE limits are well defined in the current specification. The last sentence has the risk that the BD and CCE limit in a slot can be larger than the existing ones.  From this perspective, we think the wording proposed by HW in the last round discussion is more suitable, i.e. ‘The maximum capable number of BDs **in a slot keeps the same maximum number of BDs in a slot as that in Rel-15/16**’ |
| Sharp | Y | Agree with vivo. |
| LG | Y with modifications | We suggest a note that scheme#2 may not be in the scope and can be achieved by using existing Rel-15/16 mechanisms. |
| Huawei, HiSilicon | Y with modification | Share similar view with Qualcomm and CATT. |
| Fraunhofer | Y with modifications | In principle we are fine with vivo’s proposed last sentence. However, as Intel mentioned the term “maximum capable” for N seems unclear to us and should be replaced by a more appropriate solution. |
|  |  |  |

For Scheme#3, three responses indicate to not capture it into TR as cited above. Hence, FL suggest comments focus on the concrete concern on the exact wording, instead of general comment about the need or not.

**[FL5]** **Proposal 8.2.1-3: Capture the following feature description for Scheme #3 in the TR:**

|  |
| --- |
| **Scheme #3**: **Dynamic adaptation of PDCCH monitoring parameters**   * In Rel-15/16, the parameters of PDCCH monitoring is configured by RRC signaling on a per search space set basis. Scheme #3 is to dynamically adapt PDCCH monitoring parameters e.g. maximum number of PDCCH candidates per PDCCH monitoring occasion and minimum time separation between two consecutive PDCCH monitoring occasions. |

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| OPPO | N | We also think not to capture the Scheme #3. Most of companies assume it is not in the scope and can be taken in other WI. Only very few company study it here and would be misleading.  Also, the text after e.g. is even too detail. |
| Samsung | Y | We are generally fine with the description. But to address the concern about the overlapping with Rel-17 PS, we suggest to limit the adaptation to PDCCH BD. For Rel-17 PS, they consider much broad PDCCH adaptation granularity, e.g. search space switching.  Also, additional description can be provided to elaborate how the scheme works, and the differences from static schemes.  Therefore, we suggest modifications below.  **Scheme #3**: **Dynamic adaptation of PDCCH ~~monitoring parameters~~ Blind Decoding (BD)**  In Rel-15/16, the parameters of PDCCH monitoring is configured by RRC signaling on a per search space set basis. Scheme #3 is to dynamically adapt PDCCH ~~monitoring~~ BD parameters e.g. maximum number of PDCCH candidates per PDCCH monitoring occasion and minimum time separation between two consecutive PDCCH monitoring occasions. For example, to address real-time traffic variations on a cell or for a UE while accounting for blocking, a gNB can indicate reduced/full PDCCH BD on the cell to the UE when traffic is low/high. |
| Huawei, HiSilicon | N | Current wording of S3 is just to introduce dynamic adaptation of Scheme#1 and Scheme#2. In this sense, we don’t think it is needed to capture this. It would leave to work item phase to decide whether dynamic adaptation is needed. Furthermore, it is needed to justify the additional power saving gain of dynamic adaptation. |
| Intel | Neutral | We are not sure this scheme is within scope |
| Nokia, NSB | N |  |
| CATT | Y | Our understanding is that capturing above descriptions in TR does not necessarily means we have to study it under RedCap session. It just provides information what we studied during RedCap SI. From this perspective, we are OK to capture it in the TR. For the last sentence, i.e., ’ minimum time separation between two consecutive PDCCH monitoring occasions’, it is misleading as ‘minimum time separation’ is meaningless for a search space set considering a SS only have one periodicity. ‘PDCCH monitoring periodicity’ make more sense. |
| LG | N | We don’t see the difference with PDCCH monitoring adaptation being discussed in power saving WI. |
| Spreadtrum |  | It is more suitable for power saving WI. |
| ZTE,sanechips | Yes | We think “minimum time separation” in scheme2 and the “minimum separation” scheme3 shall be kept consistent. |
|  |  |  |
| Qualcomm | Y |  |
| InterDigital | Y |  |
| Futurewei |  | We do not see scheme 3 as within the scope. We are okay to capture it with a note to indicate that scheme 3 is not explicitly within the scope |
| Ericsson | N | Agree with Futurewei. Also, in our understanding, similar schemes as Scheme #3 are also being considered in the Rel-17 power saving WI. So, we should not prioritize capturing Scheme #3, which is also in line with the agreements during the GTW session. |
| MediaTek | N | This could be considered (if not already) in Rel-17 power saving WI. |

As commented by one response [CATT], the intention of capturing scheme 3 here is just to provide information as we already captured the evaluation results into TR. Whether or not to recommend for work item phase is totally separate discussions. Please focus on the wording, instead of need of this scheme.

**[FL6]** **Proposal 8.2.1-3: Capture the following feature description for Scheme #3 in the TR:**

|  |
| --- |
| **Scheme #3**: **Dynamic adaptation of PDCCH ~~monitoring parameters~~ Blind Decoding (BD) in connected mode**  In Rel-15/16, the parameters of PDCCH monitoring is configured by RRC signaling on a per search space set basis. Scheme #3 is to dynamically adapt PDCCH ~~monitoring~~ BD parameters e.g. maximum number of PDCCH candidates per PDCCH monitoring occasion and minimum time separation between two consecutive PDCCH monitoring occasions. For example, to address real-time traffic variations on a cell or for a UE while accounting for blocking, a gNB can indicate reduced/full PDCCH BD on the cell to the UE when traffic is low/high. |

**When commenting, please provide details about what modification is needed in order to add it into TR to make progress, instead of only raising your concerns. Thanks!!**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | Y | Note that in TS 38.213, a monitored PDCCH candidate is equivalent to a blind decode per email discussion in PDCCH session (in “[92b-NR-02-213] draft CR to 38.213 - update 1” in May 2018). It is better to clarify whether the PDCCH candidate in this FL refers to the number of PDCCH candidates configured in search space set configuration or refers to BD in this sentence “adapt PDCCH ~~monitoring~~ BD parameters e.g. maximum number of PDCCH candidates per PDCCH monitoring occasion”. |
| Intel |  | We are generally fine to capture the description, however, the last sentence seems more of an observation or motivation, and not quite suitable as part of feature description. Suggest to delete this sentence. |
| Samsung | Y |  |
| Futurewei | Y | Capture in a note that it may not be within scope of SID |
| InterDigital | Y |  |
| Ericsson | Y | We suggest adding “-related parameters”:  **Dynamic adaptation of PDCCH Blind Decoding (BD)-related parameters in connected mode**  Although we are not convinced on the potential power saving benefits of the above scheme (on top of other schemes), we are okay to capturing the above description for the sake of making progress. |
| Lenovo, Motorola Mobility | Y |  |
| CATT |  | Share same views as Intel. |
| LG | Y | We suggest a note that Scheme#3 may not be in the scope. |

|  |  |  |
| --- | --- | --- |
| Huawei, HiSilicon | Y | Generally fine. We are also OK with Ericsson’s revision.  Regarding the last added example, we share similar view with Intel and CATT. However, as compromise, if we decide to capture it, we don’t think we should capture the purpose and suggest just capture the gNB indication part.  “For example, ~~to address real-time traffic variations on a cell or for a UE while accounting for blocking,~~ a gNB can indicate reduced/full PDCCH BD per slot on the cell to the UE when traffic is low/high.” |
| Fraunhofer | Y |  |
|  |  |  |

## 8.2.2 Analysis of UE power saving

**[FL5] Q 8.2.2-1: In addition to observations agreed in GTW session, what other observations need to be added into TR 38.875 for power saving gain for FR1 and FR2? Please briefly explain why, if propose to add new observations. Companies views on the following two observations proposed by one response [Ericsson] can be provided in ‘Comments’ column.**

|  |
| --- |
| * Most sources only considered only DL-only traffic in their evaluations. One source has also considered 50% DL and 50% UL traffic for VoIP. The power saving gains in this case were observed to be less than that of the DL-only case. * Scheme #1 can already be achieved by proper configuration by the network using existing Rel-15/16 configuration parameters. |

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| OPPO | N | The results already give individual case. |
| Samsung | N |  |
| Intel | N | Scheme # 1 is particularly about reduced BD/CCE limits compared to those in Rel15/16. We do not see the relevance of the second bullet here. |
| vivo | N | For bullet #1, all the results have already been captured in the table with several Notes clarifying the key different assumptions. There is no need to additionally draw observation according to the results from individual source, otherwise, there will be endless proposals and discussions.  For bullet #2, the scheme#1 is to reduce the BD budget that UE is able to support, which is hardcoded in Rel-15/16 specifications and cannot be adapted by the network. |
| Huawei, HiSilicon | N | 1. For the first observation, we see some companies also provide results with different UL and DL configurations. We don’t think we need a separate observation based on each UL/DL configurations. 2. We provide the observations regarding the power saving gain due to the BD reduction. We think the second observation is not relevant here. |
| LG | N |  |
| ZTE,sanechips | N |  |
| Qualcomm | N | In bullet 1, there is no need to highlight the DL vs. DL-UL hybrid as DL-UL hybrid is not mandatory evaluation and it is already captured in evaluation result tables.  Bullet 2 is misleading. As long as BD limit is reduced or other PDCCH adaptation is adopted, it has to be enabled by network configuration. The key point is whether network can guarantee to do it.  Both bullets should be removed. |
| Futurewei | N |  |
| Ericsson | Y | The UL state has a considerable impact on the power saving gain and, hence, it should not be ignored. Therefore, we believe the first bullet is an important observation to capture in the TR in order to make a fair determination of the power saving benefits of Scheme #1.  Minor edit: “Most sources only considered DL-only traffic in their evaluations”. |

## 8.2.3 Analysis of performance impacts

The performance impacts study evaluation includes impacts of PDCCH blocking probability, latency and scheduling flexibility.

### 8.2.3.1 PDCCH Blocking probability

The PDCCH blocking probability is defined as the probability that all PDCCH candidates for a UE are blocked/overlapped with candidates used by other UEs, which is ratio between the number of the blocked UEs over the number of all UEs that need to be scheduled.

Many contributions pointed out that PDCCH blocking probability depends on various factors.

* CORESET size
* DCI format sizes
* Number of UEs needs to be scheduled simultaneously in a MO (this depends on traffic model)
* Aggregation Level (AL) distributions for AL [1,2,4,8,16].
* Number of PDCCH candidates

These factors should be carefully considered for PDCCH blocking probability analysis to ensure meaningful findings were used for Redcap devices study, taking into account the unique characteristic of Redcap devices e.g. light load, relaxed latency etc.

In the post email thread [102-e-Post-NR-RedCap-01], the following was agreed as evaluation assumptions for PDCCH blocking probability evaluation:

**Table 6 : Baseline parameters for the PDCCH blocking rate evaluation**

|  |  |
| --- | --- |
| **Parameters** | **Assumptions** |
| SCS/BW | FR1: 30KHz/20MHz; 15kHz/20MHz is optional FR2: 120KHz/[100]MHz |
| CORESET duration | 2 symbols, with 3 symbols optional |
| DCI size | 40 bits (Not including CRC) |
| Delay toleration (Slot) | 1 (1: implies that PDCCH is blocked if it can’t be scheduled in the given slot), with 2 optional |
| Note 1: “Number of users” represents the number of UEs that need to be scheduled simultaneously in a slot and company can provide PDCCH blocking probabilities corresponding to a range of ‘number of users’ on different rows in Tab-7 | |

Contribution [6] studied the percentage of number of UE scheduled per slot for Uma (2.6GHz) scenario. The results were reported as follows. It was observed in [6] that the number of simultaneously scheduled UEs per slot is no more than 3 in nearly 99.6% cases, rarely 4 or 5 in the simulated case.

Table 7: Percentage of number of UE scheduled per slot for Uma (2.6GHz) scenario [6].

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Percentage of number of UE scheduled per slot** | **Number of scheduled UE per slot** | | | | | **System blocking probability**  **When the total CCE number is 16 (i.e. 30KHz and 2-symbol PDCCH) and 50% BD reduction** |
| 0 | 1 | 2 | 3 | 4 |
| Medium Loading (N=12, M=0), 1 Rx RedCap | 52.4% | 37.6% | 7.8% | 1.8% | 0.4% | 0.400% |
| Medium Loading (N=12, M=4), 1 Rx RedCap | 48.3% | 41.1% | 8.2% | 1.9% | 0.4% | 0.419% |
| Medium Loading (N=12, M=12), 1 Rx RedCap | 43.2% | 44.9% | 9.3% | 2.0% | 0.4% | 0.464% |
| Medium Loading (N=12, M=0), 2 Rx RedCap | 53.2% | 37.3% | 7.5% | 1.6% | 0.3% | 0.372% |
| Medium Loading (N=12, M=4), 2 Rx RedCap | 50.4% | 39.5% | 7.8% | 1.8% | 0.4% | 0.400% |
| Medium Loading (N=12, M=12), 2 Rx RedCap | 43.5% | 44.4% | 9.3% | 2.2% | 0.5% | 0.481% |

The following PDCCH AL distributions of AL [1,2,4,8,16] were evaluated by companies in Phase 2 of email thread [102-e-Post-NR-RedCap-01]:

Table 8: PDCCH AL distributions of AL [1,2,4,8,16], FR1 and FR2

|  |
| --- |
| PDCCH AL distributions of AL [1,2,4,8,16] |
| * Configuration 1 (A1): [0.5, 0.4, 0.05, 0.03, 0.02], assuming majority of the UEs are in is good coverage * Configuration 2 (A2): [0.1, 0.2, 0.4, 0.2, 0.1]: Majority of the UEs are in medium coverage * Configuration 3 (A3): [0.05, 0.05, 0.2, 0.3, 0.4]: Majority of the UEs are in poor coverage * Configuration 4 (A4): [0.3 0.5 0.1 0.06 0.04] * Configuration 5 (A5): [0.4 0.45 0.08 0.04 0.03] * Configuration 6 (A6): [0.2 0.55 0.14 0.06 0.05] * Configuration 7 (A7): [0.4 0.3 0.2 0.05 0.05] |

In addition, a set of number of PDCCH candidates for AL [1,2,4,8,16] were evaluated as summarized In Table 9:

Table 9: Number of PDCCH Candidates for AL [1,2,4,8,16]

|  |  |  |  |
| --- | --- | --- | --- |
|  | Without BD reduction | Approximately 25% reduction in BDs | Approximately 50% reduction in BDs |
| FR1 | * Configuration 1: [6, 6, 2, 2, 2] * Configuration 2: [6, 5, 4, 2, 1] * Configuration 3: [6, 4, 4, 2, 2] * Configuration 4: [18, 0, 0, 0, 0], [0, 9, 0, 0, 0], [0, 0, 4, 0, 0], [0, 0, 0, 2, 0], [0, 0, 0, 0, 1] * Configuration 5: [6, 6, 2, 2, 1] * Configuration 6: [16, 8, 4, 2, 1] * Configuration 7: [8, 6, 2, 2, 2] * Configuration 8: [2, 4, 8, 4, 2] * Configuration 9: [2, 2, 4, 6, 8] * Configuration 10 [16,14,8,4,2] | * Configuration 1: [5, 5, 1, 1, 1] * Configuration 2: [4, 3, 3, 2, 1] * Configuration 3: [6, 4, 1, 1, 1] * Configuration 4: [2, 4, 4, 2, 1] * Configuration 5: [1, 4, 4, 2, 2] * Configuration 6: [4, 4, 2, 2, 1] * Configuration 7: [13, 0, 0, 0, 0], [0, 9, 0, 0, 0], [0, 0, 4, 0, 0], [0, 0, 0, 2, 0], [0, 0, 0, 0, 1] * Configuration 8: [5,3,3,1,1] * Configuration 9: [11, 8, 2, 1, 1] * Configuration 10: [5, 4, 2, 2, 2] * Configuration 11: [1, 3, 7, 3, 1] * Configuration 12: [1,1,4,4,6] * Configuration 13: [13,11,6,2,1] * Configuration 14: [5 3 2 2 1] | * Configuration 1: [3, 3, 1, 1, 1] * Configuration 2: [3, 2, 2, 1, 1] * Configuration 3: [5, 1, 1, 1, 1] * Configuration 4: [1, 2, 4, 1, 1] * Configuration 5: [1, 1, 3, 2, 2] * Configuration 6: [9, 0, 0, 0, 0], [0, 9, 0, 0, 0], [0, 0, 4, 0, 0], [0, 0, 0, 2, 0], [0, 0, 0, 0, 1] * Configuration 7: [6 6 2 2 1] * Configuration 8: [8 4 1 1 1] * Configuration 9: [4,3,1,1,1] * Configuration 10: [1,1,5,2,1] * Configuration 11: [1,1,2,3,4] * Configuration 12: [9, 8, 3, 1, 1] * Configuration 13: [2 2 2 2 1] |
| FR2 | * Configuration 1: [4, 3, 1, 1, 1] * Configuration 2: [1,2,4,2,1] | * Configuration 1: [2, 2, 1, 1, 1] * Configuration 2: [3, 2, 0, 1, 1] * Configuration 3: [4, 3, 0, 0, 0] * Configuration 4: [1, 3, 1, 1, 1] * Configuration 5: [3, 2, 1, 1, 1] * Configuration 6: [1, 1, 3, 2, 1] | * Configuration 1: [1, 1, 1, 1, 1] * Configuration 2: [2, 2, 0, 0, 1] * Configuration 3: [4, 1, 0, 0, 0] * Configuration 4: [0, 3, 1, 1, 0] * Configuration 5: [0, 2, 1, 1, 1] |

Table 10 and Table 11A~11E summarized the evaluation results of PDCCH block probabilities on FR1 and FR2 for the following cases, which were provided in email thread [102-e-Post-NR-RedCap-01] or individual contribution for different number of UEs simultaneously scheduled by gNB in a slot:

* Case 1: Reference case with no reduction in BD limit.
* Case 2: Approximately 25% reduction in BD limit.
* Case 3: Approximately 50% reduction in BD limit.

#### **FR1 Results**

Table 10A: PDCCH blocking rate for FR1, with 30kHz/20MHz, CORESET duration: 2 symbols, Delay toleration: 1, AL distribution: A1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Company | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Notes |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |  |
| 1 | Vivo | 2 | 2 | C1 | 2.02% | C1 | 3.52% | 1.5% | C1 | 3.59% | 1.6% |  |
| 3 | 2 | C1 | 3.56% | C1 | 5.03% | 1.5% | C1 | 5.08% | 1.5% |  |
| 4 | 2 | C1 | 4.82% | C1 | 6.39% | 1.6% | C1 | 7.01% | 2.2% |  |
| 5 | 2 | C1 | 5.94% | C1 | 7.64% | 1.7% | C1 | 9.42% | 3.5% |  |
| 1~5 | 2 | C1 | 0.25% | C1 | 0.41% | 0.2% | C1 | 0.41% | 0.2% | Note 1 |
| 2 | Ericsson | 3 | <=2 | C2 | 3.00% | C2 | 3.00% | 0.0% | C2 | 3.50% | 0.5% | Note 8 |
| 6 | <=2 | C2 | 6.00% | C2 | 7.00% | 1.0% | C2 | 9.00% | 3.0% | Note 8 |
| 3 | Qualcomm | 1 | 2 | C1 | 0.00% | C6 | 0.00% | 0.0% | C1 | 0.00% | 0.0% | Note 2 |
| 2 | 2 | C1 | 0.42% | C6 | 0.65% | 0.2% | C1 | 0.81% | 0.4% | Note 2 |
| 3 | 2 | C1 | 1.00% | C6 | 1.30% | 0.3% | C1 | 1.68% | 0.7% | Note 2 |
| 4 | 2 | C1 | 1.62% | C6 | 2.09% | 0.5% | C1 | 2.87% | 1.3% | Note 2 |
| 5 | 2 | C1 | 2.67% | C6 | 3.27% | 0.6% | C1 | 4.65% | 2.0% | Note 2 |
| 6 | 2 | C1 | 3.55% | C6 | 4.33% | 0.8% | C1 | 6.50% | 3.0% | Note 2 |
| 7 | 2 | C1 | 4.69% | C6 | 5.89% | 1.2% | C1 | 8.72% | 4.0% | Note 2 |
| 8 | 2 | C1 | 6.40% | C6 | 8.07% | 1.7% | C1 | 11.5% | 5.1% | Note 2 |
| 9 | 2 | C1 | 8.25% | C6 | 10.4% | 2.2% | C1 | 14.3% | 6.1% | Note 2 |
| 10 | 2 | C1 | 10.6% | C6 | 13.1% | 2.5% | C1 | 17.4% | 6.8% | Note 2 |
| 1 | 2 | C4 | 0.00% | C7 | 0.00% | 0.0% | C6 | 0.00% | 0.0% | Note 3 |
| 2 | 2 | C4 | 0.08% | C7 | 0.08% | 0.0% | C6 | 0.08% | 0.0% | Note 3 |
| 3 | 2 | C4 | 0.48% | C7 | 0.53% | 0.1% | C6 | 0.55% | 0.1% | Note 3 |
| 4 | 2 | C4 | 1.12% | C7 | 1.17% | 0.1% | C6 | 1.23% | 0.1% | Note 3 |
| 5 | 2 | C4 | 2.10% | C7 | 2.16% | 0.1% | C6 | 2.22% | 0.1% | Note 3 |
| 6 | 2 | C4 | 3.00% | C7 | 3.04% | 0.0% | C6 | 3.07% | 0.1% | Note 3 |
| 7 | 2 | C4 | 4.03% | C7 | 4.06% | 0.0% | C6 | 4.11% | 0.1% | Note 3 |
| 8 | 2 | C4 | 5.43% | C7 | 5.49% | 0.1% | C6 | 5.57% | 0.1% | Note 3 |
| 9 | 2 | C4 | 7.00% | C7 | 7.04% | 0.0% | C6 | 7.16% | 0.2% | Note 3 |
| 10 | 2 | C4 | 8.95% | C7 | 9.00% | 0.1% | C6 | 9.15% | 0.2% | Note 3 |
| 4 | Nokia | 2 | 2 | C2 | 4.00% | C8 | 4.00% | 0.0% | C2 | 4.00% | 0.0% | Note 8 |
| 3 | 2 | C2 | 6.00% | C8 | 6.00% | 0.0% | C2 | 6.00% | 0.0% | Note 8 |
| 4 | 2 | C2 | 9.00% | C8 | 10.0% | 1.0% | C2 | 12.0% | 3.0% | Note 8 |
| 5 | 2 | C2 | 12.0% | C8 | 15.0% | 3.0% | C2 | 20.0% | 8.0% | Note 8 |
| 6 | 2 | C2 | 18.0% | C8 | 21.0% | 3.0% | C2 | 31.0% | 13.0% | Note 8 |
| 7 | 2 | C2 | 28.0% | C8 | 31.0% | 3.0% | C2 | 44.0% | 16.0% | Note 8 |
| 8 | 2 | C2 | 38.0% | C8 | 41.0% | 3.0% | C2 | 58.0% | 20.0% | Note 8 |
| 5 | Huawei, HiSilicon | 5 | Note 4 | C5 | 6.07% | - |  | - | C7 | 6.07% | 0.0% | Note 5 |
| 5 | 2 | C5 | 6.07% | C6 | 6.90% | 0.8% | C1 | 9.30% | 3.2% |  |
| 10 | Note 4 | C5 | 17.3% | - |  | - | C7 | 17.3% | 0.0% | Note 5 |
| 10 | 2 | C5 | 17.3% | C6 | 23.3% | 6.0% | C1 | 24.1% | 6.8% |  |
| 6 | InterDigital | 2 |  | C1 | 1.96% | C1 | 3.31% | 1.4% | C1 | 3.43% | 1.5% |  |
| 3 |  | C1 | 3.50% | C1 | 5.08% | 1.6% | C1 | 5.30% | 1.8% |  |
| 4 |  | C1 | 4.67% | C1 | 6.31% | 1.6% | C1 | 7.04% | 2.4% |  |
| 5 |  | C1 | 5.83% | C1 | 7.32% | 1.5% | C1 | 9.22% | 3.4% |  |
| 6 |  | C1 | 7.19% | C1 | 8.55% | 1.4% | C1 | 11.8% | 4.6% |  |
| 7 |  | C1 | 8.65% | C1 | 10.1% | 1.5% | C1 | 14.4% | 5.8% |  |
| 8 |  | C1 | 10.82% | C1 | 12.2% | 1.4% | C1 | 17.6% | 6.8% |  |
| 9 |  | C1 | 13.71% | C1 | 15.1% | 1.4% | C1 | 20.8% | 7.1% |  |
| 10 |  | C1 | 17.26% | C1 | 18.4% | 1.1% | C1 | 24.2% | 6.9% |  |
| 7 | Intel | 2 | 1 | C6 | 1.9% | C9 | 1.9% | 0.0% | C8 | 1.9% | 0.0% |  |
| 4 | 1 | C6 | 6% | C9 | 6% | 0.0% | C8 | 6% | 0.0% |  |
| 8 | 1 | C6 | 20% | C9 | 20% | 0.0% | C8 | 20% | 0.0% |  |
| 8 | ZTE | 2 | 2 | C7 | 2.01% | C10 | 2.01% | 0.0% | C9 | 4.21% | 2.2% |  |
| 4 | 2 | C7 | 3.04% | C10 | 3.10% | 0.1% | C9 | 10.8% | 7.8% |  |
| 6 | 2 | C7 | 4.72% | C10 | 4.87% | 0.2% | C9 | 16.9% | 12.2% |  |
| 8 | 2 | C7 | 7.31% | C10 | 7.53% | 0.2% | C9 | 35.5% | 28.2% |  |
| 9 | Samsung | 1 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 0.00% | 0.0% | Note 8 |
| 2 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 0.00% | 0.0% | Note 8 |
| 3 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 2.00% | 2.0% | Note 8 |
| 4 | 2 | C3 | 0.00% | C2 | 1.00% | 1.0% | C2 | 7.00% | 7.0% | Note 8 |
| 5 | 2 | C3 | 0.00% | C2 | 3.00% | 3.0% | C2 | 13.0% | 13.0% | Note 8 |
| 6 | 2 | C3 | 1.00% | C2 | 6.00% | 5.0% | C2 | 20.0% | 19.0% | Note 8 |
| 7 | 2 | C3 | 2.00% | C2 | 10.0% | 8.0% | C2 | 26.0% | 24.0% | Note 8 |
| 8 | 2 | C3 | 4.00% | C2 | 15.0% | 11.0% | C2 | 32.0% | 28.0% | Note 8 |
| 9 | 2 | C3 | 6.00% | C2 | 20.0% | 14.0% | C2 | 37.0% | 31.0% | Note 8 |
| 10 | 2 | C3 | 8.00% | C2 | 25.0% | 17.0% | C2 | 42.0% | 34.0% | Note 8 |
| 1 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 0.00% | 0.0% | Note 6, 8 |
| 2 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 0.00% | 0.0% | Note 6, 8 |
| 3 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 0.00% | 0.0% | Note 6, 8 |
| 4 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 0.00% | 0.0% | Note 6, 8 |
| 5 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 2.00% | 2.0% | Note 6, 8 |
| 6 | 2 | C3 | 0.00% | C2 | 0.00% | 0.0% | C2 | 2.00% | 2.0% | Note 6, 8 |
| 7 | 2 | C3 | 0.00% | C2 | 1.00% | 1.0% | C2 | 7.00% | 7.0% | Note 6, 8 |
| 8 | 2 | C3 | 0.00% | C2 | 1.00% | 1.0% | C2 | 7.00% | 7.0% | Note 6, 8 |
| 9 | 2 | C3 | 0.00% | C2 | 3.00% | 3.0% | C2 | 13.0% | 13.0% | Note 6, 8 |
| 10 | 2 | C3 | 0.00% | C2 | 3.00% | 3.0% | C2 | 13.0% | 13.0% | Note 6, 8 |
| 1 | 2 | C3 | 0.00% | C3 | 0.00% | 0.0% | C3 | 0.00% | 0.0% | Note 7, 8 |
| 2 | 2 | C3 | 0.00% | C3 | 0.00% | 0.0% | C3 | 8.00% | 8.0% | Note 7, 8 |
| 3 | 2 | C3 | 0.00% | C3 | 0.00% | 0.0% | C3 | 14.0% | 14.0% | Note 7, 8 |
| 4 | 2 | C3 | 0.00% | C3 | 1.00% | 1.0% | C3 | 19.0% | 19.0% | Note 7, 8 |
| 5 | 2 | C3 | 0.00% | C3 | 1.00% | 1.0% | C3 | 22.0% | 22.0% | Note 7, 8 |
| 6 | 2 | C3 | 1.00% | C3 | 2.00% | 1.0% | C3 | 25.0% | 24.0% | Note 7, 8 |
| 7 | 2 | C3 | 2.00% | C3 | 3.00% | 1.0% | C3 | 28.0% | 26.0% | Note 7, 8 |
| 8 | 2 | C3 | 3.00% | C3 | 5.00% | 2.0% | C3 | 31.0% | 28.0% | Note 7, 8 |
| 9 | 2 | C3 | 6.00% | C3 | 7.00% | 1.0% | C3 | 34.0% | 28.0% | Note 7, 8 |
| 10 | 2 | C3 | 8.00% | C3 | 10.0% | 2.0% | C3 | 38.0% | 30.0% | Note 7, 8 |
| 10 | Futurewei | 1 | <= 2 | C1 | 0.00% | C6 | 0.00% | 0.0% | C1 | 0.00% | 0.0% |  |
| 2 | <= 2 | C1 | 0.00% | C6 | 1.00% | 1.0% | C1 | 1.00% | 1.0% |  |
| 3 | <= 2 | C1 | 0.00% | C6 | 3.00% | 3.0% | C1 | 4.00% | 4.0% |  |
| 4 | <= 2 | C1 | 1.00% | C6 | 4.00% | 3.0% | C1 | 7.00% | 6.0% |  |
| 5 | <= 2 | C1 | 2.00% | C6 | 7.00% | 5.0% | C1 | 12.0% | 10.0% |  |
| 6 | <= 2 | C1 | 3.00% | C6 | 9.00% | 6.0% | C1 | 15.0% | 12.0% |  |
| 7 | <= 2 | C1 | 3.00% | C6 | 15.0% | 12.0% | C1 | 23.0% | 20.0% |  |
| 8 | <= 2 | C1 | 5.00% | C6 | 17.0% | 12.0% | C1 | 25.0% | 20.0% |  |
| 9 | <= 2 | C1 | 7.00% | C6 | 20.0% | 13.0% | C1 | 33.0% | 26.0% |  |
| 10 | <= 2 | C1 | 11.0% | C6 | 26.0% | 15.0% | C1 | 36.0% | 25.0% |  |
| Note 1: Metric: the whole system blocking probability. It can be calculated by summing the product of the percentage of each number of UE simultaneously scheduled per slot and its corresponding blocking probability.  Note 2: Each UE is configured with all the ALs  Note 3: Each UE is configured with a single AL  Note 4: Reference case：2；50% BD reduction case:1  Note 5: For RedCap UEs using 2RX; BD reduction by reducing DCI size budget is evaluated (i.e. 'the number of DCI sizes to monitor per PDCCH candidate' is set to 2 for the reference case and 1 for approximately 50% reduction in BD limits).  Note 6: With enhancement of UE group scheduling with 2 UEs per DCI.  Note 7: with enhancement of PDCCH drooping based on predetermined CCE AL priority order = [1 2 4 8 16]  Note 8: Good coverage | | | | | | | | | | | | |

Table 10B: PDCCH blocking rate for FR1, with 30kHz/20MHz, CORESET duration: 2 symbols, Delay toleration: 1, AL distribution: A2

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Company | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Notes |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |  |
| 1 | Ericsson | 3 | <=2 | C2 | 17.0% | C2 | 17.0% | 0.0% | C2 | 21.0% | 4.0% | Note 8 |
| 6 | <=2 | C2 | 40.0% | C2 | 42.0% | 2.0% | C2 | 46.0% | 6.0% | Note 8 |
| 2 | Qualcomm | 1 | 2 | C1 | 0.0% | C6 | 0.0% | 0.0% | C1 | 0.0% | 0.0% | Note 2 |
| 2 | 2 | C1 | 3.9% | C6 | 4.3% | 0.4% | C1 | 9.4% | 5.5% | Note 2 |
| 3 | 2 | C1 | 10.5% | C6 | 11.2% | 0.7% | C1 | 18.3% | 7.8% | Note 2 |
| 4 | 2 | C1 | 17.4% | C6 | 18.4% | 1.0% | C1 | 25.7% | 8.3% | Note 2 |
| 5 | 2 | C1 | 24.8% | C6 | 26.3% | 1.5% | C1 | 32.4% | 7.6% | Note 2 |
| 6 | 2 | C1 | 32.1% | C6 | 33.8% | 1.7% | C1 | 38.9% | 6.8% | Note 2 |
| 7 | 2 | C1 | 38.5% | C6 | 40.4% | 1.9% | C1 | 44.3% | 5.8% | Note 2 |
| 8 | 2 | C1 | 44.4% | C6 | 46.2% | 1.8% | C1 | 49.2% | 4.8% | Note 2 |
| 9 | 2 | C1 | 48.9% | C6 | 50.7% | 1.8% | C1 | 53.1% | 4.2% | Note 2 |
| 10 | 2 | C1 | 53.2% | C6 | 55.0% | 1.8% | C1 | 56.7% | 3.5% | Note 2 |
| 1 | 2 | C4 | 0.0% | C7 | 0.0% | 0.0% | C6 | 0.0% | 0.0% | Note 3 |
| 2 | 2 | C4 | 3.5% | C7 | 3.5% | 0.0% | C6 | 3.5% | 0.0% | Note 3 |
| 3 | 2 | C4 | 8.1% | C7 | 8.1% | 0.0% | C6 | 8.1% | 0.0% | Note 3 |
| 4 | 2 | C4 | 13.9% | C7 | 13.9% | 0.0% | C6 | 13.9% | 0.0% | Note 3 |
| 5 | 2 | C4 | 21.1% | C7 | 21.1% | 0.0% | C6 | 21.2% | 0.1% | Note 3 |
| 6 | 2 | C4 | 28.7% | C7 | 28.8% | 0.1% | C6 | 28.9% | 0.2% | Note 3 |
| 7 | 2 | C4 | 35.8% | C7 | 35.9% | 0.1% | C6 | 36.0% | 0.2% | Note 3 |
| 8 | 2 | C4 | 42.1% | C7 | 42.2% | 0.1% | C6 | 42.3% | 0.2% | Note 3 |
| 9 | 2 | C4 | 47.3% | C7 | 47.3% | 0.0% | C6 | 47.4% | 0.1% | Note 3 |
| 10 | 2 | C4 | 51.8% | C7 | 51.9% | 0.1% | C6 | 52.0% | 0.2% | Note 3 |
| 3 | Nokia | 2 | 2 | C2 | 19.0% | C8 | 21.0% | 2.0% | C2 | 21.0% | 2.0% | Note 8 |
| 3 | 2 | C2 | 36.0% | C8 | 38.0% | 2.0% | C2 | 47.0% | 11.0% | Note 8 |
| 4 | 2 | C2 | 64.0% | C8 | 68.0% | 4.0% | C2 | 78.0% | 14.0% | Note 8 |
| 5 | 2 | C2 | 87.0% | C8 | 88.0% | 1.0% | C2 | 94.0% | 7.0% | Note 8 |
| 6 | 2 | C2 | 97.0% | C8 | 98.0% | 1.0% | C2 | 99.0% | 2.0% | Note 8 |
| 7 | 2 | C2 | 100% | C8 | 100% | 0.0% | C2 | 100% | 0.0% | Note 8 |
| 4 | ZTE | 2 | 2 | C8 | 9.5% | C11 | 9.5% | 0.0% | C10 | 10.0% | 0.5% |  |
| 4 | 2 | C8 | 24.7% | C11 | 24.8% | 0.1% | C10 | 27.2% | 2.5% |  |
| 6 | 2 | C8 | 39.2% | C11 | 39.4% | 0.2% | C10 | 42.8% | 3.6% |  |
| 8 | 2 | C8 | 49.5% | C11 | 49.6% | 0.1% | C10 | 53.9% | 4.4% |  |
| 5 | Samsung | 1 | 2 | C3 | 0.0% | C2 | 0.0% | 0.0% | C2 | 0.00 | 0.0% | Note 8 |
| 2 | 2 | C3 | 0.0% | C2 | 1.0% | 1.0% | C2 | 3.0% | 3.0% | Note 8 |
| 3 | 2 | C3 | 0.0% | C2 | 1.0% | 1.0% | C2 | 7.0% | 7.0% | Note 8 |
| 4 | 2 | C3 | 1.0% | C2 | 3.0% | 2.0% | C2 | 12.0% | 11.0% | Note 8 |
| 5 | 2 | C3 | 2.0% | C2 | 5.0% | 3.0% | C2 | 18.0% | 16.0% | Note 8 |
| 6 | 2 | C3 | 3.0% | C2 | 8.0% | 5.0% | C2 | 23.0% | 20.0% | Note 8 |
| 7 | 2 | C3 | 5.0% | C2 | 11.0% | 6.0% | C2 | 28.0% | 23.0% | Note 8 |
| 8 | 2 | C3 | 8.0% | C2 | 15.0% | 7.0% | C2 | 32.0% | 24.0% | Note 8 |
| 9 | 2 | C3 | 11.0% | C2 | 18.0% | 7.0% | C2 | 36.0% | 25.0% | Note 8 |
| 10 | 2 | C3 | 15.0% | C2 | 22.0% | 7.0% | C2 | 40.0% | 25.0% | Note 8 |
| 1 | 2 | C3 | 0.0% | C2 | 0.0% | 0.0% | C2 | 0.0% | 0.0% | Note 6, 8 |
| 2 | 2 | C3 | 0.0% | C2 | 0.0% | 0.0% | C2 | 0.00, | 0.0% | Note 6, 8 |
| 3 | 2 | C3 | 0.0% | C2 | 2.6% | 2.6% | C2 | 3.0% | 3.0% | Note 6, 8 |
| 4 | 2 | C3 | 0.0% | C2 | 2.6% | 2.6% | C2 | 3.0% | 3.0% | Note 6, 8 |
| 5 | 2 | C3 | 0.0% | C2 | 4.6% | 4.6% | C2 | 7.0% | 7.0% | Note 6, 8 |
| 6 | 2 | C3 | 0.0% | C2 | 4.6% | 4.6% | C2 | 7.0% | 7.0% | Note 6, 8 |
| 7 | 2 | C3 | 1.0% | C2 | 7.3% | 6.3% | C2 | 12.0% | 11.0% | Note 6, 8 |
| 8 | 2 | C3 | 1.0% | C2 | 7.3% | 6.3% | C2 | 12.0% | 11.0% | Note 6, 8 |
| 9 | 2 | C3 | 2.0% | C2 | 12.4% | 10.4% | C2 | 18.0% | 16.0% | Note 6, 8 |
| 10 | 2 | C3 | 2.0% | C2 | 12.4% | 10.4% | C2 | 18.0% | 16.0% | Note 6, 8 |
| 1 | 2 | C3 | 0.0% | C4 | 0.0% | 0.0% | C4 | 0.0% | 0.0% | Note 6, 8 |
| 2 | 2 | C3 | 0.0% | C4 | 1.0% | 1.0% | C4 | 3.0% | 3.0% | Note 6, 8 |
| 3 | 2 | C3 | 0.0% | C4 | 1.0% | 1.0% | C4 | 6.0% | 6.0% | Note 6, 8 |
| 4 | 2 | C3 | 1.0% | C4 | 2.0% | 1.0% | C4 | 9.0% | 8.0% | Note 6, 8 |
| 5 | 2 | C3 | 2.0% | C4 | 3.0% | 1.0% | C4 | 11.0% | 9.0% | Note 6, 8 |
| 6 | 2 | C3 | 3.0% | C4 | 5.0% | 2.0% | C4 | 15.0% | 12.0% | Note 6, 8 |
| 7 | 2 | C3 | 5.0% | C4 | 7.0% | 2.0% | C4 | 18.0% | 13.0% | Note 6, 8 |
| 8 | 2 | C3 | 8.0% | C4 | 10.0% | 2.0% | C4 | 22.0% | 14.0% | Note 6, 8 |
| 9 | 2 | C3 | 11.0% | C4 | 13.0% | 2.0% | C4 | 25.0% | 14.0% | Note 6, 8 |
| 10 | 2 | C3 | 15.0% | C4 | 16.0% | 1.0% | C4 | 29.0% | 14.0% | Note 6, 8 |
| Note 1: Metric: the whole system blocking probability. It can be calculated by summing the product of the percentage of each number of UE simultaneously scheduled per slot and its corresponding blocking probability.  Note 2: Each UE is configured with all the ALs  Note 3: Each UE is configured with a single AL  Note 4: Reference case：2；50% BD reduction case:1  Note 5: For RedCap UEs using 2RX; BD reduction by reducing DCI size budget is evaluated (i.e. 'the number of DCI sizes to monitor per PDCCH candidate' is set to 2 for the reference case and 1 for approximately 50% reduction in BD limits).  Note 6: With enhancement of UE group scheduling with 2 UEs per DCI.  Note 7: with enhancement of PDCCH drooping based on predetermined CCE AL priority order = [1 2 4 8 16]  Note 8: Medium coverage | | | | | | | | | | | | |

Table 10C: PDCCH blocking rate for FR1, with 30kHz/20MHz, CORESET duration: 2 symbols, Delay toleration: 1, AL distribution: A3

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Company | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Notes |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |
| 1 | Ericsson | 3 | <= 2 | C2 | 46.0% | C2 | 47.0% | 1.0% | C2 | 49.0% | 3.0% | Note 8 |
| 6 | <= 2 | C2 | 66.0% | C2 | 67.0% | 1.0% | C2 | 69.0% | 3.0% | Note 8 |
| 2 | Qualcomm | 1 | 2 | C1 | 0.0% | C6 | 0.0% | 0.0% | C1 | 0.0% | 0.0% | Note 2 |
| 2 | 2 | C1 | 18.5% | C6 | 19.0% | 0.4% | C1 | 23.4% | 4.9% | Note 2 |
| 3 | 2 | C1 | 35.5% | C6 | 36.3% | 0.8% | C1 | 40.0% | 4.5% | Note 2 |
| 4 | 2 | C1 | 48.0% | C6 | 49.1% | 1.1% | C1 | 51.5% | 3.5% | Note 2 |
| 5 | 2 | C1 | 56.8% | C6 | 58.0% | 1.2% | C1 | 59.7% | 2.9% | Note 2 |
| 6 | 2 | C1 | 62.7% | C6 | 64.0% | 1.3% | C1 | 65.4% | 2.7% | Note 2 |
| 7 | 2 | C1 | 67.4% | C6 | 68.8% | 1.4% | C1 | 70.0% | 2.6% | Note 2 |
| 8 | 2 | C1 | 70.9% | C6 | 72.3% | 1.4% | C1 | 73.4% | 2.5% | Note 2 |
| 9 | 2 | C1 | 73.5% | C6 | 74.8% | 1.3% | C1 | 75.9% | 2.4% | Note 2 |
| 10 | 2 | C1 | 75.7% | C6 | 77.0% | 1.3% | C1 | 78.0% | 2.3% | Note 2 |
| 1 | 2 | C4 | 0.0% | C7 | 0.0% | 0.0% | C6 | 0.0% | 0.0% | Note 3 |
| 2 | 2 | C4 | 17.9% | C7 | 17.9% | 0.0% | C6 | 17.9% | 0.0% | Note 3 |
| 3 | 2 | C4 | 33.9% | C7 | 33.9% | 0.0% | C6 | 33.9% | 0.0% | Note 3 |
| 4 | 2 | C4 | 46.2% | C7 | 46.3% | 0.0% | C6 | 46.3% | 0.1% | Note 3 |
| 5 | 2 | C4 | 54.8% | C7 | 54.9% | 0.1% | C6 | 54.9% | 0.1% | Note 3 |
| 6 | 2 | C4 | 60.8% | C7 | 60.8% | 0.1% | C6 | 60.9% | 0.1% | Note 3 |
| 7 | 2 | C4 | 65.4% | C7 | 65.5% | 0.1% | C6 | 65.6% | 0.2% | Note 3 |
| 8 | 2 | C4 | 69.0% | C7 | 69.1% | 0.1% | C6 | 69.1% | 0.2% | Note 3 |
| 9 | 2 | C4 | 71.5% | C7 | 71.6% | 0.1% | C6 | 71.7% | 0.2% | Note 3 |
| 10 | 2 | C4 | 73.7% | C7 | 73.8% | 0.1% | C6 | 73.9% | 0.2% | Note 3 |
| 3 | ZTE | 2 | 2 | C9 | 32.0% | C12 | 32.1% | 0.1% | C11 | 32.2% | 0.2% |  |
| 4 | 2 | C9 | 55.3% | C12 | 55.5% | 0.1% | C10 | 57.7% | 2.3% |  |
| 6 | 2 | C9 | 66.4% | C12 | 66.6% | 0.2% | C10 | 69.0% | 2.6% |  |
| 8 | 2 | C9 | 72.0% | C12 | 72.5% | 0.5% | C10 | 75.0% | 3.0% |  |
| 4 | Samsung | 1 | 2 | C3 | 0.0% | C2 | 0.0% | 0.0% | C2 | 0.00 | 0.0% | Note 8 |
| 2 | 2 | C3 | 0.0% | C2 | 8.0% | 8.0% | C2 | 12.0% | 12.0% | Note 8 |
| 3 | 2 | C3 | 3.0% | C2 | 15.0% | 12% | C2 | 22.0% | 19.0% | Note 8 |
| 4 | 2 | C3 | 7.0% | C2 | 20.0% | 13% | C2 | 30.0% | 23.0% | Note 8 |
| 5 | 2 | C3 | 12.0% | C2 | 26.0% | 14% | C2 | 36.0% | 24.0% | Note 8 |
| 6 | 2 | C3 | 17.0% | C2 | 30.0% | 13% | C2 | 41.0% | 24.0% | Note 8 |
| 7 | 2 | C3 | 22.0% | C2 | 34.0% | 12% | C2 | 46.0% | 24.0% | Note 8 |
| 8 | 2 | C3 | 28.0% | C2 | 37.0% | 9.0% | C2 | 49.0% | 21.0% | Note 8 |
| 9 | 2 | C3 | 33.0% | C2 | 41.0% | 8.0% | C2 | 52.0% | 19.0% | Note 8 |
| 10 | 2 | C3 | 38.0% | C2 | 43.0% | 5.0% | C2 | 55.0% | 17.0% | Note 8 |
| 1 | 2 | C3 | 0.0% | C2 | 0.0% | 0.0% | C2 | 0.0% | 0.0% | Note 6, 8 |
| 2 | 2 | C3 | 0.0% | C2 | 0.0% | 0.0% | C2 | 0.0% | 0.0% | Note 6, 8 |
| 3 | 2 | C3 | 0.0% | C2 | 1.0% | 1.0% | C2 | 12.0% | 12.0% | Note 6, 8 |
| 4 | 2 | C3 | 0.0% | C2 | 1.0% | 1.0% | C2 | 12.0% | 12.0% | Note 6, 8 |
| 5 | 2 | C3 | 3.0% | C2 | 1.0% | -2.0% | C2 | 22.0% | 19.0% | Note 6, 8 |
| 6 | 2 | C3 | 3.0% | C2 | 1.0% | -2.0% | C2 | 22.0% | 19.0% | Note 6, 8 |
| 7 | 2 | C3 | 7.0% | C2 | 3.0% | -4.0% | C2 | 30.0% | 23.0% | Note 6, 8 |
| 8 | 2 | C3 | 7.0% | C2 | 3.0% | -4.0% | C2 | 30.0% | 23.0% | Note 6, 8 |
| 9 | 2 | C3 | 12.0% | C2 | 5.0% | -7.0% | C2 | 36.0% | 24.0% | Note 6, 8 |
| 10 | 2 | C3 | 12.0% | C2 | 5.0% | -7.0% | C2 | 36.0% | 24.0% | Note 6, 8 |
| 1 | 2 | C3 | 0.0% | C5 | 0.0% | 0.0% | C5 | 0.0% | 0.0% | Note 7, 8 |
| 2 | 2 | C3 | 0.0% | C5 | 0.0% | 0.0% | C5 | 0.0% | 0.0% | Note 7, 8 |
| 3 | 2 | C3 | 3.0% | C5 | 3.0% | 0.0% | C5 | 4.0% | 1.0% | Note 7, 8 |
| 4 | 2 | C3 | 7.0% | C5 | 8.0% | 1.0% | C5 | 8.0% | 1.0% | Note 7, 8 |
| 5 | 2 | C3 | 12.0% | C5 | 13.0% | 1.0% | C5 | 13.0% | 1.0% | Note 7, 8 |
| 6 | 2 | C3 | 17.0% | C5 | 18.0% | 1.0% | C5 | 18.0% | 1.0% | Note 7, 8 |
| 7 | 2 | C3 | 22.0% | C5 | 23.0% | 1.0% | C5 | 24.0% | 2.0% | Note 7, 8 |
| 8 | 2 | C3 | 28.0% | C5 | 28.0% | 0.0% | C5 | 30.0% | 2.0% | Note 7, 8 |
| 9 | 2 | C3 | 33.0% | C5 | 34.0% | 1.0% | C5 | 35.0% | 2.0% | Note 7, 8 |
| 10 | 2 | C3 | 38.0% | C5 | 38.0% | 0.0% | C5 | 40.0% | 2.0% | Note 7, 8 |
| Note 1: Metric: the whole system blocking probability. It can be calculated by summing the product of the percentage of each number of UE simultaneously scheduled per slot and its corresponding blocking probability.  Note 2: Each UE is configured with all the ALs  Note 3: Each UE is configured with a single AL  Note 4: Reference case：2；50% BD reduction case:1  Note 5: For RedCap UEs using 2RX; BD reduction by reducing DCI size budget is evaluated (i.e. 'the number of DCI sizes to monitor per PDCCH candidate' is set to 2 for the reference case and 1 for approximately 50% reduction in BD limits).  Note 6: With enhancement of UE group scheduling with 2 UEs per DCI.  Note 7: with enhancement of PDCCH drooping based on predetermined CCE AL priority order = [1 2 4 8 16]  Note 8: Poor coverage | | | | | | | | | | | | |

Table 10D: PDCCH blocking rate for FR1, with 30kHz/20MHz, CORESET duration: 2 symbols, Delay toleration: 1, AL distribution: Others except A1/A2/A3

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | AL distribution in Table 8 | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Comments |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |
| Huawei, HiSilicon | A4 | 5 | Note 4 | C5 | 12.3% | - |  | - | C7 | 12.30% | 0.0% | Note 1, 2 |
| A4 | 5 | 2 | C5 | 12.3% | C6 | 13.8% | 1.5% | C1 | 16.30% | 4.0% | Note1 |
| A4 | 10 | Note 4 | C5 | 29.4% | - |  | - | C7 | 29.40% | 0.0% | Note1, 2 |
| A4 | 10 | 2 | C5 | 29.4% | C6 | 33.9% | 4.5% | C1 | 34.30% | 4.9% | Note1 |
| Panasonic [5] | A7 | 4 |  | C1 | 5.93% | C14 | 7.07% | 1.1% | C13 | 13.9% | 8.0% |  |
| A7 | 6 |  | C1 | 10.1% | C14 | 13.7% | 3.6% | C13 | 23.2% | 13.1% |  |
| Note 1: For RedCap UEs using 1RX;  Note 2: BD reduction by reducing DCI size budget is evaluated (i.e. 'the number of DCI sizes to monitor per PDCCH candidate' is set to 2 for the reference case and 1 for approximately 50% reduction in BD limits). | | | | | | | | | | | | |

The following table 11A~11E summarized the PDCCH blocking rates due to reduced blind decoding for FR1with optional values for at least one parameter in Table 13 (describe and highlighted in the Table Title)

Table 11A: PDCCH blocking rate for FR1, with 15kHz/20MHz, CORESET duration: 2 symbols, Delay toleration: 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | AL distribution in Table 8 | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Comments |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |
| vivo | A1 | 2 | 2 | C1 | 0.00% | C1 | 1.36% | 1.36% | C1 | 1.17% | 1.17% |  |
| A1 | 3 | 2 | C1 | 0.56% | C1 | 2.14% | 1.58% | C1 | 2.32% | 1.76% |  |
| A1 | 4 | 2 | C1 | 1.31% | C1 | 2.94% | 1.63% | C1 | 3.35% | 2.04% |  |
| A1 | 5 | 2 | C1 | 1.90% | C1 | 3.73% | 1.83% | C1 | 4.14% | 2.24% |  |
| A1 | 1~5 | 2 | C1 | 0.02% | C1 | 0.17% | 0.15% | C1 | 0.05% | 0.03% | Note 1 |
| Note 1: Metric: the whole system blocking probability. It can be calculated by summing the product of the percentage of each number of UE simultaneously scheduled per slot and its corresponding blocking probability. | | | | | | | | | | | | |

Table 11B: PDCCH blocking rate for FR1, with 15kHz/20MHz, CORESET duration: 3 symbols, Delay toleration: 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | AL distribution in Table18 | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Note |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |
| vivo | A1 | 2 | 2 | C1 | 0.00% | C1 | 0.89% | 0.89% | C1 | 0.90% | 0.90% |  |
| A1 | 3 | 2 | C1 | 0.34% | C1 | 1.54% | 1.20% | C1 | 1.59% | 1.25% |  |
| A1 | 4 | 2 | C1 | 0.62% | C1 | 2.25% | 1.63% | C1 | 2.16% | 1.54% |  |
| A1 | 5 | 2 | C1 | 1.08% | C1 | 2.76% | 1.68% | C1 | 2.82% | 1.74% |  |
| A1 | 1~5 | 2 | C1 | 0.01% | C1 | 0.18% | 0.17% | C1 | 0.25% | 0.24% | Note 1 |
| Nokia | A1 | 2 | 2 | C2 | 0.00% | C8 | 0.00% | 0.00% | C2 | 0.00% | 0.00% |  |
| A1 | 3 | 2 | C2 | 1.00% | C8 | 1.00% | 0.00% | C2 | 2.00% | 1.00% |  |
| A1 | 4 | 2 | C2 | 2.00% | C8 | 3.00% | 1.00% | C2 | 6.00% | 4.00% |  |
| A1 | 5 | 2 | C2 | 4.00% | C8 | 7.00% | 3.00% | C2 | 11.0% | 7.00% |  |
| A1 | 6 | 2 | C2 | 10.0% | C8 | 12.0% | 2.00% | C2 | 16.0% | 6.00% |  |
| A1 | 7 | 2 | C2 | 15.0% | C8 | 17.0% | 2.00% | C2 | 23.0% | 8.00% |  |
| A1 | 8 | 2 | C2 | 18.0% | C8 | 22.0% | 4.00% | C2 | 31.0% | 13.0% |  |
| Intel | A1 | 2 | 1 | C10 | 0.01% | C13 | 0.01% | 0.00% | C12 | 0.01% | 0.00% |  |
| A1 | 4 | 1 | C10 | 0.02% | C13 | 0.02% | 0.00% | C12 | 0.12% | 0.10% |  |
| A1 | 8 | 1 | C10 | 0.07% | C13 | 0.07% | 0.00% | C12 | 0.28% | 0.21% |  |
| A1 | 10 | 1 | C10 | 0.20% | C13 | 0.20% | 0.00% | C12 | 0.6% | 0.40% |  |
| A1 | 15 | 1 | C10 | 1.80% | C13 | 1.80% | 0.00% | C12 | 2.5% | 0.70% |  |

Note 1: Metric: the whole system blocking probability. It can be calculated by summing the product of the percentage of each number of UE simultaneously scheduled per slot and its corresponding blocking probability.

Table 11C: PDCCH blocking rate for FR1, with 15kHz/20MHz, CORESET duration: 2 symbols, Delay toleration: 1, 2 or 3 slots

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | AL distribution in Table14 | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Comments |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |  |
| ZTE | A1 | 2 | 2 | C7 | 0.00% | C10 | 0.00% | 0.00% | C9 | 0.14% | 0.14% | Note 1 |
| A1 | 4 | 2 | C7 | 0.08% | C10 | 0.08% | 0.00% | C9 | 0.62% | 0.54% | Note 1 |
| A1 | 6 | 2 | C7 | 0.30% | C10 | 0.49% | 0.19% | C9 | 1.34% | 1.04% | Note 1 |
| A1 | 8 | 2 | C7 | 0.70% | C10 | 1.12% | 0.42% | C9 | 2.26% | 1.56% | Note 1 |
| A1 | 2 | 2 | C7 | 0.00% | C10 | 0.00% | 0.00% | C9 | 0.06% | 0.06% | Note 2 |
| A1 | 4 | 2 | C7 | 0.03% | C10 | 0.05% | 0.02% | C9 | 0.29% | 0.26% | Note 2 |
| A1 | 6 | 2 | C7 | 0.15% | C10 | 0.25% | 0.10% | C9 | 0.67% | 0.52% | Note 2 |
| A1 | 8 | 2 | C7 | 0.37% | C10 | 0.61% | 0.24% | C9 | 1.18% | 0.81% | Note 2 |
| A1 | 2 | 2 | C7 | 0.00% | C10 | 0.00% | 0.00% | C9 | 0.04% | 0.04% | Note 3 |
| A1 | 4 | 2 | C7 | 0.03% | C10 | 0.04% | 0.01% | C9 | 0.22% | 0.19% | Note 3 |
| A1 | 6 | 2 | C7 | 0.08% | C10 | 0.16% | 0.08% | C9 | 0.46% | 0.38% | Note 3 |
| A1 | 8 | 2 | C7 | 0.24% | C10 | 0.40% | 0.16% | C9 | 0.84% | 0.60% | Note 3 |
| A2 | 2 | 2 | C8 | 0.00% | C10 | 0.76% | 0.76% | C9 | 2.02% | 2.02% | Note 1 |
| A2 | 4 | 2 | C8 | 2.48% | C10 | 4.28% | 1.80% | C9 | 9.01% | 6.53% | Note 1 |
| A2 | 6 | 2 | C8 | 10.23% | C10 | 11.14% | 0.91% | C9 | 16.91% | 6.68% | Note 1 |
| A2 | 8 | 2 | C8 | 18.23% | C10 | 18.88% | 0.65% | C9 | 24.53% | 6.30% | Note 1 |
| A3 | 2 | 2 | C9 | 0.00% | C10 | 0.03% | 0.03% | C9 | 0.03% | 0.03% | Note 1 |
| A3 | 4 | 2 | C9 | 23.58% | C10 | 24.32% | 0.74% | C9 | 26.61% | 3.03% | Note 1 |
| A3 | 6 | 2 | C9 | 39.39% | C10 | 39.50% | 0.11% | C9 | 41.55% | 2.16% | Note 1 |
| A3 | 8 | 2 | C9 | 48.95% | C10 | 49.18% | 0.23% | C9 | 51.50% | 2.55% | Note 1 |
| Note 1: Delay toleration is 1 slot  Note 2: Delay toleration is 2 slots  Note 3: Delay toleration is 3 slots | | | | | | | | | | | | |

Table 11D: PDCCH blocking rate for FR1, with 30kHz/20MHz, CORESET duration: 3 symbols, Delay toleration: 1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | AL distribution in Table14 | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Comments |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |  |
| vivo | A1 | 2 | 2 | C1 | 0.67% | C1 | 1.58% | 0.91% | C1 | 1.48% | 0.81% |  |
| A1 | 3 | 2 | C1 | 1.62% | C1 | 2.95% | 1.33% | C1 | 3.13% | 1.51% |  |
| A1 | 4 | 2 | C1 | 2.34% | C1 | 4.39% | 2.05% | C1 | 4.80% | 2.46% |  |
| A1 | 5 | 2 | C1 | 3.35% | C1 | 5.74% | 2.39% | C1 | 5.81% | 2.46% |  |
| A1 | 1~5 | 2 | C1 | 0.10% | C1 | 0.20% | 0.10% | C1 | 0.20% | 0.10% | Note 1 |
| Note 1: Metric: the whole system blocking probability. It can be calculated by summing the product of the percentage of each number of UE simultaneously scheduled per slot and its corresponding blocking probability. | | | | | | | | | | | | |

Table 11E: PDCCH blocking rate for FR1, with 30kHz/20MHz, CORESET duration: 2 symbols, Delay toleration: 1, DCI size = 60 bits (NOT including CRC)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | AL distribution in Table14 | # users | # DCI sizes | Case 1 | | Case 2 | | Case 3 | | | Comments |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |  |
| Huawei, HiSilicon | A5 | 5 | Note 1 | C5 | 8.60% | - | - | C2 | 8.60% | 0.0% | Note 2 |
| A5 | 10 | Note 1 | C5 | 23.20% | - | - | C2 | 23.20% | 0.0% | Note 2 |
| A6 | 5 | Note 1 | C5 | 14.5% | - | - | C2 | 14.5% | 0.0% | Note 2 |
| A6 | 10 | Note 1 | C5 | 33.70% | - | - | C2 | 33.70% | 0.0% | Note 2 |
| Note 1: Reference case：2；50% BD reduction case:1  Note 2: For RedCap UEs using 2RX; BD reduction by reducing DCI size budget is evaluated (i.e. 'the number of DCI sizes to monitor per PDCCH candidate' is set to 2 for the reference case and 1 for approximately 50% reduction in BD limits). | | | | | | | | | | | |

**Proposal 8.2.3.1-1: Incorporate the above Table 9 and Table 10A/B/C/D/E into text proposal in the Redcap TR 38.875 for FR1. If not, what changes to the Tables are needed in order to add into Redcap TR. If concerns on results from specific source(s) to be captured in TR 38.875, please explicitly comment with reasoning in ‘comments’ column.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Y/N** | | **Comments** |
| CATT | Y | |  |
| LG | Y | | We are okay with the tables. |
| vivo | N | | We have two major concerns in capturing the results like above   1. For AL distribution, C1 makes sense and most companies have simulated this case. Other configurations (C2~C7), no simulation results have been provided by any company showing those configurations are valid in any simulated scenario. Without such justification, we do not agree to capture results for C2~C7 2. For number of co-scheduled UEs, the range of 2~10 was arbitrarily chosen. From our simulation results, we observed it is rare case that number of co-scheduled UEs is 4 or 5, more than 5 co-scheduled UEs cannot be seen from the simulation. We would like to ask for justification for the number larger than 5. |
| Huawei, HiSilicon | Y | |  |
| Panasonic | Y | |  |
| Sharp | Y | |  |
| Samsung | Y with modification. | | Table 9 is quite large. It’s better to split it into three tables based on channel conditions, i.e. different assumption for AL distribution. At least C1, C2, C3 of AL distributions should be considered. It will help us to draw conclusions or observations for different channel conditions as well. |
| Nokia | Y | |  |
| Qualcomm | Y | |  |
| InterDigital | Y | |  |
| Fraunhofer | Y | |  |
| Futurewei | Y | | Regarding Vivo ‘s comment of only capturing C1: our understanding that it was up to the companies to decide which distribution to use, so other distributions should be included. Besides, C1-C6 model different scenarios (good/medium/bad coverage, etc.) and provide good insight that should be captured in the TR |
| Ericsson | Y | For consistency, we suggest using either percentage or non-percentage values in the tables.  In Table 8, some of the configurations for the number of PDCCH candidates per AL are not valid. The candidates should be among {0, 1, 2, 3, 4, 5, 6, 8} to be valid. In our view, such configurations should not be captured in the TR.  Our suggestion is to have a table summarizing the blocking rate values reported by the companies, instead of including Table 9 and Table 10A/B/C/D/E in the TR. The excel sheet can then be provided as a reference. | |
| Intel | Y for Table 9, Tables 10A/B/D | Other Tables 10C/E are not in line with baseline or optional configurations. Agreement does not include “Other values not precluded” for DCI size and CORESET duration. Hence, we suggest to capture tables based on agreed observations for more focused observations.  Also, note that we have corrected a copy-paste error and also added some new results. | |
| DOCOMO | Y |  | |
| OPPO | Y |  | |
| ZTE,sanechips | Y | From our point of view, any method for BD reduction is not precluded before evaluation. The candidates number after reduction should not be limited by the legacy candidates {0, 1, 2, 3, 4, 5, 6, 8}.  The delay tolerance has an impact on the PDCCH blocking and 2 slots can be an optional configuration according to the agreement. Therefore, the simulation about the delay tolerance should be included. Further, the delay tolerance simulation results are collected in Table10C and we made a revision for Table10C. | |

**Summary of 1st round email discussions**

All responses except companies agree to capture the results of Table 9 and Table 10A/B/C/D/Einto TR 38.875.

Companies views are summarized in Table below:

|  |  |  |
| --- | --- | --- |
|  | Companies | # Companies |
| Yes | CATT, LG, Huawei, HiSilicon, Panasonic, Sharp, Samsung (split Table 9), Nokia, Qualcomm, InterDigital, Fraunhofer, Futurewei, Ericsson, DoCoMo, OPPO, ZTE,sanechips | 17 |
| No | vivo (1st concern on results with AL distributions configuration Cx except C1; 2nd concern on co-scheduled UEs > 5) | 1 |
| Partially yes | Intel (Yes to Table 9/10A/10B/10D) | 1 |

**Discussion Point for GTW:**

* Handling results with AL distributions configuration Ax except A1 and co-scheduled UEs > 5 [vivo]

**[FL6] Proposal 8.2.3.1-1: To include evaluation results and observations for all configurations in Table 8 as in R1-2009571 to the TR**

One response [Samsung] suggested to split the PDCCH blocking rate Table into three tables based on AL distributions configuration C1, C2, or C3, which sounds make a lot of sense and actually necessary to figure out the corresponding observations. Hence, it was implemented in the new version of feature leader summary.

**[FL4] Proposal 8.2.3.1-1: Incorporate the revised Table 8/9, Table 10A/10B/10C/10D, Table 11A/11B/11C/11D/ 11E into Redcap TR 38.875.**

* It is up to TR editor to use a separate excel sheet to include these Tables or directly capture these tables for inclusion in the TR.

**Except the concerns raised on results of AL distribution C2/C3 and co-scheduled UEs >5 as already captured in ‘Discussion point’ above (Note that it is planned to be separately discussed first in next GTW session and not focus of this proposal), any other concerns on FL Proposal 8.2.3.1-1?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | N | * + - 1. We do not agree to capture the results assuming arbitrary AL distributions (C2/C3) without given any justification for their rationality in the practical deployment or simulation scenarios. We suggest either delete the results for AL distribution C2/C3, or if there is strong desire to capture them we should add a statement to the TR that “there is no common understanding in RAN1 regarding the AL distribution other than C1”       2. We do not agree to capture the results assuming arbitrary number of co-scheduled UEs, especially for numbers larger than 5. We suggest to either delete those results, or if there is strong desire to capture them we should add a statement to the TR that “there is common understanding in RAN1 regarding the number of co-scheduled UEs larger than 5 assuming non-full buffer traffic model”       3. One minor comment is that notation Cx is used to name both the AL distribution and the PDCCH candidate configurations, which may cause some confusion for the readers. |
| LG | Partially yes | With regard to **[FL4] Proposal 8.2.1-1**, the tables should be captured excluding the results with reduced DCI size budget. Or, it is okay to capture the whole results with a note that explicitly mentions BD is reduced by reducing the DCI size budget. |
| CATT | Y |  |
| ZTE,sanechips | Y |  |
| Huawei, HiSilicon | Y | We are fine to incorporate the revised Table 8/9, Table 10A/10B/10C/10D, Table 11A/11B/11C/11D/ 11E into Redcap TR 38.875. |
| Samsung | Y |  |
| Futurewei | Y | The template that was agreed for power savings has a column for indicating the aggregation level distribution, thereby making it clear that the evaluation was not restricted to C1. Consequently, other configurations (C2, etc.) can, and should be captured. In addition, there is no good reasons to limit the number of UEs to 5. Consequently, the tables should be included as is. |
| Qualcomm | Y |  |
| Ericsson | N | There can be a confusion related to the column for “Blocking rate increase compared to Case 1” in the Tables. The blocking rate increase can be presented in two ways. Let a and b be the blocking rate for the reference case and reduced BD case. The blocking rate increase can be:   * Option 1: Absolute increase: (b%-a%) * Option 2: Relative increase: 100\*[(b-a)/a] %   For example, if the blocking rate increases from 20% to 30%, the absolute increase is 10% while the relative increase is 50%.  In our opinion, it is important to clarify this metric and the way that it should be presented in the TR. We are fine with including both absolute and relative values, in line with ZTE’s comments.  In Table 10B, we think it should be Note 8, instead of Note 9.  In Table 9, some of the configurations (e.g., configurations 7, 9, 13) for the number of PDCCH candidates per AL are not valid. The candidates should be among {0, 1, 2, 3, 4, 5, 6, 8} to be valid. In our view, such configurations should not be captured in the TR. |
| Nokia, NSB | Y |  |
| Intel | N | We think it maybe premature to agree to capture the tables before the planned GTW discussion. As we mentioned before, it is expected to understand the justification first how in practice AL distributions such as C2 and C3 can work for simultaneously scheduling a reasonable number of UEs with low blocking probability, e.g., 10% or lower. We are expected to capture results in TR that can be implementable in practice. |
| FL5 | Seven responses agreed to capture the Table 8/9, Table 10A/10B/10C/10D, Table 11A/11B/11C/11D/ 11E into Redcap TR 38.875 for PDCCH blocking rate performance.  One response indicates that ‘Cx’ is used for both PDCCH AL distribution configuration of AL [1,2,4,8,16] in Table 8 and configuration of number of PDCCH candidates in Table 9, which may cause confusion for reader. To address this concern, FL made some editorial changes with using ‘Ax’ for PDCCH AL distribution configuration in Table 8 and keeping ‘Cx’ for configuration of number of PDCCH candidates.  Two responses continue raising concerns about evaluation results of Ax other than A1 and the number of simultaneously scheduled UE > 5. However, as clarified by FL, whether or not to capture the A2/A3/others are separate discussion as planned in GTW session and not focus of this discussion. The intention of this discussion is to ensure that no concern on the formulation of Table themselves. Once the A2/A3/others are addressed, we can directly agree all tables or simply excluding the tables of A2/A3 based on the outcome of GTW.  One response indicates to discuss the definition of newly added column “Blocking rate increase compared to Case 1”. First of all, FL would like to clarify why this column is needed. Eventually, what needs to be captured in TR is the increase of blocking rate caused by the reduced BDs. On one hand, FL agreed with the response that how to make observations based on these columns, i.e. absolute increase (i.e. newly added column) and/or relative increase should be discussed and concluded. On the other hand, this discussion supposed to be in observation section and not here. Hence, FL plans to trigger discussions on this response on the observation section.    **[FL5]** **Proposal 8.2.3.1-1:** If A2/A3/others would be agreed for inclusion in the TR, incorporate the revised Table 8/9, Table 10A/10B/10C/10D, Table 11A/11B/11C/11D/ 11E into Redcap TR 38.875.   * It is up to TR editor to use a separate excel sheet to include these Tables or directly capture these tables for inclusion in the TR. * The table will be further updated with potential updated PDCCH blocking results. | |
| vivo | If AL distributions other than A1 are to be captured, we think a statement like the following should be added into the TR  “there is no common understanding in RAN1 regarding the validity of AL distributions other than C1” | |
| Huawei, HiSilicon | For our results, there are some places where the note is not captured correctly, e.g. some of the note is not applicable and some note is missed for the corresponding row. Therefore, we update the Note in the table. After the revision, we support the FL5’s Proposal 8.2.3.1-1. | |
| ZTE,sanechips | We are fine with the FL5’s Proposal 8.2.3.1-1 | |
| Futurewei | Ok to capture. Vivo’s note is not necessary | |
| Ericsson | We are fine with FL’s proposal (although we think that there are invalid configurations in Table 9, as we also commented in our response to FL4). Additionally, we are also okay to capture relative increase.  Agree with Futurewei. Vivo’s note is not required. | |

**[FL6]** **Proposal 8.2.3.1-2:** If A2/A3/others would be agreed for inclusion in the TR, incorporate the revised Table 8/9, Table 10A/10B/10C/10D, Table 11A/11B/11C/11D/ 11E into Redcap TR 38.875.

* It is up to TR editor to use a separate excel sheet to include these Tables or directly capture these tables for inclusion in the TR.
* The table will be further updated with potential updated PDCCH blocking results.

**On Observations**

Similar as drafting observations for evaluation results of power saving gain, it is necessary to first agree sort of high-level methodology regarding how to formulate the observations based on the collected results e.g. how to separate observations for PDCCH blocking rate performance.

The following was agreed in Thursday GTW session:

|  |
| --- |
| Agreements: Using both absolute increase and relative increase (as summarized in R1-2009571) to capture the observations for PDCCH blocking rate increase into TR 38.875.  Agreements: Separate the following observations to capture the PDCCH blocking rate increase into TR 38.875:   * + Separate observations for Aggregation Level (AL) distributions for AL [1,2,4,8,16] i.e. C1/C2/C3/Others.   + Separate observations for number of simultaneously scheduled UEs X.   + Separate observations for 25% and 50% reduction in BD limit.   + FFS separate observations for baseline parameters and optional parameters, including comparison between baseline parameters and optional parameters. |

**[FL5] Q 8.2.3.1-3: Which of the two options can be used to capture PDCCH blocking rate impact? If none of them, what other method can be considered? Please provide detailed answer if new methodology is preferred.**

* **Option 1:**
* Step 1: Determine the % (smallest PDCCH blocking rate) and% (largest PDCCH blocking rate) value of Case 1 based on the smallest and largest values reported by each company ‘ at least considering:
  + Note that: <%~% > vector is generated on a per company basis at this step.
* Step-2: Determine average/mean value average\_a of and excluding the smallest and the largest values of % and % among companies.
  + , where K denotes the number of source companies that simulated X<=5 and X>5 cases, respectively.
* Step-3: Reuse the same approach to derive the and values.
* Step-4: Determine the absolute increase and relative increase as follows:
  + X% = [(~].
  + Y% = [(~].
* Step-5: Capture the following into TR for PDCCH blocking rate impact based on the template in Q 8.2.3.1-1

|  |
| --- |
| * For FR1 with AL distribution configuration A1 in Table 8, it was observed that the PDCCH blocking rate is increased X% from [which corresponds to Y% increase relative to [ |

* Explicitly mention the result/observations if it was provided by a few source companies e.g. 1 or 2 with special setup or assumptions.
* **Option 2:** 
  + Step 1: Determine a single average/mean value based on values reported by each company ‘
    - for company ‘j’. M represents the number of configurations simulated by company ‘j’ for the corresponding case, e.g. **X<=5.**
  + Step 2: Determine a single average/mean value by averaging the values from different companies for a sperate observation, excluding the smallest and the largest values of among companies.
    - , K denotes the number of source companies that simulated a same observation configuration e.g. Table 10A after excluding the smallest and largest value.
  + Reuse the same approach to derive the
  + Step-4: Determine the absolute increase and relative increase as follows:
    - X% = [-].
    - Y% = [(].
  + Step-5: Capture the following into TR for PDCCH blocking rate impact based on the template in Q 8.2.3.1-1

|  |
| --- |
| For FR1 with AL distribution configuration A1 in Table 8, it was observed that the PDCCH blocking rate is increased X% from [which corresponds to Y% increase relative to [ |

* Explicitly mention the result/observations if it was provided by a few source companies e.g. 1 or 2 with special setup or assumptions.

Please carefully check and provide detailed comments if propose to use different approaches.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Samsung | Y with modification | We prefer Option 1 with a range for X%, and Y%. The range is necessary to reflect different assumptions on additional configuration not discussed or unavoidable errors of the simulation.  In addition, it’s not clear what observation we expect to get from the last bullet. We think the special setup or assumptions related to enhancements for reducing PDCCH blocking are essential. For example, DCI size budget reduction, or one PDCCH to schedule multiple PDSCHs.  Therefore, we suggest the following modification.   * Explicitly mention the result/observations ~~if it was provided by a few source companies e.g. 1 or 2~~ with special setup or assumptions to mitigate PDCCH blocking rate. |
| Intel | Y | Option 1 is OK. We may clarify that a1 and a2 correspond to blocking rate of baseline? |
| vivo | Option 2 with modifications | We think the methodology should be able to achieve the following   1. For each of the co-scheduled UE number X, to derive a representative blocking rate based on the average across different companies. The reason of doing so is that the blocking rate is highly dependent on the assumption on the number of co-scheduled UEs therefore we should not mix the results across different number of co-scheduled UEs since that will lose some important information. Furthermore, we do not think the results with X>5 should be captured, as there is no evidence that the system will operator like that in a practical scenario. 2. Different representative blocking rate values are provided for each BD reduction rate, i.e. 50% reduction, 25% reduction, no reduction…   Based on above, we suggest the following modifications to Option 2.   * **Option 2:**    + ~~Step 1: Determine a single average/mean value based on values reported by each company ‘~~      - ~~for company ‘j’. M represents the number of configurations simulated by company ‘j’ for the corresponding case, e.g.~~ **~~X<=5.~~**   + Step 2: For each of the co-schedule UE number M (1<M<5), Determine a single average/mean value by averaging the values from different companies for a sperate observation, excluding the smallest and the largest values of among companies.     - , K denotes the number of source companies that simulated a same observation configuration e.g. Table 10A after excluding the smallest and largest value.   + Reuse the same approach to derive the   + Step-4: Determine the absolute increase and relative increase as follows:     - X% = [-].     - Y% = [(].   + Step-5: Capture the following into TR for PDCCH blocking rate impact based on the template in Q 8.2.3.1-1  |  | | --- | | For FR1 with AL distribution configuration A1 in Table 8, it was observed that the PDCCH blocking rate is increased X% from [which corresponds to Y% increase relative to [ | |
| Huawei, HiSilicon |  | Option 2 is preferred. |
| Nokia, NSB |  | Option 2 is preferred |
| CATT |  | Option1 is preferred |
| ZTE,sanechips | Option2 with modification | From our understanding, for option 1, means the minimum average blocking rate with UE number 2 for case1 and UE number 6 for case2. means the maximum average blocking rate with UE number 5 for case1 and UE number 10 for case2. So actually, the average UE blocking rate is based on the UE number 1,5,6,10 in the form of absolute increase and relative increase. In another word, X%=[(increased blocking rate for UE number 2~(increased blocking rate for UE number 5)] for case 1. We are OK with the blocking rate based on each UE number. However, if only some typical UE numbers are selected, a uniform distribution is preferred for us, e.g.,2,4,6,8.  So we generally agree on vivo’s method, and a further modification is needed as following: can be replaced as which means the blocking rate value from company *i* with UE number *M*, where M={2,4,6,8} is preferred for us.  Last, BTW, we are a little confused about the meaning of M (the number of configurations simulated by company ‘j’ ) in the step1 of option2. Maybe there needs a clarification. |
| Futurewei |  | Option 2 |
| Ericsson |  | Option 2 is preferred. |

**Summary of 5th round email discussions.**

Companies position is summarized in the following Table:

|  |  |  |
| --- | --- | --- |
|  | Companies | # of Companies |
| Option1 | Samsung, CATT | 2 |
| Option 2 | Vivo, Huawei, HiSilicon, ZTE, Sanechips, Futurewei, Ericsson, [Intel] | 8 |

One response indicates that is some ambiguity regarding the words “M (the number of configurations simulated by company ‘j’ ) in the step1 of option2.”. FL updates the proposals with some clarifications to make it clearer.

**[FL6] Proposal 8.2.3.1-3: Using the following methodology to capture PDCCH blocking rate impact:**

* **Option 2:** For each of the co-schedule UE numbers denoting as ‘N’ (1<N<=10)
  + Step 1: Determine a single average/mean value based on values reported by each company ‘ with existing Rel-15/16 schemes for DCI transmission
    - for company ‘j’. M represents the number of configurations that are simulated by company ‘j’ for ‘N’ co-scheduled UEs in a slot.
  + Step 2: Determine a single average/mean value by averaging the values from different companies for a sperate observation, excluding the smallest and the largest values of among companies if number of source companies > 3.
    - , where ‘K’ denotes the number of source companies that simulated a same observation configuration (e.g. ‘N=2’ in Table 10A) after excluding the smallest and largest value.
  + Step-3: Reuse the same approach to derive the for Case 2 and Case 3 with 25% and 50% BD reduction.
  + Step-4: Determine the absolute increase and relative increase as follows:
    - X\_N% = [-].
    - Y\_N% = [(].
  + Step-5: Capture the following into TR for PDCCH blocking rate impact based on the template in Q 8.2.3.1-1

|  |
| --- |
| For FR1 with AL distribution configuration A1 in Table 8 with ‘N’ co-scheduled UE in a slot, it was observed that the PDCCH blocking rate is increased X\_N% from [which corresponds to Y\_N% increase relative to [ |

Note that it is necessary to not exclude the smallest and highest values for the case when number of source companies <=3, since if we do that, essentially only one company result is captured without averaging for 3 sources and does not work for 1 or 2 sources (exists for several configurations as detailed below).

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y |  |
| Qualcomm | Y |  |
| Intel | Y |  |
| Samsung | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y | Small edit is Step 3:  Step-3: Reuse the same approach to derive the Average\_b\_N for Case 2 and Case 3 with approximately 25% and 50% BD reduction. |
| CATT | Y |  |
| LG | Y |  |
| Huawei, HiSilicon | Y with slight change | We are fine if the number N is clarified that this does not mean we will have separate observation for each value in the range of 0<N<=10.  **Option 2:** For ~~each~~ the co-schedule UE numbers to be used for the observations denoting as ‘N’ (1<N<=10) |
| Fraunhofer | Y |  |
|  |  |  |

**[FL6] Proposal 8.2.3.1-4: Capturing the following formulation for PDCCH blocking rate impact observations decoding into TR 38.875 section 8.2.3.1.**

* The observation for PDCCH blocking rate impact is formulated using the vector format: , which represents the following:
  + With co-scheduled UEs in a slot and reduction in maximum PDCCH blind decoding, the PDCCH blocking rate is increased approximately from , which corresponds to increase relative to . With co-scheduled UEs in a slot and reduction in maximum PDCCH blind decoding, the PDCCH blocking rate is increased approximately from , which corresponds to increase relative to .

Note that this unified formulation is important to avoid messing up TR with repeated wording to capture PDCCH blocking rate for different cases. We have in total 10 tables for FR1 and each table includes 10 configuration of UE numbers, which results 10\*10 = 100!! Repeated description words/paragraphs and 10+ pages to simply capture this PDCCH blocking impacts section with repeated words. TR can be significantly simplified by this unified formulation, which was proved in following sections.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Company** | | **Y/N** | **Comments** | |
| vivo | | Y with clarifications | We are fine with the proposed formulation in general. Just one clarification, we understand A% is the blocking rate for the case with no BD reduction, if so there is no need to separate it as A1% and A2% in the sub-bullet, since everything is compared with a single baseline? | |
| Qualcomm | | Y |  | |
| Intel | | Y with clarifications | “co-scheduled” should be replaced by “simultaneously scheduled” to be consistent with the wording of the note. Otherwise, options seem to include cases where UEs can be scheduled in TDM manner within a slot. | |
| Samsung | | Y |  | |
| Futurewei | | Y |  | |
| InterDigital | | Y |  | |
| Ericsson | | Y | We have also the same question as Vivo. | |
| CATT | | Y |  | |
| LG | | Y | A1 and A2 are not clear. | |
| Huawei, HiSilicon | | Yes with modifications | | | In general we think this is a good way to develop the formulation. However, we think the formulation needs to be flexible enough, and not to exclude observations due to the formulation. Considering besides the A and z1 values we can make observations which also consider other aspects, e.g. how the z1 is achieved, we propose to add optional field [Note] in the formulation.  We can put anything that needs to be explicitly explained in the optional field [N1/N2]. | |
| Fraunhofer | | Y |  | |
|  | |  | | |  | |

To avoid misunderstanding on the averaged PDCCH blocking rate results caused by varied number of sources companies (e.g. PDCCH blocking rate with 7 vs. 8 UEs), the following general description was proposed, like what we did for the observations of power saving gain section:

**[FL6]** **Proposal 8.2.3.1-5: Capturing the following into the TR 38.875:**

* In general, it is expected that the PDCCH blocking rate caused by a given BD reduction is increased with a larger number of co-scheduled UEs in a slot.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | The actual PDCCH blocking rate will certainly increase when the co-scheduled UEs in a slot is increased, this is regardless whether BD reduction is applied or not, we are not sure about the necessity of this proposal. If it needs to be captured, suggest the following revisions.  In general, it is expected that the PDCCH blocking rate ~~caused by a given BD reduction~~ is increased with a larger number of co-scheduled UEs in a slot. |
| Qualcomm |  | This proposal is quite vague. It is hard to say how general this “in general” is. If the PDCCH blocking rate already saturated when the number of UEs is large, there is not much increase of blocking probability due to BD reduction anymore. This also depends on whether CCEs is the gating factor. |
| Intel | N | We think such observation is obvious and need not be captured. It is not clear what is implied by “larger number of UEs” – greater than 3-4 UEs or greater than 10-20 UEs and also agree with Vivo that this does not depend on any BD reduction. Thus, if we really want a basic observation, it should be updated as (including Vivo’s suggestion):  In general, for a given set of physical resources for mapping PDCCH CORESET(s), it is expected that the PDCCH blocking rate ~~caused by a given BD reduction~~ is increased with a larger number of simultaneously scheduled UEs. ~~co-scheduled UEs in a slot.~~ |
| Samsung |  | We agree with the modification from Intel. |
| Futurewei |  | Okay to capture, although a little bit on the obvious side… |
| InterDigital | Y | Ok with Intel’s modification. |
| Ericsson | N | We suggest further clarifying this proposal:  Does it mean the increase of blocking rate due to the BD reduction increases with a larger number of co-scheduled UEs in a slot?   * this is not necessarily true, for example for large number of UEs (e.g., 10) the blocking rate can be high (close to 1) and almost the same for both the reference case and the reduced BD case   Or does it mean the blocking rate increases with a larger number of co-scheduled UEs in a slot?   * this is always correct, irrespective of the BD limit. |
| Sharp | N | Agree with Qualcomm. It is too obvious to expect an increase. But the focus should be how much the increase/impact is. |
| Huawei, HiSilicon | Y with modifications | We think it is needed to capture the observation with some revision:  In general, it is expected that the PDCCH blocking rate caused by a given BD reduction without reduced number of DCI sizes is increased with a larger number of co-scheduled UEs in a slot. If the number of DCI sizes is reduced also, the PDCCH blocking rate is not increased. |
| Fraunhofer | Y | Ok with Intel’s version. |
|  |  |  |

**[FL6]** **Proposal 8.2.3.1-6:** For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 10A:

* 10 sources ([vivo], [Ericsson], [Qualcomm], [Nokia], [Huawei, HiSilicon], [InterDigital], [Intel],[ZTE], [Samsung], [Futurewei]) reported the evaluation results of PDCCH blocking rate for FR1 with baseline evaluation parameters in Table 6 and configuration ‘A1’ in Table 8. The following was observed for PDCCH blocking rate performance impact for FR1 with AL distribution configuration A1:
* < 2, 1.63%, [25%, 0.39%, 23.9%], [50%, 0.77%, 47.11%] >
* < 3, 2.70%, [25%, 0.71%, 30.85%], [50%, 1.28%, 47.26%] >
* < 4, 3.22%, [25%, 0.99%, 30.85%], [50%, 4.35%, 135.32%] >
* < 5, 4.07%, [25%, 1.98%, 48.68%], [50%, 6.81%, 167.16%] >
* < 6, 4.84%, [25%, 2.25%, 48.68%], [50%, 9.70%, 200.54%] >
* < 7, 5.34%, [25%, 6.36%, 119.24%], [50%, 15.8%, 296%] >
* < 8, 9.81%, [25%, 4.54%, 46.24%], [50%, 16.21%, 165.24%] >
* < 9, 7.32%, [25%, 7.79%, 106.43%], [50%, 19.59%, 267.74%] >
* < 10, 10.39%, [25%, 11.84%, 113.99%], [50%, 17.71%, 170.45%] >

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | There has been no justification of co-scheduled users in a slot > 4 in practical deployment. If the bullets with co-scheduled users > 4 is to be captured, we should also capture a observation:  The probability of co-scheduled users in a slot larger than 4 is low. |
| Qualcomm | Y |  |
| Intel | Y | We also suggest to capture the note that results/observations based on A1 are prioritized for recommendations. |
| Samsung | Y | We think it’s necessary to capture the results for large co-located UEs, too. The co-scheduled RedCap UEs could be larger for some use cases, such as industrial wireless sensors. |
| Futurewei | Y | Okay. Suggest to have one decimal only |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Regarding the number of PDCCH candidates in Table 9, for the baseline (Case 1), C4, C6 and C10 are invalid configurations. Similarly, for Case 2 (25% BD reduction), C7, C9, C13, and for Case 3 (50% BD reduction), C6 and C12 are invalid. Note that, according to TS 38.331, search space configuration, the number of PDCCH candidates should be among {0, 1, 2, 3, 4, 5, 6, 8}. The results provided for invalid configurations may not be reasonable, for example 0% increase in the blocking rate with a 50% BD reduction. Therefore, in order to have more accurate results, we think invalid configurations need not be included. |
| LG | Y |  |
| Huawei, HiSilicon | Y with modifications | Besides the observations above, we should give observations and analysis on the results with 0% PDCCH blocking rate increase, which is very important and meaningful for the network. |

**[FL6]** **Proposal 8.2.3.1-7:** For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 10B:

* Evaluation results of PDCCH blocking rate were reported for FR1 with configuration ‘A2’ in Table 8 and the baseline evaluation parameters in Table 6.
  + 5 sources ([Ericsson], [Qualcomm], [Nokia], [ZTE], [Samsung]) reported the following evaluation results:
    - < 2, 6.6%, [25%, 0.1%, 1.52%], [50%, 1.63%, 24.62%] >
    - < 3, 13.15%, [25%, 0.18%, 1.33%], [50%, 3.95%, 30.04%] >
    - < 4, 20.18%, [25%, 0.3%, 1.49%], [50%, 3.33%, 16.48%] >
    - < 6, 36.53%, [25%, 1.03%, 2.83%], [50%, 4.37%, 11.95%] >
  + 3 sources ([Qualcomm], [Nokia] [Samsung]) reported the following evaluation results:
    - < 5, 37.32%, [25%, 1.58%, 4.24%], [50%, 8.95%, 23.98%] >
    - < 7, 47.38%, [25%, 2.33%, 4.92%], [50%, 8.67%, 18.29%] >
  + 3 sources ([Qualcomm], [ZTE] [Samsung]) reported the following evaluation results:
    - <8, 33.58%, [25%, 2.68%, 7.99%], [50%, 10.30%, 30.67%]>
* 2 sources ([Qualcomm], [Samsung]) reported the following evaluation results:
  + <9, 29.55%, [25%, 3.95%, 13.37%], [50%, 13.58%, 45.94%]>
  + <10, 33.75%, [25%, 3.98%, 11.78%], [50%, 13.43%, 39.78%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | N | We repeat our comment as before, A2 is unreasonable AL distribution. Even looking at the baseline case with no BD reduction, the baseline blocking rates A% are unreasonably high. The system does not work well with 20% blocking rate and above, there is no value to capture results for unreasonable setup. |
| Qualcomm | Y |  |
| Intel | N | As Vivo mentioned, A2 is not a realistic configuration as it results in high blocking rate without even considering BD reduction.  If at all anything needs to be captured since companies have reported the results, a note should be added as follows:  **Note: Configuration A2 may not be a typical configuration in practice since prohibitively large blocking rate is observed for simultaneously scheduling multiple UEs even without BD reduction.** |
| Samsung | Y |  |
| Futurewei | Y | All distributions should be included |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Please see our comment for **[FL6]** **Proposal 8.2.3.1-6** |
| LG | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6]** **Proposal 8.2.3.1-8:** For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 10C.

* Evaluation results of PDCCH blocking rate were reported for FR1 with configuration ‘A3’ in Table 8 and the baseline evaluation parameters in Table 6.
* 3 sources ([Qualcomm], [Samsung]), [ZTE] or [Ericsson]) reported the following evaluation results:
* <2, 16.73%, [25%, 2.78%, 16.63%], [50%, 4.88%, 29.18%]>
* <3, 27.90%, [25%, 4.47%, 16.01%], [50%, 8.08%, 28.97%]>
* <4, 36.47%, [25%, 4.6%, 12.61%], [50%, 9.07%, 24.86%]>
* 2 sources ([Qualcomm], [Samsung]) reported the following evaluation results:
  + <5, 33.9%, [25%, 7.33%, 21.61%], [50%, 12.75%, 37.61%]>
* 4 sources ([Qualcomm], [Samsung]]), [ZTE], [Ericsson]) reported the following evaluation results:
  + <6, 63.88%, [25%, 0.62%, 0.98%], [50%, 2.2%, 3.44%]>
* 2 sources ([Qualcomm], [Samsung]) reported the following evaluation results:
  + <7, 44.62%, [25%, 6.38%, 14.42%], [50%, 12.7%, 28.73%]>
  + <9, 52.75%, [25%, 4.35%, 8.25%], [50%, 10.15%, 19.24%]>
  + <10, 56.35%, [25%, 2.85%, 5.06%], [50%, 9.12%, 16.19%]>
* 2 sources ([Qualcomm], [ZTE]) reported the following evaluation results:
  + <8, 56.65%, [25%, 3.42%, 6.03%], [50%, 8.43%, 14.89%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | N | Same comment as before. The baseline blocking rate results for A3 is even more weird than A2. We cannot imagine any operator will run the system with such high blocking rate therefore no value to capture the results for such unreasonable setup. |
| Qualcomm | Y |  |
| Intel | N | Similarly as above, A3 is not a realistic configuration as it results in high blocking rate without even considering BD reduction.  If at all anything needs to be captured since companies have reported the results, at note should be added as follows:  **Note: Configuration A3 may not be a typical configuration in practice since prohibitively large blocking rate is observed for simultaneously scheduling multiple UEs even without BD reduction.** |
| Samsung | Y |  |
| Futurewei | Y | Cf previous comment |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Please see our comment for **[FL6]** **Proposal 8.2.3.1-6** |
| LG | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6]** **Proposal 8.2.3.1-9:** For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 10D:

* 1 source ([Huawei, HiSilicon]) reported the following evaluation results of PDCCH blocking rate for FR1 with baseline evaluation parameters in Table 6 and configuration ‘A4’ in Table 8:
  + <5, 12.3%, [25%, 1.5%, 12.20%], [50%, 4%, 32.52%]>
  + <10, 29.4%, [25%, 4.5%, 15.31%], [50%, 4.9%, 16.67%]>
* 1 source ([Panasonic]) reported the following evaluation results of PDCCH blocking rate for FR1 with baseline evaluation parameters in Table 6 and configuration ‘A7’ in Table 8:
  + <4, 5.93%, [25%, 1.1%, 18.55%], [50%, 8%, 134.91%]>
  + <6, 10.1%, [25%, 3.6%, 35.64%], [50%, 13.1%, 129.7 %]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | No strong view. Although evaluated by single company, but the baseline blocking rate shown in A4 and A7 seems in a reasonable range compare to A2 or A3. |
| Qualcomm | Y |  |
| Intel |  | A4 and A7 are more reasonable choices for practical operation. We are Ok to capture them. |
| Samsung | Y |  |
| Futurewei | Y | Cf previous comment |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Please see our comment for **[FL6]** **Proposal 8.2.3.1-6** |
| LG | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6]** **Proposal 8.2.3.1-10:**

For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 11A:

* 1 source ([vivo]) reported the evaluation results of PDCCH blocking rate for FR1 with configuration ‘A1’ in Table 8 and the baseline evaluation parameters in Table 6 except 15kHz SCS and 20MHz.
* <2, 0%, [25%, 1.36%, N/A], [50%, 1.17%, N/A]>
* <3, 0.56%, [25%, 1.58%, 284.14%], [50%, 1.76%, 314.29%]>
* <4, 1.31%, [25%, 1.63%, 124.43%], [50%, 2.04%, 155.73%]>
* <5, 1.9%, [25%, 1.83%, 96.32%], [50%, 2.24%, 117.89%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y | We support to capture different results for AL distribution “A1” |
| Qualcomm | Y |  |
| Intel | Y |  |
| Samsung | Y |  |
| Futurewei | Y | Cf previous comment |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Please see our comment for **[FL6]** **Proposal 8.2.3.1-6** |
| LG | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6]** **Proposal 8.2.3.1-11:**

For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 11B:

* Evaluation results of PDCCH blocking rate were reported for FR1 with configuration ‘A1’ in Table 8 and the baseline evaluation parameters in Table 6 except the following: 15kHz SCS/20 MHz BW and 3-symbols CORESET duration.
  + - 3 sources ([vivo], [Nokia], [Intel]) reported the following evaluation results:
* <2, 0%, [25%, 0.3%, N/A], [50%, 0.3%, N/A]>
* <3, 0.67%, [25%, 0.6%, 89.55%], [50%, 1.13%, 167.91%]>
* <4, 0.88%, [25%, 0.88%, 100%], [50%, 1.88%, 213.64%]>
* <5, 2.54%, [25%, 2.34%, 92.13%], [50%, 4.37%, 172.05%]>
* 1 source ([Nokia]) reported the following evaluation results with using C2 in Table 9 as number of PDCCH candidates for AL [1,2,4,8,16]
  + <6, 10%, [25%, 2%, 20%], [50%, 6%, 60%]>
  + <7, 12.50%, [25%, 2%, 16%], [50%, 7%, 56%]>
* 2 sources ([Nokia], [Intel]) reported the evaluation result:
  + <8, 9.04%, [25%, 2%, 22.14%], [25%, 6.61%, 73.10%]>
* 1 source ([Intel]) reported the following evaluation results with using C10 in Table 9 as number of PDCCH candidates for AL [1,2,4,8,16]:
* <10, 0.2%, [25%, 0%, 0%], [50%, 0.4%, 200%]>
* <15, 1.8%, [25%, 0%, 0%], [50%, 0.7%, 38.89%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y | We support to capture different results for AL distribution “A1” |
| Qualcomm | Y |  |
| Intel | Y |  |
| Samsung | Y |  |
| Futurewei | Y | Cf previous comment |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Please see our comment for **[FL6]** **Proposal 8.2.3.1-6** |
| LG | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6]** **Proposal 8.2.3.1-12:**

For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 11C:

* 1 source ([ZTE]) reported the evaluation results of PDCCH blocking rate for FR1 with configuration A1/A2/A3 in Table 8 and baseline evaluation parameters in Table 6 except the following parameters: 15kHz SCS/20 MHz BW and 1/2/3 slots delay tolerance.
  + The following was observed for AL distribution configuration ‘A1’:
    - <2, 0%, [25%, 0%, N/A], [50%, 0.08%, N/A]>
    - <4, 0.05%, [25%, 0.01%, 21.4%], [50%, 0.33%, 707%]>
    - <6, 0.18%, [25%, 0.12%, 70%], [50%, 0.65%, 366%]>
    - <8, 0.44%, [25%, 0.27%, 63%], [50%, 0.99%, 227%]>
  + The following was observed for AL distribution configuration ‘A2’:
    - <2, 0%, [25%, 0.76%, N/A], [50%, 2.02%, N/A]>
    - <4, 2.48%, [25%, 1.80%, 72.58%], [50%, 6.53%, 263%]>
    - <6, 10.23%, [25%, 0.91%, 8.9%], [50%, 6.68%, 65.30%]>
    - <8, 18.23%, [25%, 0.65%, 3.57%], [50%, 6.30%, 34.56%]>
  + The following was observed for AL distribution configuration ‘A3’:
    - <2, 0%, [25%, 0.03%, N/A], [50%, 0.03%, N/A]>
    - <4, 23.58%, [25%, 0.74%, 3.14%], [50%, 3.03%, 12.85%]>
    - <6, 39.39%, [25%, 0.11%, 0.28%], [50%, 2.16%, 5.48%]>
    - <8, 48.95%, [25%, 0.23%, 0.47%], [50%, 2.55%, 5.21%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Partially Y | We support to capture different results for AL distribution “A1” (i.e. 1st sub-bullet)  We do not agree to capture results for AL distribution ”A2” or “A3” (i.e. 2nd and 3rd sub-bullet), the reason has been explained before. |
| Qualcomm | Y |  |
| Intel | Y for A1 only |  |
| Samsung | Y |  |
| Futurewei | Y | Cf previous comment |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Please see our comment for **[FL6]** **Proposal 8.2.3.1-6** |
| LG | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6]** **Proposal 8.2.3.1-13:** For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 11D:

* 1 source ([vivo]) reported the evaluation results of PDCCH blocking rate for FR1 with configuration A1 in Table 8 and baseline evaluation parameters in Table 6 except 3-symbols CORESET duration is assumed. The following was observed:
  + <2, 0.67%, [25%, 0.91%, 135%], [50%, 0.81%, 120.9%]>
  + <3, 1.62%, [25%, 1.33%, 82%], [50%, 1.51%, 93.21%]>
  + <4, 2.34%, [25%, 2.05%, 87.6%], [50%, 2.46%, 105.13%]>
  + <5, 3.35%, [25%, 2.39%, 71.3%], [50%, 2.46%, 73.43%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y | We support to capture different results for AL distribution “A1” |
| Qualcomm | Y |  |
| Intel | Y |  |
| Samsung | Y |  |
| Futurewei | Y | Cf previous comment |
| InterDigital | Y |  |
| Ericsson | Y, with modifications | Please see our comment for **[FL6]** **Proposal 8.2.3.1-6** |
| LG | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6]** **Proposal 8.2.3.1-14:** For FR1, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR for Table 10A/10D/11E:

* 1 source ([Huawei, HiSilicon]) reported the evaluation results of PDCCH blocking rate for FR1 with configuration A4/A5/A6 in Table 8 and baseline evaluation parameters in Table 6 except 60-bits DCI payload size (not including CRC) is assumed.

The following was observed with 50% BD reduction by reducing the monitored DCI sizes from 2 to 1:

* + For configuration A1: (Results in Table 10A with ‘Note 4’)
* <5, 6.07%, [50%, 0%, 0%]>,
* <10, 17.3%, [50%, 0%, 0%]>
* For configuration A4: (Results in Table 10D with ‘Note 4’)
* <5, 12.3%, [50%, 0%, 0%]>,
* <10, 29.4%, [50%, 0%, 0%]>
* For configuration A5: (Results in Table 11E with ‘Note 1’)
  + <5, 8.6%, [50%, 0%, 0%]>,
  + <10, 23.20%, [50%, 0%, 0%]>
* For configuration A6: (Results in Table 11E with ‘Note 1’)
  + <5, 14.5%, [50%, 0%, 0%]>,
  + <10, 33.70%, [50%, 0%, 0%]>
* 1 source ([Samsung]) reported the evaluation results of PDCCH blocking rate for FR1 with configuration A1 in Table 8 and baseline evaluation parameters in Table 6 with UE group scheduling and PDCCH dropping based on predefined CCE AL priority order.

The following was observed:

* With UE group scheduling: (Results in Table 10A with “Note 6”)
  + <2, 0%, [25%, 0%, N/A], [50%, 0%, N/A]>,
  + <3, 0%, [25%, 0%, N/A], [50%, 0%, N/A]>,
  + <4, 0%, [25%, 0%, N/A], [50%, 0%, N/A]>,
  + <5, 0%, [25%, 0%, N/A], [50%, 2%, N/A]>,
  + <6, 0%, [25%, 0%, N/A], [50%, 2%, N/A]>,
  + <7, 0%, [25%, 1%, N/A], [50%, 7%, N/A]>,
  + <8, 0%, [25%, 1%, N/A], [50%, 7%, N/A]>,
  + <9, 0%, [25%, 3%, N/A], [50%, 13%, N/A]>,
  + <10, 0%, [25%, 3%, N/A], [50%, 13%, N/A]>
* With PDCCH dropping based on predefined CCE AL priority order [1,2,4,8,16]: (Results in Table 10A with “Note 7”)
  + <2, 0%, [25%, 0%, N/A], [50%, 8%, N/A]>,
  + <3, 0%, [25%, 0%, N/A], [50%, 14%, N/A]>,
  + <4, 0%, [25%, 1%, N/A], [50%, 19%, N/A]>,
  + <5, 0%, [25%, 1%, N/A], [50%, 22%, N/A]>,
  + <6, 1%, [25%, 1%, 100%], [50%, 24%, 2400%]>,
  + <7, 2%, [25%, 1%, 50%], [50%, 26%, 1300%]>,
  + <8, 3%, [25%, 2%, 67%], [50%, 28%, 933%]>,
  + <9, 6%, [25%, 1%, 17%], [50%, 28%, 467%]>
  + <10, 8%, [25%, 2%, 25%], [50%, 30%, 375%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | No strong view. |
| Intel |  | No strong view. 60 bits payload was not part of the baseline assumption. |
| Samsung | Y | The study on potential enhancements for minimizing the PDCCH blocking should be captured. |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Huawei, HiSilicon | Y |  |

**[FL6] Q 8.2.3.1-1: Except the observed above, what other observations need to be added into TR 38.875 for PDCCH blocking rate impact for FR1? Please briefly explain why, if propose to add new observations.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | Y | We should capture  1 source ([vivo]) reported the probability of number of co-scheduled UEs per slot in FR1 with non-full buffer traffic and medium cell loading, it is observed that the probability of 3 or 4 co-scheduled UEs in a slot are 2% and 0.4% respectively. |
| Qualcomm | Y |  |
| Huawei, HiSilicon | Y | We should capture:  PDCCH blocking rate increase is 0% if the number of DCI sizes is reduced by half simultaneously with the 50% BD reduction. |

#### **FR2 Results**

Table 12A: PDCCH blocking rate due to reduced blind decoding for FR2, with 120kHz, CORESET duration: 2 symbols, Delay toleration: 1, AL distribution: A1

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Company | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Comments |
| # PDCCH candidates for AL [1,2,4,8,16] in Table9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table19 | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table9 | PDCCH blocking rate | Blocking rate increase relative to Case 1 |
| 1 | Ericsson | 3 | <=2 | C2 | 1.00% | C2 | 1.2% | 0.20% | C2 | 4.4% | 3.4% | Note 1,5 |
| 6 | <= 2 | C2 | 3.90% | C2 | 6.8% | 2.90% | C2 | 14.0% | 10.1% | Note 1, 5 |
| 2 | Qualcomm | 2 | 2 | C1 | 0.20% | C5 | 0.4% | 0.20% | C1 | 4.0% | 3.8% |  |
| 4 | 2 | C1 | 1.10% | C5 | 1.9% | 0.80% | C1 | 11.4% | 10.3% |  |
| 6 | 2 | C1 | 2.60% | C5 | 4.5% | 1.90% | C1 | 17.7% | 15.1% |  |
| 8 | 2 | C1 | 5.10% | C5 | 7.8% | 2.70% | C1 | 23.5% | 18.4% |  |
| 10 | 2 | C1 | 8.40% | C5 | 12.0% | 3.60% | C1 | 28.9% | 20.5% |  |
| 12 | 2 | C1 | 12.70% | C5 | 16.6% | 3.90% | C1 | 33.5% | 20.8% |  |
| 14 | 2 | C1 | 17.70% | C5 | 21.5% | 3.80% | C1 | 38.0% | 20.3% |  |
| 16 | 2 | C1 | 22.90% | C5 | 26.5% | 3.60% | C1 | 41.7% | 18.8% |  |
| 18 | 2 | C1 | 28.20% | C5 | 31.4% | 3.20% | C1 | 45.4% | 17.2% |  |
| 20 | 2 | C1 | 33.50% | C5 | 36.1% | 2.60% | C1 | 48.7% | 15.2% |  |
| 3 | Nokia | 2 | 2 | C1 | 0.00% | C1 | 1.0% | 1.00% | C1 | 3.0% | 3.0% |  |
| 3 | 2 | C1 | 2.00% | C1 | 4.0% | 2.00% | C1 | 7.0% | 5.0% |  |
| 4 | 2 | C1 | 6.00% | C1 | 9.0% | 3.00% | C1 | 15.0% | 9.0% |  |
| 5 | 2 | C1 | 11.00% | C1 | 14.0% | 3.00% | C1 | 26.0% | 15.0% |  |
| 6 | 2 | C1 | 15.00% | C1 | 20.0% | 5.00% | C1 | 40.0% | 25.0% |  |
| 7 | 2 | C1 | 20.00% | C1 | 29.0% | 9.00% | C1 | 59.0% | 39.0% |  |
| 8 | 2 | C1 | 26.00% | C1 | 40.0% | 14.00% | C1 | 77.0% | 51.0% |  |
| 4 | Samsung | 1 | 2 | C1 | 0.00% | C2 | 5.0% | 5.00% | C2 | 8.0% | 8.0% | Note 5 |
| 2 | 2 | C1 | 0.00% | C2 | 5.0% | 5.00% | C2 | 8.0% | 8.0% | Note 5 |
| 3 | 2 | C1 | 0.00% | C2 | 7.0% | 7.00% | C2 | 14.0% | 14.0% | Note 5 |
| 4 | 2 | C1 | 1.00% | C2 | 12.0% | 11.00% | C2 | 22.0% | 21.0% | Note 5 |
| 5 | 2 | C1 | 3.00% | C2 | 18.0% | 15.00% | C2 | 31.0% | 28.0% | Note 5 |
| 6 | 2 | C1 | 7.00% | C2 | 24.0% | 17.00% | C2 | 38.0% | 31.0% | Note 5 |
| 7 | 2 | C1 | 11.00% | C2 | 31.0% | 20.00% | C2 | 45.0% | 34.0% | Note 5 |
| 8 | 2 | C1 | 16.00% | C2 | 37.0% | 21.00% | C2 | 50.0% | 34.0% | Note 5 |
| 9 | 2 | C1 | 22.00% | C2 | 42.0% | 20.00% | C2 | 55.0% | 33.0% | Note 5 |
| 10 | 2 | C1 | 26.00% | C2 | 47.0% | 21.00% | C2 | 59.0% | 33.0% | Note 5 |
| 1 | 2 | C1 | 0.00% | C2 | 5.0% | 5.00% | C2 | 8.0% | 8.0% | Note 3, 5 |
| 2 | 2 | C1 | 0.00% | C2 | 5.0% | 5.00% | C2 | 8.0% | 8.0% | Note 3, 5 |
| 3 | 2 | C1 | 0.00% | C2 | 5.0% | 5.00% | C2 | 8.0% | 8.0% | Note 3, 5 |
| 4 | 2 | C1 | 0.00% | C2 | 5.0% | 5.00% | C2 | 8.0% | 8.0% | Note 3, 5 |
| 5 | 2 | C1 | 0.00% | C2 | 7.0% | 7.00% | C2 | 14.0% | 14.0% | Note 3, 5 |
| 6 | 2 | C1 | 0.00% | C2 | 7.0% | 7.00% | C2 | 14.0% | 14.0% | Note 3, 5 |
| 7 | 2 | C1 | 1.00% | C2 | 12.0% | 11.00% | C2 | 22.0% | 21.0% | Note 3, 5 |
| 8 | 2 | C1 | 1.00% | C2 | 12.0% | 11.00% | C2 | 22.0% | 21.0% | Note 3, 5 |
| 9 | 2 | C1 | 3.00% | C2 | 18.0% | 15.00% | C2 | 31.0% | 28.0% | Note 3, 5 |
| 10 | 2 | C1 | 3.00% | C2 | 18.0% | 15.00% | C2 | 31.0% | 28.0% | Note 3,5 |
| 1 | 2 | C1 | 0.00% | C3 | 10.0% | 10.00% | C3 | 10.0% | 10.0% | Note 4,5 |
| 2 | 2 | C1 | 0.00% | C3 | 10.0% | 10.00% | C3 | 18.0% | 18.0% | Note 4,5 |
| 3 | 2 | C1 | 0.00% | C3 | 10.0% | 10.00% | C3 | 24.0% | 24.0% | Note 4,5 |
| 4 | 2 | C1 | 1.00% | C3 | 11.0% | 10.00% | C3 | 29.0% | 28.0% | Note 4,5 |
| 5 | 2 | C1 | 3.00% | C3 | 13.0% | 10.00% | C3 | 32.0% | 29.0% | Note 4,5 |
| 6 | 2 | C1 | 7.00% | C3 | 16.0% | 9.00% | C3 | 36.0% | 29.0% | Note 4,5 |
| 7 | 2 | C1 | 11.00% | C3 | 20.0% | 9.00% | C3 | 41.0% | 30.0% | Note 4,5 |
| 8 | 2 | C1 | 16.00% | C3 | 25.0% | 9.00% | C3 | 44.0% | 28.0% | Note 4,5 |
| 9 | 2 | C1 | 22.00% | C3 | 30.0% | 8.00% | C3 | 49.0% | 27.0% | Note 4,5 |
| 10 | 2 | C1 | 26.00% | C3 | 35.0% | 9.00% | C3 | 52.0% | 26.0% | Note 4,5 |
| Note 1: Digital Beamforming.  Note 3: With enhancement of UE group scheduling with 2 Ues per DCI.  Note 4: with enhancement of PDCCH drooping based on predetermined CCE AL priority order = [1 2 4 8 16]  Note 5: Good coverage | | | | | | | | | | | | |

Table 12B: PDCCH blocking rate due to reduced blind decoding for FR2, with 120kHz, CORESET duration: 2 symbols, Delay toleration: 1, AL distribution: A2

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Company | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Notes |
| # PDCCH candidates for AL [1,2,4,8,16] in Table 9 | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table9 | PDCCH blocking rate | Blocking rate ncrease relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table9 | PDCCH blocking rate | Blocking rate ncrease relative to Case 1 |
| 1 | Ericsson | 3 | <= 2 | C2 | 18.0% | C2 | 20.0% | 2.0% | C2 | 24.00% | 6.0% | Note 1,6 |
| 6 | <= 2 | C2 | 36.0% | C2 | 40.0% | 4.0% | C2 | 44.00% | 8.0% | Note 1,6 |
| 2 | Qualcomm | 1 | 2 | C1 | 0.0% | C5 | 0.0% | 0.0% | C1 | 0.00% | 0.0% |  |
| 2 | 2 | C1 | 7.4% | C5 | 7.8% | 0.4% | C1 | 10.80% | 3.4% |  |
| 3 | 2 | C1 | 14.2% | C5 | 15.3% | 1.1% | C1 | 20.30% | 6.1% |  |
| 4 | 2 | C1 | 20.4% | C5 | 22.0% | 1.6% | C1 | 28.00% | 7.6% |  |
| 5 | 2 | C1 | 25.9% | C5 | 27.9% | 2.0% | C1 | 34.50% | 8.6% |  |
| 6 | 2 | C1 | 31.2% | C5 | 33.6% | 2.4% | C1 | 40.40% | 9.2% |  |
| 7 | 2 | C1 | 35.8% | C5 | 38.4% | 2.6% | C1 | 45.30% | 9.5% |  |
| 8 | 2 | C1 | 40.3% | C5 | 43.0% | 2.7% | C1 | 49.70% | 9.4% |  |
| 9 | 2 | C1 | 44.0% | C5 | 46.7% | 2.7% | C1 | 53.30% | 9.3% |  |
| 10 | 2 | C1 | 47.5% | C5 | 50.1% | 2.6% | C1 | 56.60% | 9.1% |  |
| 3 | ZTE | 2 | 2 | C2 | 9.2% | C6 | 10.0% | 0.8% | C1 | 22.88% | 13.7% | Note 5 |
| 4 | 2 | C2 | 26.1% | C6 | 28.9% | 2.9% | C1 | 44.00% | 18.0% | Note 5 |
| 6 | 2 | C2 | 40.9% | C6 | 43.3% | 2.5% | C1 | 54.92% | 14.1% | Note 5 |
| 8 | 2 | C2 | 51.9% | C6 | 54.3% | 2.5% | C1 | 62.61% | 10.7% | Note 5 |
| 4 | Samsung | 1 | 2 | C1 | 0.0% | C2 | 40.0% | 40.0% | C2 | 61.00% | 61.0% | Note 5 |
| 2 | 2 | C1 | 11.0% | C2 | 42.0% | 31.0% | C2 | 61.00% | 50.0% | Note 5 |
| 3 | 2 | C1 | 19.0% | C2 | 45.0% | 26.0% | C2 | 61.00% | 42.0% | Note 5 |
| 4 | 2 | C1 | 25.0% | C2 | 47.0% | 22.0% | C2 | 62.00% | 37.0% | Note 5 |
| 5 | 2 | C1 | 30.0% | C2 | 50.0% | 20.0% | C2 | 63.00% | 33.0% | Note 5 |
| 6 | 2 | C1 | 35.0% | C2 | 52.0% | 17.0% | C2 | 64.00% | 29.0% | Note 5 |
| 7 | 2 | C1 | 39.0% | C2 | 54.0% | 15.0% | C2 | 66.00% | 27.0% | Note 5 |
| 8 | 2 | C1 | 43.0% | C2 | 56.0% | 13.0% | C2 | 67.00% | 24.0% | Note 5 |
| 9 | 2 | C1 | 46.0% | C2 | 58.0% | 12.0% | C2 | 68.00% | 22.0% | Note 5 |
| 10 | 2 | C1 | 49.0% | C2 | 60.0% | 11.0% | C2 | 69.00% | 20.0% | Note 5 |
| 1 | 2 | C1 | 0.0% | C2 | 40.0% | 40.0% | C2 | 61.00% | 61.0% | Note3, 5 |
| 2 | 2 | C1 | 0.0% | C2 | 40.0% | 40.0% | C2 | 61.00% | 61.0% | Note3, 5 |
| 3 | 2 | C1 | 11.0% | C2 | 42.0% | 31.0% | C2 | 61.00% | 50.0% | Note3, 5 |
| 4 | 2 | C1 | 11.0% | C2 | 42.0% | 31.0% | C2 | 61.00% | 50.0% | Note3, 5 |
| 5 | 2 | C1 | 19.0% | C2 | 45.0% | 26.0% | C2 | 61.00% | 42.0% | Note3, 5 |
| 6 | 2 | C1 | 19.0% | C2 | 45.0% | 26.0% | C2 | 61.00% | 42.0% | Note3, 5 |
| 7 | 2 | C1 | 25.0% | C2 | 47.0% | 22.0% | C2 | 62.00% | 37.0% | Note3, 5 |
| 8 | 2 | C1 | 25.0% | C2 | 47.0% | 22.0% | C2 | 62.00% | 37.0% | Note3, 5 |
| 9 | 2 | C1 | 30.0% | C2 | 50.0% | 20.0% | C2 | 63.00% | 33.0% | Note3, 5 |
| 10 | 2 | C1 | 30.0% | C2 | 50.0% | 20.0% | C2 | 63.00% | 33.0% | Note3, 5 |
| 1 | 2 | C1 | 0.0% | C4 | 0.0% | 0.0% | C4 | 20.00% | 20.0% | Note 4, 5 |
| 2 | 2 | C1 | 11.0% | C4 | 11.0% | 0.0% | C4 | 30.00% | 19.0% | Note 4, 5 |
| 3 | 2 | C1 | 19.0% | C4 | 19.0% | 0.0% | C4 | 38.00% | 19.0% | Note 4, 5 |
| 4 | 2 | C1 | 25.0% | C4 | 27.0% | 2.0% | C4 | 43.00% | 18.0% | Note 4, 5 |
| 5 | 2 | C1 | 30.0% | C4 | 32.0% | 2.0% | C4 | 48.00% | 18.0% | Note 4, 5 |
| 6 | 2 | C1 | 35.0% | C4 | 37.0% | 2.0% | C4 | 52.00% | 17.0% | Note 4, 5 |
| 7 | 2 | C1 | 39.0% | C4 | 41.0% | 2.0% | C4 | 55.00% | 16.0% | Note 4, 5 |
| 8 | 2 | C1 | 43.0% | C4 | 45.0% | 2.0% | C4 | 58.00% | 15.0% | Note 4, 5 |
| 9 | 2 | C1 | 46.0% | C4 | 49.0% | 3.0% | C4 | 61.00% | 15.0% | Note 4, 5 |
| 10 | 2 | C1 | 49.0% | C4 | 53.0% | 4.0% | C4 | 63.00% | 14.0% | Note 4, 5 |
| Note 1: Digital Beamforming.  Note 3: With enhancement of UE group scheduling with 2 Ues per DCI.  Note 4: with enhancement of PDCCH drooping based on predetermined CCE AL priority order = [1 2 4 8 16]  Note 5: Medium coverage | | | | | | | | | | | | |

Table 12C: PDCCH blocking rate due to reduced blind decoding for FR2, with 120kHz, CORESET duration: 2 symbols, Delay toleration: 1, AL distribution: A3

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| # | Company | # users | # DCI sizes | Case 1 | | Case 2 | | | Case 3 | | | Notes |
| # PDCCH candidates for AL [1,2,4,8,16] in Table15B | PDCCH blocking rate | # PDCCH candidates for AL [1,2,4,8,16] in Table15B | PDCCH blocking rate | Blocking rate increase relative to Case 1 | # PDCCH candidates for AL [1,2,4,8,16] in Table15B | PDCCH blocking rate | Blocking rate ncrease relative to Case 1 |
| 1 | Ericsson | 3 | <= 2 | C2 | 45.0% | C2 | 47.0% | 2.0% | C2 | 49.0% | 4.0% | Note 1, 5 |
| 6 | <= 2 | C2 | 63.0% | C2 | 65.0% | 2.0% | C2 | 67.0% | 4.0% | Note 1, 5 |
| 2 | Qualcomm | 1 | 2 | C1 | 0.0% | C5 | 0.0% | 0.0% | C1 | 0.0% | 0.0% |  |
| 2 | 2 | C1 | 21.2% | C5 | 21.7% | 0.5% | C1 | 23.1% | 1.9% |  |
| 3 | 2 | C1 | 36.2% | C5 | 37.0% | 0.8% | C1 | 39.4% | 3.2% |  |
| 4 | 2 | C1 | 46.8% | C5 | 47.9% | 1.1% | C1 | 50.5% | 3.7% |  |
| 5 | 2 | C1 | 54.1% | C5 | 55.4% | 1.3% | C1 | 58.3% | 4.2% |  |
| 6 | 2 | C1 | 59.5% | C5 | 60.9% | 1.4% | C1 | 63.8% | 4.3% |  |
| 7 | 2 | C1 | 63.9% | C5 | 65.4% | 1.5% | C1 | 68.3% | 4.4% |  |
| 8 | 2 | C1 | 67.2% | C5 | 68.7% | 1.5% | C1 | 71.5% | 4.3% |  |
| 9 | 2 | C1 | 69.7% | C5 | 71.2% | 1.5% | C1 | 74.1% | 4.4% |  |
| 10 | 2 | C1 | 71.7% | C5 | 73.1% | 1.4% | C1 | 76.1% | 4.4% |  |
| 3 | Samsung | 1 | 2 | C1 | 0.0% | C2 | 20.0% | 20.0% | C2 | 49.0% | 49.0% | Note 5 |
| 2 | 2 | C1 | 15.0% | C2 | 32.0% | 17.0% | C2 | 58.0% | 43.0% | Note 5 |
| 3 | 2 | C1 | 25.0% | C2 | 42.0% | 17.0% | C2 | 64.0% | 39.0% | Note 5 |
| 4 | 2 | C1 | 34.0% | C2 | 49.0% | 15.0% | C2 | 68.0% | 34.0% | Note 5 |
| 5 | 2 | C1 | 41.0% | C2 | 55.0% | 14.0% | C2 | 72.0% | 31.0% | Note 5 |
| 6 | 2 | C1 | 47.0% | C2 | 59.0% | 12.0% | C2 | 74.0% | 27.0% | Note 5 |
| 7 | 2 | C1 | 52.0% | C2 | 63.0% | 11.0% | C2 | 76.0% | 24.0% | Note 5 |
| 8 | 2 | C1 | 56.0% | C2 | 66.0% | 10.0% | C2 | 78.0% | 22.0% | Note 5 |
| 9 | 2 | C1 | 59.0% | C2 | 68.0% | 9.0% | C2 | 79.0% | 20.0% | Note 5 |
| 10 | 2 | C1 | 62.0% | C2 | 71.0% | 9.0% | C2 | 80.0% | 18.0% | Note 5 |
| 1 | 2 | C1 | 0.0% | C2 | 20.0% | 20.0% | C2 | 49.0% | 49.0% | Note 3, 5 |
| 2 | 2 | C1 | 0.0% | C2 | 20.0% | 20.0% | C2 | 49.0% | 49.0% | Note 3, 5 |
| 3 | 2 | C1 | 15.0% | C2 | 32.0% | 17.0% | C2 | 58.0% | 43.0% | Note 3, 5 |
| 4 | 2 | C1 | 15.0% | C2 | 32.0% | 17.0% | C2 | 58.0% | 43.0% | Note 3, 5 |
| 5 | 2 | C1 | 25.0% | C2 | 42.0% | 17.0% | C2 | 64.0% | 39.0% | Note 3, 5 |
| 6 | 2 | C1 | 25.0% | C2 | 42.0% | 17.0% | C2 | 64.0% | 39.0% | Note 3, 5 |
| 7 | 2 | C1 | 34.0% | C2 | 49.0% | 15.0% | C2 | 68.0% | 34.0% | Note 3, 5 |
| 8 | 2 | C1 | 34.0% | C2 | 49.0% | 15.0% | C2 | 68.0% | 34.0% | Note 3, 5 |
| 9 | 2 | C1 | 41.0% | C2 | 55.0% | 14.0% | C2 | 72.0% | 31.0% | Note 3, 5 |
| 10 | 2 | C1 | 41.0% | C2 | 55.0% | 14.0% | C2 | 72.0% | 31.0% | Note 3, 5 |
| 1 | 2 | C1 | 0.0% | C4 | 0.0% | 0.0% | C5 | 5.0% | 5.0% | Note 4,5 |
| 2 | 2 | C1 | 14.0% | C4 | 15.0% | 1.0% | C5 | 19.0% | 5.0% | Note 4,5 |
| 3 | 2 | C1 | 26.0% | C4 | 26.0% | 0.0% | C5 | 31.0% | 5.0% | Note 4,5 |
| 4 | 2 | C1 | 34.0% | C4 | 35.0% | 1.0% | C5 | 40.0% | 6.0% | Note 4,5 |
| 5 | 2 | C1 | 41.0% | C4 | 42.0% | 1.0% | C5 | 47.0% | 6.0% | Note 4,5 |
| 6 | 2 | C1 | 47.0% | C4 | 48.0% | 1.0% | C5 | 52.0% | 5.0% | Note 4,5 |
| 7 | 2 | C1 | 52.0% | C4 | 52.0% | 0.0% | C5 | 57.0% | 5.0% | Note 4,5 |
| 8 | 2 | C1 | 56.0% | C4 | 56.0% | 0.0% | C5 | 61.0% | 5.0% | Note 4,5 |
| 9 | 2 | C1 | 59.0% | C4 | 60.0% | 1.0% | C5 | 64.0% | 5.0% | Note 4,5 |
| 10 | 2 | C1 | 62.0% | C4 | 63.0% | 1.0% | C5 | 67.0% | 5.0% | Note 4,5 |
| Note 1: Digital Beamforming.  Note 3: With enhancement of UE group scheduling with 2 Ues per DCI.  Note 4: with enhancement of PDCCH drooping based on predetermined CCE AL priority order = [1 2 4 8 16]  Note 5: Poor coverage | | | | | | | | | | | | |

**[FL6]** **Proposal 8.2.3.1-15:** If A2/A3 would be agreed for inclusion in the TR, incorporate the revised Table 12A/12B/12C into Redcap TR 38.875

* It is up to TR editor to use a separate excel sheet to include these Tables or directly capture these tables for inclusion in the TR.
* The table will be further updated with potential updated PDCCH blocking results.

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | Y |  |
| Intel | N | We do not need to agree to this now. If A2/A3 are to be agreed, how to capture them can also be decided then. |
| Samsung | Y |  |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| LG | Y |  |

**Observations**

**[FL6]** **Proposal 8.2.3.1-16:**For FR2, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 12A:

* Evaluation results of PDCCH blocking rate were reported for FR2 with configuration ‘A1’ in Table 8 and the baseline evaluation parameters in Table 6.
  + 4 sources ([Ericsson], [Qualcomm], [Nokia], [Samsung]) reported the following evaluation results:
    - <2, 0.07%, [25%, 2.07%, 3100%], [50%, 4.93%, 7400%]>
    - <3, 1%, [25%, 3.07%, 307%], [50%, 7.47%, 747%]>
    - <4, 2.7%, [25%, 4.93%, 183%], [50%, 13.43%, 498%]>
    - <5, 7%, [25%, 9%, 129%], [50%, 21.5%, 307%]>
    - <6, 7.13%, [25%, 6.7%, 94%], [50%, 20.30%, 285%]>
    - <7, 15.50%, [25%, 14.5%, 94%], [50%, 36.5%, 235%]>
    - <8, 15.70%, [25%, 12.57%, 80%], [50%, 34.47%, 220%]>
    - <10, 17.20%, [25%, 12.3%, 72%], [50%, 26.75%, 156%]>
  + 1 source ([Samsung]) reported the following evaluation results:
    - <9, 22%, [25%, 20%, 91%], [50%, 33%, 150%]>
  + 1 source ([Qualcomm]) reported the following evaluation results:
    - <12, 12.7%, [25%, 3.9%, 31%], [50%, 20.80%, 164%]>
    - <14, 17.70%, [25%, 3.8%, 21%], [50%, 20.30%, 115%]>
    - <16, 22.90%, [25%, 3.6%, 16%], [50%, 18.80%, 82%]>
    - <18, 28.20%, [25%, 3.2%, 11%], [50%, 17.20%, 61%]>
    - <20, 33.50%, [25%, 2.6%, 8%], [50%, 15.20%, 45%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo |  | Results with reasonable number of co-scheduled UE in a slot should be captured. |
| Qualcomm | Y |  |
| Intel | Y |  |
| Samsung | Y |  |
| Futurewei | Y | Okay. Suggest to have one decimal only |
| InterDigital | Y |  |
| Ericsson | Y |  |
| LG | Y |  |

**[FL6]** **Proposal 8.2.3.1-17:** For FR2, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 12B:

* 4 sources ([Ericsson], [Qualcomm], [Nokia], [Samsung]) reported the following evaluation results of PDCCH blocking rate for FR2 with configuration ‘A2’ in Table 8 and the baseline evaluation parameters in Table 6:
  + <2, 9.2%, [25%, 10.73%, 117%], [50%, 22.36%, 243%]>
  + <3, 17.07%, [25%, 9.7%, 57%], [50%, 18.03%,106%]>
  + <4, 23.83%, [25%, 8.8%, 37%], [50%, 20.83%, 87%]>
  + <5, 27.95%, [25%, 11%, 39%], [50%, 20.8%, 74%]>
  + <6, 35.78%, [25%, 6.45%, 18%], [50%, 15.06%, 42%]>
  + <7, 37.40%, [25%, 8.8%, 24%], [50%, 18.25%, 49%]>
  + <8, 45.07%, [25%, 6.03%,13%], [50%, 14.70%, 33%]>
  + <9, 45%, [25%, 7.35%, 16%], [50%, 15.65%, 35%]>
  + <10, 48.25%, [25%, 6.8%, 14%], [50%, 14.55%, 30%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | N | A2 results in unreasonable baseline blocking rate, e.g. 20%+ blocking rate even without BD reduction. |
| Qualcomm | Y |  |
| Intel | N | Same concern as Vivo. Same comment and note (as compromise) as suggested wrt A2 in responses for FR1 can be added here as well. |
| Samsung | Y |  |
| Futurewei | Y | All distributions to be included |
| InterDigital | Y |  |
| Ericsson | Y |  |
| LG | Y |  |

**[FL6]** **Proposal 8.2.3.1-18:** For FR2, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for Table 12C:

* 3 sources ([Ericsson], [Qualcomm], [Samsung]) reported the following evaluation results of PDCCH blocking rate for FR2 with configuration ‘A2’ in Table 8 and the baseline evaluation parameters in Table 6:
  + <2, 18.10%, [25%, 8.75%, 48%], [50%, 22.45%, 124%]>
  + <3, 35.40%, [25%, 6.6%, 19%], [50%, 15.40%,44%]>
  + <4, 40.4%, [25%, 8.05%, 20%], [50%, 18.85%, 47%]>
  + <5, 47.55%, [25%, 7.65%, 16%], [50%, 17.6%, 37%]>
  + <6, 56.5%, [25%, 5.13%, 9%], [50%, 11.77%, 21%]>
  + <7, 57.95%, [25%, 6.25%, 11%], [50%, 14.2%, 25%]>
  + <8, 61.6%, [25%, 5.75%,9%], [50%, 13.15%, 21%]>
  + <9, 64.35%, [25%, 5.25%, 8%], [50%, 12.20%, 19%]>
  + <10, 66.85%, [25%, 5.2%, 8%], [50%, 11.2%, 17%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | N | A2 results in unreasonable baseline blocking rate, e.g. 20%+ blocking rate even without BD reduction. |
| Qualcomm | Y |  |
| Intel | N | Same concern as Vivo. Same comment and a similar note (as compromise) as suggested wrt A2 in responses for FR1 can be added here as well. |
| Samsung | Y |  |
| Futurewei | Y | All distributions included |
| InterDigital | Y |  |
| Ericsson | Y |  |
| LG | Y |  |

**[FL6]** **Proposal 8.2.3.1-19:** For FR2, capturing the following observation in the TR (editorial modifications by TR editor can be made for inclusion in the TR for Table 12A:

* 1 source ([Samsung]) reported the evaluation results of PDCCH blocking rate for FR2 with configuration A1 in Table 8, baseline evaluation parameters in Table 6, and with UE group scheduling or PDCCH dropping based on predefined CCE AL priority order.

The following was observed:

* With UE group scheduling: (Results in Table 12A with “Note 3”)
  + <2, 0%, [25%, 5%, N/A], [50%, 8%, N/A]>,
  + <3, 0%, [25%, 5%, N/A], [50%, 8%, N/A]>,
  + <4, 0%, [25%, 5%, N/A], [50%, 8%, N/A]>,
  + <5, 0%, [25%, 7%, N/A], [50%, 14%, N/A]>,
  + <6, 0%, [25%, 7%, N/A], [50%, 14%, N/A]>,
  + <7, 1%, [25%, 11%, 1100%], [50%, 21%, 2100%]>,
  + <8, 1%, [25%, 11%, 1100%], [50%, 21%, 2100%]>,
  + <9, 3%, [25%, 15%, 500%], [50%, 28%, 933%]>,
  + <10, 3%, [25%, 15%, 500%], [50%, 28%, 933%]>
* With PDCCH dropping based on predefined CCE AL priority order [1,2,4,8,16]: (Results in Table 12A with “Note 4”)
  + <2, 0%, [25%, 10%, N/A], [50%, 18%, N/A]>,
  + <3, 0%, [25%, 10%, N/A], [50%, 24%, N/A]>,
  + <4, 1%, [25%, 10%, 1000%], [50%, 28%, 2800%]>,
  + <5, 3%, [25%, 10%, 333%], [50%, 29%, 967%]>,
  + <6, 7%, [25%, 9%, 129%], [50%, 29%, 414%]>,
  + <7, 11%, [25%, 9%, 82%], [50%, 30%, 273%]>,
  + <8, 16%, [25%, 9%, 56%], [50%, 28%,175%]>,
  + <9, 22%, [25%, 8%, 36%], [50%, 27%, 123%]>
  + <10, 26%, [25%, 9%, 35%], [50%, 26%,100%]>

**Note: if the answer is ‘no’, please provide detailed information regarding which of observations need to be modified and how to modify to add it into TR 38.875.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Qualcomm | Y |  |
| Samsung | Y | The study on potential enhancements for minimizing the PDCCH blocking should be captured. |
| Futurewei | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |

**[FL6] Q 8.2.3.1-2: Except the observed above, what other observations need to be added into TR 38.875 for PDCCH blocking rate impact for FR2? Please briefly explain why, if propose to add new observations.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
|  |  |  |
|  |  |  |
|  |  |  |

### 8.2.3.2 Latency and Scheduling flexibility

The latency impacts were studied in [2,6] with following observations:

* P1 [2]: Reduction of BD and CCE limits increases PDCCH blocking probability as well as latency. Moreover, it restricts scheduling flexibility and efficient multiplexing for scheduling multiple UEs.
* P2 [6]: The latency increase caused by BD reduction is negligible.

**Q 8.2.3.2-1: Which of the listed (P1, P2) can be incorporated into text proposal in the Redcap TR for the potential latency and scheduling flexibility performance impacts? If none of them, what is suggested to be captured in the latency and scheduling flexibility analysis section in TR?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | P1 |
| LG | P1 |
| vivo | P2. Due to the long DRX cycle associated with the simulated traffic model, the additional latency impact due to different PDCCH monitoring cases is marginal. For PDCCH blocking and scheduling flexibility, they are more suitable for the previous section 8.2.3.1 |
| Huawei, HiSilicon | We also have an observation in [4], which could be the P3:   * Observation 6: When BD reduction with the same DCI size budget is considered, the number of outage UEs would be increased due to the higher PDCCH blocking rate.   We think we should distinguish the reduction of BD into:   1. BD reduction by reducing DCI size budget; 2. BD reduction with the same DCI size budget;   Based on our results in Table 9, the following is suggested to be captured:  BD reduction by reducing DCI size budget shall not impact the latency and scheduling flexibility and when BD reduction with the same DCI size budget is considered, the number of outage UEs would be increased due to the higher PDCCH blocking rate. |
| Panasonic | P1 |
| Sharp | P2 |
| Samsung | P2. Latency can be negligible for RedCap use cases. |
| Nokia | P1 |
| Qualcomm | None of the two seems to capture the overall picture. We propose to add the following based on our evaluation study of PDCCH blocking probability by BD reduction   * Pn [24]: Scheduling flexibility impact by BD reduction depends on multiple factors at least including BW, AL distribution, channel condition, number of ALs per UE, number of UEs that need to be scheduled. |
| MediaTek | P1 |
| InterDigital | P1 |
| Fraunhofer | P1 |
| Futurewei | More discussion is needed before concluding this aspect: if BDs are reduced, all other things being the same (scheme 1a in question 1), P1 is appropriate. However, other schemes (e.g., reducing the number of DCI sizes to monitor) do not affect performance, but may have other impact to study (e.g., what is the impact of reducing the number of DCI sizes).  The QC suggestion could be a good starting point for a top level observation but then, more details should be provided to quantify the impact of each listed parameter |
| Ericsson | P1 should be captured, but not P2. |
| Intel | More discussion is needed before such as observations can be captured. In our analysis, scheduling flexibility loss due to BD reduction up to 50% was minimal at least for the agreed configurations. Below is our observation, copied here for reference:  **Observation 5: For AL distribution [0.5, 0.4, 0.05, 0.03, 0.02], scheduling flexibility is not compromised for 30kHz, 2OS CORESET configuration and only minimally impacted for 15kHz 3OS CORESET, when BD numbers are reduced by half.** |
| DOCOMO | P1 |
| Lenovo, Motorola Mobility | P2. Considering relaxed latency requirements (e.g. 5-10ms, <100ms, < 500ms) for RedCap UEs, a small increase of latency related to PDCCH blocking shouldn’t be a concern. |
| OPPO | P2 |
| ZTE,sanechips | We think P1 and P2 can be applied for different cases according to companies’ simulation scenarios, and both of them should be counted.  Therefore, Combine P1 and P2 as following.  In some cases, reduction of BD and CCE limits increases PDCCH blocking probability as well as latency. Moreover, it restricts scheduling flexibility and efficient multiplexing for scheduling multiple UEs(P1)  In some other cases, the latency increase caused by BD reduction is negligible (P2). |

Summary of 1st round email discussions:

Companies positions were summarized in the Table below:

|  |  |  |
| --- | --- | --- |
|  | Companies | #of companies |
| P1 | CATT, LG, Panasonic, Nokia, MediaTek, InterDigital, Fraunhofer, Ericsson, DoCoMo | 9 |
| P2 | Vivo, Sharp, Samsung, Lenovo, Motorola Mobility, OPPO, | 6 |
| Combined | ZTE, sanechips | 2 |

**[FL6]** **Proposal 8.2.3.2-1: Capturing the following into TR 38.875 for section 8.2.3 for latency impact:**

* Scheduling flexibility impact by BD reduction depends on multiple factors at least including BW, AL distribution, channel condition, number of ALs per UE, number of UEs that need to be scheduled. If BD reduction with a same DCI size budget like in Rel-15, it increases latency. However, the increased latency due to BD reduction is negligible when a long DRX cycle is configured for Redcap devices. If BD reduction with reducing DCI size budget, there is no impact on the latency performance.

**If no, what needs to be modified to add it into TR 38.875?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| vivo | N | We propose the following modifications. Basically keep the observation simple and not coupled with detailed schemes.   * Scheduling flexibility impact by BD reduction depends on multiple factors at least including BW, AL distribution, channel condition, number of ALs per UE, number of UEs that need to be scheduled. ~~If BD reduction with a same DCI size budget like in Rel-15, it increases latency.~~ However, the increased latency due to BD reduction is negligible when a long DRX cycle is configured for Redcap devices. ~~If BD reduction with reducing DCI size budget, there is no impact on the latency performance.~~ |
| Qualcomm | Y with modifications | Flexibility impact by BD reduction also depends on SCS. |
| Intel | N | Fine with Vivo’s version, with minor revision   * Scheduling flexibility impact by BD reduction depends on multiple factors at least including BW, AL distribution, channel condition, number of ALs per UE, number of UEs that need to be simultaneously scheduled. ~~If BD reduction with a same DCI size budget like in Rel-15, it increases latency. However, the~~ Overall impact to latency due to BD reduction is negligible in typical scenarios when a long DRX cycle may be configured to Redcap devices. ~~If BD reduction with reducing DCI size budget, there is no impact on the latency performance.~~   The deleted sentences on DCI format size budget are not correct simply since a higher DCI size budget requirement for the UE (a more capable UE) can never worsen performance (latency here). |
| Samsung | Y with modifications | DCI size budget reduction is just one out many potential enhancements to provide more scheduling flexibility. So, we suggest to capture all studied schemes as below.   * Scheduling flexibility impact by BD reduction depends on multiple factors at least including BW, AL distribution, channel condition, number of ALs per UE, number of UEs that need to be scheduled~~. If BD reduction with a same DCI size budget like in Rel-15, it increases latency.~~ However, the increased latency due to BD reduction is negligible when a long DRX cycle is configured for Redcap devices. Enhancements relative to Rel-15/16 can be considered to provide more scheduling flexibility if necessary. The enhancements studied include reduced DCI size budget, UE-grouping scheduling, modification to PDCCH candidates dropping rule. ~~If BD reduction with reducing DCI size budget, there is no impact on the latency performance.~~ |
| Futurewei |  | In our view, this sentence should be removed: “. However, the increased latency due to BD reduction is negligible when a long DRX cycle is configured for Redcap devices” |
| Ericsson | N | We suggest the following updates to the text:  Scheduling flexibility impact by BD reduction depends on multiple factors at least including BW, AL distribution, channel condition, number of ALs per UE, number of UEs that need to be scheduled. However, in general, reduction of BDs restricts scheduling flexibility and efficient multiplexing for scheduling multiple UEs. If BD reduction is done with a same DCI size budget like in Rel-15, it increases latency~~.~~ However, the increased latency due to BD reduction is ~~negligible~~ smaller when a longer DRX cycle is configured for Redcap devices. If BD reduction is done with reducing DCI size budget, there is no significant impact on the latency performance. However, DCI size budget reduction requires DCI size alignment (e.g., padding) of several DCI formats, which impacts resource utilization (due to additional overhead) and scheduling flexibility. This, in turn, may impact blocking rate and consequently latency.  It should also be clarified if the above text is for Scheme #1. |
| Lenovo, Motorola Mobility | Y |  |

|  |  |  |
| --- | --- | --- |
| Huawei, HiSilicon | Y with modification | RedCap can be used for wearable device, which have VoIP traffic. In this case, a long DRX cycle is not acceptable. The largest DRX cycle length for VoIP is 40ms. We have observed by evaluations that the increment of PDCCH blocking and latency shall impact the number of UEs out of service.  We propose to remove the following sentence and we are OK for other part.  *~~However, the increased latency due to BD reduction is negligible when a long DRX cycle is configured for Redcap devices.~~* |
| Fraunhofer | Y with modifications | Agree with Samsung. |
|  |  |  |

## 8.2.4 Analysis of coexistence with legacy UEs

Several contributions [2, 7] analyzed potential coexistence issues with legacy UEs caused by reduced PDCCH monitoring. The specification impact analysis based on papers were listed below:

* C1 [2]: The potential impacts on legacy UEs, in terms of PDCCH blocking probability, when coexisting with RedCap UEs depend on the scheduling strategy and system parameters. If legacy UEs are prioritized over RedCap UEs in the gNB scheduling, we do not expect any coexistence impact on the legacy UEs.
* C2 [7]: The coexistence impacts from reducing BD and CCE limits can be mitigated by gNB configuration.

**Q 8.2.4-1: Does the list above (C1, C2) can be incorporated into text proposal in the Redcap TR for the coexistence impacts that need to be considered? If not, please explain why? what other aspects need to be added?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | C1 can be incorporated but further study is needed. For coverage recovery, RedCap UEs’ PDCCHs tend to be on higher ALs, and legacy UEs in poor coverage cannot avoid impact. RedCap UEs may be fine with relaxed latency requirement, but, it should be clarified. |
| vivo | There should be no impact to legacy UEs as BD are not reduced for legacy UEs. |
| Huawei, HiSilicon | We think C2 is reasonable observation. |
| Panasonic | FFS |
| Sharp | C1 and C2 |
| Samsung | No. The PDCCH blocking probability for legacy UEs is impacted by the number of UEs served per cell. It doesn’t matter the coexistence UE is RedCap UE or legacy UE. The reduced PDCCH monitoring capability of RedCap won’t cause any coexistence issue for legacy UEs. |
| Nokia | C1 and C2 |
| Qualcomm | C1 is obvious for legacy UE. It would be equally important if proponent of C1 [2] can clarify how RedCap UEs are impacted if legacy UEs are always prioritized.  It is unclear what does C2 really mean. It is better if proponent of C2 [7] can present some details about whether the impact is to legacy UE or to RedCap UE and how gNB can mitigate the impact by configuration. |
| MediaTek | C1 |
| InterDigital | It is not clear why leagcy UEs are impacted by reduced PDCCH monitoring of RedCap UEs. |
| Futurewei | Both observations are acceptable |
| Ericsson | C1 and C2 should be captured. |
| Intel | It seems this topic received limited attention in this meeting. More discussion is needed. |
| DOCOMO | No. Reduced PDCCH monitoring does not have impact on coexistence with legacy UEs |
| Lenovo, Motorola Mobility | C1 |
| OPPO | Both |
| ZTE,sanechips | C1 and C2. |

Summary of 1st round email discussions:

Companies positions were summarized in the Table below:

|  |  |  |
| --- | --- | --- |
|  | Companies | #of companies |
| C1 | LG, MediaTek, Lenovo, Motorola Mobility | 4 |
| C2 | Huawei, HiSilicon | 2 |
| Both | Sharp, Nokia, Futurewei, Ericsson, OPPO, ZTE, Sanechips | 7 |
| No impact | Vivo, Samsung, InterDigital, DoCoMo | 4 |

In FL view, there may have impact on legacy UEs when Redcap UEs share a CORESET with legacy UEs simply because of the relatively larger AL levels compared to normal UEs due to reduced #Rx antenna. On the other hand, it is also true that legacy UEs in a same CORESET may also need larger aggregation levels depending on varied channel condition. Hence, two options were listed below for further discussions:

**[FL6]** **Q 8.2.4-1: Which of the listed options can be captured into TR 38.875 for section 8.2.4? Please provide details if you think other option is not needed? Or, if possible, please modify the favored Option to reflect the other option.**

* Option 1: The potential impacts on legacy UEs, in terms of PDCCH blocking probability, when coexisting with RedCap UEs in a shared CORESET depend on the scheduling strategy and system parameters. If legacy UEs are prioritized over RedCap UEs by network implementation choice, there is no any coexistence impact on the legacy UEs at the cost of increased latency at the Redcap device side.
* Option 2: Reduced PDCCH monitoring for Redcap devices has no impacts on legacy UEs.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We are fine with either option 1 or 2. |
| Qualcomm | Option 1 seems more understandable. |
| Intel | Option 1 seems more appropriate; as an editorial comment, suggest to replace “there is no any …” with “there may not be any”. |
| Samsung | Both seem to be okay. |
| Futurewei | In a sense, it depends which scheme is used. For instance, with scheme 1, option 1a is applicable, whereas with scheme 1b, option 2 is better. In order to keep the observations at a relatively high level, suggest the following rewording of option 2: “Reduced PDCCH monitoring for Redcap devices has limited impacts on legacy UEs. For some schemes, there is no impact” |
| Ericsson | Option 1 |
| Lenovo, Motorola Mobility | Option 2.  Alternatively, option 1 with the following modification (since there is no or negligible latency increase for RedCap UE).  Option 1: The potential impacts on legacy UEs, in terms of PDCCH blocking probability, when coexisting with RedCap UEs in a shared CORESET depend on the scheduling strategy and system parameters. If legacy UEs are prioritized over RedCap UEs by network implementation choice, there is no any coexistence impact on the legacy UEs ~~at the cost of increased latency at the Redcap device side~~. |
| Sharp | Option 1 |
| LG | Option 1 |
| HW | We don’t think we should assume legacy UEs are prioritized over RedCap UEs by network implementation. We should at least remove: If legacy UEs are prioritized over RedCap UEs by network implementation choice, there is no any coexistence impact on the legacy UEs at the cost of increased latency at the Redcap device side.  We don’t agree with Option2. |
| Fraunhofer | Option 1 |
|  |  |

## 8.2.5 Analysis of specification impacts

Several contributions [2,7] also point out the specification impacts from the reduced PDCCH monitoring.

* S1 [2]: If the network assist BD reduction and UE power saving using existing configurations without any specified restriction for RedCap, specification changes are not required.
* S2 [2]: If a specific set of number of PDCCH candidates needs to be hardcoded for RedCap, there will be a specification impact.
* S3 [7]: The specification impacts by reducing the BDs and CCEs may be mainly on the RRC parameters, DCI design or the UE behaviors related to blind decoding.

**Q 8.2.5-1: Which of list above (S1, S2, S3) capture the most important specifications impacts that need to be considered for reduced PDCCH monitoring? If none, what other aspects need to be added?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| CATT | Y |  |
| LG | Y | S1, S2 |
| vivo | N | For scheme #1, agree with S2  For scheme #2, the spec impact would be the specification of supported PDCCH monitoring span gap (i.e. X) and potentially multi-slot scheduling from a single monitoring span. |
| Huawei, HiSilicon | N | In our view, BD limit, DCI size budget and DCI format design shall be impacted. |
| Panasonic | Y | S1 and S2. |
| Sharp | Y | S2 and S3 |
| Samsung | Y | Both S2 and S3 are possible. It depends on what type of power saving schemes (in Section 8.2.1 we support eventually. |
| Nokia | Y | S1 and S2 |
| Qualcomm | Y | For S1, it is unclear how UE can be guaranteed that actual BD number is reduced by network without any change to specification. If there is not any specification impact, then even eMBB may use the network assisted BD reduction. S1 should not be captured.  S2 can be captured. But it can be changed from “If a specific set of number of PDCCH candidates” to “a specific set of “reduced” number”. This is because Rel-15 BD limit is also a specific set of number of PDCCH candidates.  For S3, it is a very broad conclusion. Would be better to further clarify by proponent ([7]) the specification change is for adaptive PDCCH monitoring configuration, PDCCH overhead reduction (i.e., by using less PDCCH for scheduling) or DCI size reduction etc. or all of them. Then it can be captured.  For the table in “12. Conclusion”, please also add Qualcomm to the companies supporting scheme 3. |
| MediaTek | Y | S1 and S2 |
| InterDigital | Y | S2 and S3 |
| FUTUREWEI |  | S1 as written is too strong, but could be reworded as:  S4 If the network assist BD reduction and UE power saving using existing configurations without any specified restriction for RedCap, only limited specification changes are ~~not~~ required |
| Ericsson | Y | S1 and S2 should be captured. |
| Intel |  | We think specification impact can be discussed together with the methods for reducing BD numbers, Section 8.2.1 |
| DOCOMO | Y | S1, S2 |
| Lenovo, Motorola Mobility | Y | S2, S3 |
| OPPO | N | The specification impact can be discussed further. |
| ZTE,sanechips | Y | S2 and S3. The details can be clarified according to the discussion of Proposal 8.2.1-1 |

Summary of 1st round email discussion:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Yes | | No | |
| Companies | # of companies | Companies | # of companies |
| S1 | CATT, LG, Panasonic, Nokia, MediaTek, Ericsson, DoCoMo, | 7 | Vivo, Qualcomm, OPPO | 3 |
| S2 | CATT, LG, vivo, Panasonic, Sharp, Samsung, Nokia, Qualcomm, MediaTek, InterDigital, Ericsson, DoCoMo, Lenovo, Motorola Mobility, ZTE, Sanechips. | 16 | OPPO | 1 |
| S3 | CATT, Sharp, Samsung, InterDigital, ZTE, Sanechips. | 6 | OPPO | 1 |

All responses except one agreed to capture S2 as specification impacts. One response indicates to further discuss. One response indicates to add ‘reduced’ in S2 above to make it clear.

Note that, as usual for study item TR, this section focuses on what is the potential specification impact. Hence, the need of ‘S1’ is not clear at least for this section since it has no specification impact. To reflect the relevant comments, the word “may” is used as reducing BD may or may not have impact on specification.

Given the limited time left, the following was proposed by FL based on agreeable S2 to make progress. We can further progress on S3.

**[FL6]** **Proposal 8.2.5-1: Capturing the following into TR 38.875 for section 8.2.5 for Scheme 1**

* Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include the reduced maximum number of PDCCH candidates, the reduced DCI size budget and DCI format design for multiple PDSCHs scheduling to minimize the PDCCH blocking rate impact.

**If not, what modification is needed to add into TR 38.875?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We think the DCI size alignment maybe impacted as well if reduced size budget is reduced, suggest to revise as following.   * Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include the reduced maximum number of PDCCH candidates, the reduced DCI size budget, modification to DCI size alignment rule and DCI format design for multiple PDSCHs scheduling to minimize the PDCCH blocking rate impact. |
| Qualcomm | Fine with the proposal. |
| Intel | Fine with modified version from Vivo. |
| Samsung | We think PDCCH candidates dropping rule maybe impacted as well if maximum number of PDCCH candidates is reduced. So, we suggest following modification.   * Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include the reduced maximum number of PDCCH candidates, the reduced DCI size budget, DCI format design for multiple PDSCHs scheduling, modification to PDCCH candidates dropping rule, to minimize the PDCCH blocking rate impact. |
| Futurewei | Ok in principle. We suggest to reword as “specification impact may including reducing the maximum number of PDCCH candidates, or reducing the DCI size budget and DCI format design for multiple PDSCHs scheduling to minimize the PDCCH blocking rate impact. |
| Ericsson | Although we understand FL’s point of view, in our view, it is very important to capture S1. This captures that the potential power saving can be achieved by existing network configuration, i.e., without specification impact.   * S1 [2]: If the network assist BD reduction and UE power saving using existing configurations without any specified restriction for RedCap, specification changes are not required. |
| Lenovo, Motorola Mobility | Fine with the proposal |
| LG | We suggest to capture that the potential power saving may be achieved by existing network configuration, i.e., without specification impact. |
| Huawei and HiSilicon | Generally fine, with the following revision:   * Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include the reduced maximum number of PDCCH candidates, the reduced DCI size budget and DCI format design ~~for multiple PDSCHs scheduling~~ to minimize the PDCCH blocking rate impact. |
| Fraunhofer | Fine with Samsung’s version. |
|  |  |

**[FL6]** **Proposal 8.2.5-2: Capturing the following into TR 38.875 for section 8.2.5 for Scheme 2**

* For Extending the PDCCH monitoring gap to X slots (X), the minimum configurable gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasion) is increased from 1 slot to X>1 slots and X needs to be specified. The maximum number of configurable BDs in X slots are reduced compared to Rel-15, which is required to be specified.

**If not, what modification is needed to add into TR 38.875? Kindly note that please focus on the specification impact wording, instead of commenting the need of capturing scheme #2 impact, as we already agreed to capture all schemes including scheme 2 already.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Suggest modification to the last sentence  For Extending the PDCCH monitoring gap to X slots (X), the minimum configurable gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasion) is increased from 1 slot to X>1 slots and X needs to be specified. The maximum number of configurable BDs in X slots ~~are reduced compared to Rel-15, which~~ is required to be specified. |
| Qualcomm | The last sentence should be removed. We do not think it is necessary to define such a new multi-slot BD limit. It is not preferred for UE to implement another or additional counting procedure other than what we have from Rel-15.   * ~~The maximum number of configurable BDs in X slots are reduced compared to Rel-15, which is required to be specified.~~ |
| Samsung | We think PDCCH candidates dropping rule maybe impacted as well if the gap is extended to be X>1 slot. Also, we think the enhancements for minimizing PDCCH blocking rate also applies to Scheme #2. So, we suggest following modification.  For Extending the PDCCH monitoring gap to X slots (X), ~~the minimum configurable gap (i.e.~~ the minimum separation between two consecutive PDCCH monitoring occasion~~)~~ is increased from 1 slot to X>1 slots and X needs to be specified. The maximum number of configurable BDs in X slots are reduced compared to Rel-15, which is required to be specified. Enhancement, such as the reduced DCI size budget, DCI format design for multiple PDSCHs scheduling, modification to PDCCH candidates dropping rule, may be needed to minimize the PDCCH blocking rate impact. |
| Futurewei | Include a note that scheme 2 may not be within scope of SID |
| Ericsson | The following statement should be added to the text.  “If extending the PDCCH monitoring gap to X slots is achieved using existing configurations without any specified restriction for RedCap, specification changes are not required.”  Also, in our understanding, “the maximum number of configurable BDs in X slots are reduced compared to Rel-15, which is required to be specified” may not be necessary, since the maximum number of BDs in a slot can be the same as in Rel-15/16. The average number of BDs per slots is reduced with extended gap. |
| Lenovo, Motorola Mobility | The maximum number of BDs for RedCap UEs can still be specified per slot-basis, while the minimum separation between two consecutive PDCCH monitoring occasions is specified to be X slots (X>1). Thus, we suggest modifying the proposal as follows:  For Extending the PDCCH monitoring gap to X slots (X), the minimum configurable gap (i.e. the minimum separation between two consecutive PDCCH monitoring occasion) is increased from 1 slot to X>1 slots and X needs to be specified. The maximum number of configurable BDs per slot ~~in X slots~~ are reduced compared to Rel-15, which is required to be specified. |
| Sharp | Agree with vivo. But it is better to keep consistency of the wording for either “configurable” or “capable”. |
| Huawei, HiSilicon | We have concerns on: “The maximum number of configurable BDs in X slots are reduced compared to Rel-15, which is required to be specified.”. |
| Fraunhofer | Agree with vivo’s version. |
|  |  |

**[FL6]** **Proposal 8.2.5-3: Capturing the following into TR 38.875 for section 8.2.5 for Scheme #3**

* For dynamic adaptation of PDCCH monitoring parameters scheme, specification impacts may include mechanisms used to dynamically adapt PDCCH monitoring parameters e.g. maximum number of PDCCH candidates per PDCCH per PDCCH monitoring occasion and minimum time separation between two consecutive PDCCH monitoring occasions.

**If not, what modification is needed to add into TR 38.875? Kindly note that please focus on the specification impact wording, instead of commenting the need of capturing scheme #3 impact, as we already agreed to capture all schemes including scheme #3 already.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Similar to comments to scheme 3, the definition and differentiation between PDCCH candidate and BD needs to be clarified. The yellow highlighted text below is not clear.   * For dynamic adaptation of PDCCH monitoring parameters scheme, specification impacts may include mechanisms used to dynamically adapt PDCCH monitoring parameters e.g. maximum number of PDCCH candidates per PDCCH per PDCCH monitoring occasion and minimum time separation between two consecutive PDCCH monitoring occasions. |
| Samsung | The adaptation should be limited to PDCCH blind decoding related parameters as specified in feature description. Also, we think the enhancements for minimizing PDCCH blocking rate also applies to Scheme #3. So, we suggest following modification.  For dynamic adaptation of PDCCH BD ~~monitoring~~ parameters ~~scheme~~, specification impacts may include mechanisms used to dynamically adapt PDCCH BD ~~monitoring~~ parameters e.g. maximum number of PDCCH candidates per PDCCH per PDCCH monitoring occasion and minimum time separation between two consecutive PDCCH monitoring occasions. Enhancement, such as the reduced DCI size budget, DCI format design for multiple PDSCHs scheduling, modification to PDCCH candidates dropping rule, may be needed to minimize the PDCCH blocking rate impact. |
| Futurewei | Include a note that scheme 3 may not be within scope of SID |
| Lenovo, Motorola Mobility | Fine with the proposal. |
| Huawei, HiSilicon | Generally fine. |
| Fraunhofer | Fine with the proposal. |
|  |  |

# 12. Conclusion

The following table summarizes companies’ proposals to further study the power saving scheme(s) to reduce PDCCH power consumption:

|  |  |  |
| --- | --- | --- |
| Scheme Index | Supportive Companies | # of companies |
| 1 | Huawei&HiSilicon [4], vivo [6], ZTE [7], Intel [10], Spreadtrum [15], NEC[16] , Samsung[17], OPPO [18], Lenovo [19], Sharp[20], Apple [21], Qualcomm [24], InterDigital[25], WILUS [27], Sequans [28], CATT[8], Fraunhofer [26], CMCC[11] | 19 |
| 2 | vivo[6] | 1 |
| 3 | NEC[16] ,Samsung[17], Lenovo [19] CATT[8], InterDigital, Fraunhofer [26], Qualcomm[24] | 7 |
| 4 (Remain same as in Rel-15/16) | Futurewei [3], Nokia [13], MTK [22], LG[12], Ericsson [2], DOCOMO [23] | 6 |

# References

1. 3GPP TR 38.875 Study on support of reduced capability NR devices (Rel-17)
2. [R1-2007530](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007530.zip) Reduced PDCCH monitoring for RedCap Ericsson
3. [R1-2007535](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007535.zip) Power savings for RedCap UEs FUTUREWEI
4. [R1-2007597](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007597.zip) Power saving for reduced capability devices LH, HiSilicon
5. [R1-2007625](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007625.zip) Discussion on PDCCH monitoring reduction for RedCap UEs Panasonic
6. [R1-2007669](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007669.zip) Reduced PDCCH monitoring for Reduced Capability NR devices vivo, Guangdong Genius
7. [R1-2007716](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007716.zip) Consideration on reduced PDCCH monitoring ZTE
8. [R1-2007863](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007863.zip) Discussion on PDCCH monitoring reduction CATT
9. [R1-2007888](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007888.zip) Reduced PDCCH monitoring TCL Communication Ltd.
10. [R1-2007948](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2007948.zip) On reduced PDCCH monitoring for RedCap UEs Intel Corporation
11. [R1-2008017](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008017.zip) Discussion on PDCCH monitoring reduction CMCC
12. [R1-2008049](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008049.zip) Discussion on PDCCH monitoring for reduced capability NR devices LG Electronics
13. [R1-2008069](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008069.zip) Reduced PDCCH monitoring Nokia, Nokia Shanghai Bell
14. [R1-2008085](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008085.zip) Discussion on reduced PDCCH monitoring for reduced capability device Xiaomi
15. [R1-2008105](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008105.zip) Discussion on reduced PDCCH monitoring Spreadtrum Communications
16. [R1-2008115](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008115.zip) Reduced PDCCH monitoring for REDCAP NR devices NEC
17. [R1-2008171](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008171.zip) Reduced PDCCH monitoring Samsung
18. [R1-2008261](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008261.zip) Solutions of reduced PDCCH monitoring OPPO
19. [R1-2008336](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008336.zip) PDCCH monitoring at reduced capability UE Lenovo, Motorola Mobility
20. [R1-2008395](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008395.zip) Reduced PDCCH Monitoring for RedCap Devices Sharp
21. [R1-2008470](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008470.zip) Reduced PDCCH Monitoring for RedCap Devices Apple
22. [R1-2008511](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008511.zip) Discussion on reduced PDCCH monitoring for NR RedCap UEs MediaTek Inc.
23. [R1-2008552](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008552.zip) Discussion on reduced PDCCH monitoring for RedCap NTT DOCOMO, INC.
24. [R1-2008621](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008621.zip) PDCCH Monitoring Reduction and Power Saving for RedCap Devices Qualcomm Incorporated
25. [R1-2008685](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008685.zip) Reduced PDCCH monitoring for reduced capability NR devices InterDigital, Inc.
26. [R1-2008712](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008712.zip) Reduced PDCCH Monitoring for RedCap UEs Fraunhofer HHI, Fraunhofer IIS
27. [R1-2008727](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008727.zip) Discussion on PDCCH monitoring for RedCap UE WILUS Inc.
28. [R1-2008739](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008739.zip) Reduced PDCCH monitoring for RedCap UE Sequans Communications
29. [R1-2007482](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007482.zip) FL summary on initial collection of RedCap evaluation results Moderator (Ericsson, Apple, Qualcomm)

# Annex: Previous Agreements

## **RAN1 #101 e-meeting**

*Agreements:*

* Study the impact of BD and CCE limits reduction on power saving and PDCCH blocking probability (quantitatively) and impacts on latency and scheduling flexibility (at least qualitatively).

*Agreements:*

* Study the impact of BD and CCE limits reduction on power saving and PDCCH blocking probability (quantitatively) and resulting impacts on latency and scheduling flexibility (at least qualitatively).
* Reuse the power consumption models and scaling factors for FR1 and FR2 provided in TR 38.840 (sections 8.1.1, 8.1.2, 8.1.3) as appropriate.
* For evaluation of UE power saving, for wearables, use the traffic models FTP model 3 and VoIP from TR 38.840 to characterize the wearables service types including IM, VoIP, heartbeat, etc. with proper modification of at least packet size and mean inter-arrival time. Values are FFS.
* For evaluation of UE power saving, for industrial wireless sensor use cases, use a traffic model based on the service performance requirements for the process monitoring use case in TS 22.104 Table 5.2-2. At least 64 bytes UL message (plus headers, e.g. MAC, RLC, etc.) transmitted periodically with a periodicity 100 ms should be considered (other values are encouraged).

## **RAN1 #102 e-meeting**

Agreements:

* Use the VoIP traffic model from TR 38.840 as baseline. Other VoIP traffic models are not precluded and companies to report if other VoIP traffic models are assumed in evaluation.

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:

* The scaling factor ‘0.7’ is used for 2 Rx to 1Rx power scaling for power reduction related evaluation.
* For evaluation, the power scaling for PDCCH candidate reduction defined in TR 38.840 is reused for Redcap UEs.
* For power consumption evaluation, the DRX configurations of Instant message and VoIP in TR 38.840 are reused.
* Discussion on reduced maximum number of configurable CORESET technique for power saving is deprioritized in the Redcap power saving sub-agenda
* For power consumption evaluation, use FTP-3 model with 100 Bytes packet size and 60s mean inter-arrival time as baseline for ‘heartbeat’ traffic.
* For power consumption evaluation, reuse the following DRX configuration defined in TS 38.840 for ‘heartbeat’ traffic model:
* C-DRX cycle 640 msec, inactivity timer {200, 80} msec
* FR1 On duration: 10 msec
* FR2 On duration: 5 msec

Agreements: For the PDCCH blocking rate evaluation, at least the following parameters are assumed as baseline:

|  |  |
| --- | --- |
| Parameters | Assumptions |
| Number of candidates for each AL | Each company to report. |
| SCS/BW | FR1: 30KHz/20MHz   * 15kHz/20MHz is optional   FR2: 120KHz/[100]MHz |
| CORESET duration | 2 symbols, with 3 symbols optional |
| Delay toleration (Slot) | 1 (1: implies that PDCCH is blocked if it can’t be scheduled in the given slot), with 2 optional |
| Aggregation level Distribution | Companies to report (including the necessary UE channel conditions and deployment scenario(s) for the aggregation level distribution) |

Agreements: For Redcap power consumption evaluation:

* Note that 2RX is assumed

|  |  |
| --- | --- |
| Power State | Alt.4a |
| Deep Sleep (PDS) | 0.8 |
| Light Sleep (PLS) | 18 |
| Micro sleep (PMS) | 31 |
| PDCCH-only (PPDCCH) | 50 for same-slot scheduling,  40 for cross-slot scheduling |
| PDCCH + PDSCH (PPDCCH+PDSCH) | 120 |
| PDSCH-only (PPDSCH) | 112 |
| SSB/CSI-RS proc. (PSSB) | 50 |
| Intra-frequency RRM measurement (Pintra) | ·        [60]Note4 (synchronous case, N=8, measurement only)  ·        [80]Note4 (combined measurement and search) |
| Inter-frequency RRM measurement (Pinter) | [60]Note4 (neighbor cell search power per freq. layer)  ·       [~~150~~80] Note4 (measurement only per freq. layer)  ·        Micro sleep power assumed for switch in/out a freq. layer |

Working assumption:

Adopting the following rule for power determination

* Rule 1: ‘Micro sleep’ power of 1 Rx is [0.8]x2 Rx ‘Micro sleep’ power
* Rule 2: For both 1 Rx and 2 Rx configuration,
* P(α) = max (Micro-sleep, α ∙ Pt + (1 – α) ∙ 0.7Pt))
* Pt is the PDCCH-only power for same slot and cross-slot scheduling cases.

**Conclusion**: It is up to each company to report the power consumption modeling for 3-symbols CORESET configuration and reduced number of non-overlapped CCEs.