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

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

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

**Title: Feature lead summary #11 on reduced PDCCH monitoring**

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

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

# 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 until 11/17.

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 FL11.

# 8.2 Reduced PDCCH monitoring

## 8.2.2 Analysis of UE power saving

**[FL11] Proposal 8.2.2-1: Adding the rows in proposal 8.2.2-1 for Table 2A,2B,2C and 2D with new notes.**

Table 2A: Power Saving gain, FR1, Same-Slot Scheduling, 1 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 12 | Ericsson | 0.32% | 0.59% | 0.01% | 0.02% | 0.01% | 0.02% |   |   |  | Note 6B |
| 13 | InterDigital | 4.40% | 8.80% | 1.16% | 2.04% | 0.45% | 0.92% |  |  |  |  |
| Note 6B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

Table 2B: Power Saving gain, FR1, Cross-Slot Scheduling, 1 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 9 | Ericsson | 0.30% | 0.36% | 0.01% | 0.01% | 0.01% | 0.01% |  |  |  | Note 2B |
| Note 2B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

Table 3A: Power Saving gain, FR1, Same-Slot Scheduling, 2 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 9 | Ericsson | 0.44% | 0.82% | 0.01% | 0.03% | 0.01% | 0.02% |   |   |  | Note 2B |
| Note 2B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

Table 3B: Power Saving gain, FR1, Cross-Slot Scheduling, 2 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 14 | Ericsson | 0.36% | 0.67% | 0.01% | 0.02% | 0.01% | 0.02% |   |   |  | Note 6B |
| Note 6B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

Table 4A: Power Saving gain, FR2, Same-Slot Scheduling, 1 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 5 | Ericsson | 0.77% | 1.43% | 0.03% | 0.06% | 0.03% | 0.05% |   |   |  | Note 2B |
| Note 2B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

Table 4B: Power Saving gain, FR2, Cross-Slot Scheduling, 1 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 7 | Ericsson | 0.55% | 1.03% | 0.02% | 0.04% | 0.02% | 0.04% |   |   |  | Note 2B |
| Note 2B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

Table 5A: Power Saving gain, FR2, Same-Slot Scheduling, 2 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 5 | Ericsson | 1.04% | 1.92% | 0.04% | 0.08% | 0.04% | 0.07% |   |   |  | Note 2B |
| Note 2B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

Table 5B: Power Saving gain, FR2, Cross-Slot Scheduling, 2 Rx antenna

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| # | Company | IM traffic model | Heartbeat traffic model | VoIP traffic model | Schemes (Note 1) | Notes |
| IAT = 200ms |  IAT = 80ms |
| Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| 7 | Ericsson | 0.75% | 1.40% | 0.03% | 0.06% | 0.03% | 0.05% |   |   |  | Note 2B |
| Note 2B: DL and UL (For IM traffic and Heartbeat, traffic is 50% in DL and 50% in UL) |

**[FL11] Proposal 8.2.2-2: Update the agreement as follows based on the new evaluation results for IM traffic model and Heartbeat traffic models:**

|  |
| --- |
| For FR1, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 12 sources ([vivo], [Ericsson], [Qualcomm], [CATT], [Spreadtrum], [OPPO], [Huawei, HiSilicon], [Apple], [Futurewei],[Intel], [ZTE], [InterDigital]) reported the evaluation results of power saving gain for FR1 with same-slot scheduling for the 1 Rx antenna case.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.32%~5.7%] and [0.59%~11.4%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.81% and 5.82%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~3.40%] and [0.02%~6.80%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.56% and 3.25%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~3.20%] and [0.02%~6.40%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.33% and 2.92%, respectively.
* 13 sources ([vivo], [Ericsson], [Qualcomm], [Nokia], [CATT], [Spreadtrum], [OPPO], [Huawei, HiSilicon], [Apple], [Futurewei], [Intel], [ZTE], [InterDigital]) reported the evaluation results of power saving gain for FR1 with same-slot scheduling for 2 Rx antennas cases.

The following is observed for 2 Rx antennas case: * For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.3%~6.20%] and [0.36%~12.30%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 3.05% and 6.59%.
* For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~4.10%] and [0.01%~8.20%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.65% and 3.72%, respectively.
* For the heartbeat traffic model with 80ms inactivity timer configuration maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~3.90%] and [0.02%~7.80%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.49% and 3.42%, respectively.

Agreements:For FR1, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 8 sources ([vivo], [Ericsson], [Samsung], [Qualcomm], [OPPO], [Apple], [ZTE], [MediaTek]) reported the evaluation results of power saving gain for FR1 with cross-slot scheduling for the 1 Rx antenna and 2 Rx antennas cases.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.30%~4.5%] and [0.36%~9%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.58% and 4.26%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.7%] and [0.01%~5.5%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing 36 PDCCH blind decoding by 25% and 50% are approximately 1.66% and 2.48%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.6%] and [0.01%~5.1%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.60% and 2.34%, respectively.

The following is observed for 2 Rx antennas case: * For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.36%~4.69%] and [0.67%~9.38%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 3.08% and 5.7%, respectively.
* For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.9%] and [0.02%~5.7%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.95% and 3.51%, respectively.
* For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.5%] and [0.02%~4.94%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.69% and 3.21%, respectively.

Agreements:Fo FR2, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 6 sources ([Ericsson], [CATT], [Spreadtrum], [Futurewei], [Intel], [ZTE]) reported the evaluation results of power saving gain for FR2 with same-slot scheduling for the 1 Rx antenna and 2 Rx antennas cases.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.77%~6.6%] and [1.43%~13.1%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 4.20% and 8.60%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4.30%] and [0.06%~8.60%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.72% and 3.69%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4%] and [0.05%~7.9%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.28% and 2.58%, respectively.

The following is observed for 2 Rx antennas case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.55%~6.8%] and [1.03%~13.6%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 4.52% and 8.98%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.02%~4.90%] and [0.04%~11.90%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 2.13% and 4.14%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.02%~4.6%] and [0.04%~9.2%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.99% and 3.88%, respectively.

Agreements:For FR2, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 4 sources ([Ericsson], [Samsung], [ZTE], [MediaTek]) reported the evaluation results of power saving gain for FR2 with cross-slot scheduling for the 1 Rx antenna and 2 Rx antennas cases.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.55%~6.30%] and [1.03%~12.7%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 3.19% and 6.17%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.02%~4.20%] and [0.04%~8.30%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.30% and 2.60%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.02%~3.9%] and [0.04%~7.6%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.24% and 2.48%, respectively.

The following is observed for 2 Rx antennas case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.75%~6.6%] and [1.4%~13.20%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 3.43% and 6.59%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4.90%] and [0.06%~9.60%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.05% and 2.11%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4.6%] and [0.05%~8.9%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 0.92% and 1.84%, respectively.
 |

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | Y | Thanks for implementing our spreadsheet corrections in the tables above. There seems to be some minor typos in the ranges captured in the observations (e.g., in same-slot slot scheduling with 2 Rx case in FR1). This can be double checked by the FL.  |
| ZTE,sanechips |  | Regarding the result from Ericsson, the UL parameters related to power saving have not been discussed actually. For example, the traffic model for PUSCH, the power for the state UL, and the PUCCH assumption were not discussed. Therefore, we do not think it should be merged in to the current agreement. If the results from Ericsson are necessary to be captured, the separate observation is more appropriate.As for the results from [InterDigital], we think it is fine to be merged into the agreement.For sake of progress, if the majority can accept to add the the results for DL and UL in the agreement, we are also fine. |
| Intel |  | Yes, we also agree with ZTE’s suggestion to capture Ericsson result separately since other results did not seem to consider UL traffic. |
|  |  |  |

## 8.2.5 Analysis of specification impacts

**[FL10] Updated Proposal 8.2.5-1: Capturing the following into TR 38.875 for section 8.2.5**

|  |
| --- |
| * Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include reducing the limit on maximum number of PDCCH candidates..
* For Extending the PDCCH monitoring gap to X slots (X), the minimum separation between two consecutive PDCCH monitoring occasions, spans or slots configured with PDCCH candidates is increased from 1 slot to X>1 slots and X needs to be specified.
* For dynamic adaptation of PDCCH BD parameters in connected mode, specification impacts may include mechanisms used to dynamically adapt PDCCH BD parameters e.g., maximum number of BDs per PDCCH monitoring occasion, span or slot and minimum time separation between two consecutive PDCCH monitoring occasions, spans or slots configured with PDCCH candidates.
* Additional specification impacts may include reducing DCI size budget, modification to DCI size alignment rule and DCI format design for multiple PDSCHs scheduling, modification to PDCCH candidates dropping rule, to minimize the PDCCH blocking rate impact and network restriction.
 |

**Can we add the following sentence into the proposal above for TR 38.875?**

|  |
| --- |
| “If BD reduction/extension of the PDCCH monitoring gap is achieved using existing Rel-15/16 configurations without any specified restriction for RedCap, specification changes are not required.”  |

**Note that:**

* **If you support FL proposal with adding the sentence, please response with ‘Yes, with adding sentence’.**
* **If support FL proposal without adding the sentence, please response with ‘Yes, without adding sentence’. Also, please provide reasons why you think this sentence is not needed.**

|  |  |  |
| --- | --- | --- |
| **Company** |  **Y/N** | **Comments** |
| Sharp | Yes, without adding sentence | Because we think it is obvious. |
| vivo | **Yes, without adding sentence** | The reduction is about UE capability on BD budget, which is currently hardcoded in the specification. Specification shall be changed if the hardcoded UE capability is to be reduced.  |
| ZTE | Yes, with adding sentence | A minor modification in the second paragraph may be needed as following:“X needs to be specified” is modified as “X needs to be specified at least” |
| Huawei, HiSilicon | N | If the related description in scheme#1 is deleted, the ‘for multiple PDSCHs scheduling’ in the last paragraph needs to be deleted to keep it common. Otherwise, the original description in Scheme#1 should be kept.The added sentence is not needed. |
| Samsung | Yes, without adding sentence | It’s obvious that RRC (re)configuration of search space sets in Rel-15/16 doesn’t change BD limit as the candidate schemes studied here.RRC (re)configuration of PDCCH candidates is not designed/used for power saving purpose. It cannot guarantee the BD reduction as the candidate schemes studied. Also, an editorial change needed. Replace “and” by “,” as follows.Additional specification impacts may include reducing DCI size budget, modification to DCI size alignment rule ~~and~~, DCI format design for multiple PDSCHs scheduling |
| Fraunhofer | Yes, without adding sentence | We do not see a reason to add this sentence as this is obvious. |
| Qualcomm | Yes, without adding sentence | The new sentence is not correct because there is no guarantee that network will do the proper configuration and then there may not be any reduction. |
| InterDigital | Yes, without adding sentence |  |
| Intel | Yes, without adding sentence | As other companies mentioned, this is obvious and purpose of the text is to identify what specification impacts are expected if one of more of the evaluated schemes are adopted. So that sentence also seems out of context.Minor suggestion for revising the last paragraph. -Additional specification impacts may include **one or more of** reducing DCI size budget, modification to DCI size alignment rule and DCI format design for multiple PDSCHs scheduling, modification to PDCCH candidates dropping rule, to minimize the PDCCH blocking rate impact and network restriction.Following is suggested to make the description of span-based monitoring more clear. Note that two consecutive MOs can be back to back within a slot. Based on previous version, it may be possible that someone could still interpret it wrongly even with the "1 slot" phrase in there, since the "1 slot" assumption is not quite consistent with the use of spans. The intention is to identify gap between MOs in consecutive spans.* For Extending the PDCCH monitoring gap to X slots (X), the minimum separation between two ~~consecutive~~ PDCCH monitoring occasions inconsecutive spans or slots configured with PDCCH candidates is increased from 1 slot to X>1 slots and X needs to be specified.
 |
| Futurewei | N | We don’t fully understand why the “reducing the DCI size…” sentence was deleted? From our perspective, this is an important element that should be here, and from our recollection, was problematic to only one companyThe 4th paragraph, in our view, should be removed, and the specification impacts should be listed for each paragraph.No strong view one way or another for the additional sentence |
| LG | Yes, with adding sentence |  |
| Ericsson | Yes, with adding sentence | We do not simply accept the TP without the added sentence.* It is important to capture in the TR that the power saving is already possible without specification change.
* In response to comments from Samsung and Qualcomm, the number of BD candidates per AL that the UE needs to monitor can be configured by gNB already in Rel-15/16, based on a trade-off between scheduling flexibility and UE power consumption. Different configurations can be used under different circumstances, e.g. different load situations.
* If the sentence is indeed obvious as indicated by Sharp and Fraunhofer, then there should not be a concern to capture the sentence in the TR.

As a compromise, instead of the added sentence, these words can be inserted before the bullet list with specification impacts:“For restriction of BD candidates or extension of the PDCCH monitoring gap beyond what can be achieved with existing Rel-15/16 configuration, there are the following specification impacts:”A minor update as follows can also be considered:“Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include specifying new blind decoding limits for RedCap UEs, reducing the limit on maximum number of PDCCH candidates.”. |
| DOCOMO | Yes, with/without adding sentence | Nothing is harmed by adding the sentence, but no strong view whether adding it or not. |
| CATT | Y, with adding sentence | It should be spelt out that less specification impacts should be pursued with the same target. From our understanding, the additional sentence is only related to the second bullet. |
| Spreadtrum | Yes, without adding sentence |  |
| OPPO | Yes, without adding sentence | But, seems Ericsson’s new text is ok. Since the specification should be reduce the BD limit or the candidate limit in the specification, for RedCap UE. We can accept that as compromise. |

**Summary of 10th round of email discussions**

|  |  |  |
| --- | --- | --- |
|  | Companies  | # of companies  |
| Yes, without adding sentence | Sharp, vivo, Samsung, Fraunhofer, Qualcomm, InterDigital, Intel, CATT, Spreadtrum, ZTE, OPPO | 11 |
| Yes, with adding sentence | LG, Ericsson  | 2 |
| No | Huawei, HiSilicon, Futurewei  | 3 |

Majority companies (11 responses) indicate to support FL proposal without adding note with arguing that the schemes target to reduce the ‘maximum’ number of BDs, which is hard encoded in specification and is independent of PDCCH configuration by gNB and can be leveraged by Redcap UEs to reduce power compared to existing BDs limit. One response (i.e., ZTE) updated FL regarding their position to go “without adding sentence”. Two responses indicate to remove the last sentence of 1st paragraph. However, as discussed before, the last sentence was removed simply because the 4th paragraph was commonly for all solutions to avoid duplication in words. Otherwise, same texts almost need to be copied for each bullet. The updated FL summary intends to address the concerns on this regard with modifying the ‘DCI format design’ description to avoid any unintended restriction. One response indicates to change ‘spans or slots’. However, current wording is the compromise and can be acceptable for all based on earlier discussion. Let’s keep it as what it is, unless critical issue is identified. One response insists to add one more sentence with modification, which was strongly against by majority companies. FL also took a last try to accommodate it.

**[FL11] Updated Proposal 8.2.5-1: Capturing the following into TR 38.875 for section 8.2.5**

|  |
| --- |
| * Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include reducing the limit on maximum number of PDCCH candidates.
* For Extending the PDCCH monitoring gap to X slots (X), the minimum separation between two consecutive PDCCH monitoring occasions, spans or slots configured with PDCCH candidates is increased from 1 slot to X>1 slots and X needs to be specified.
* For dynamic adaptation of PDCCH BD parameters in connected mode, specification impacts may include mechanisms used to dynamically adapt PDCCH BD parameters e.g., maximum number of BDs per PDCCH monitoring occasion, span or slot and minimum time separation between two consecutive PDCCH monitoring occasions, spans or slots configured with PDCCH candidates.
* The existing Rel-15/Rel-16 PDCCH monitoring configuration can still be used to configure the BD candidates and PDCCH monitoring gap. Additional specification impacts may include one or more of following: reducing DCI size budget, modification to DCI size alignment rule, DCI format design (including single PDSCH scheduling and multiple PDSCHs scheduling), modification to PDCCH candidates dropping rule, to minimize the PDCCH blocking rate impact and network restriction.
 |

**This is the last try for this clause to complete the TR. If the answer is ‘No’, please indicate clearly which paragraph is concerned.**

**Please note that without address this may result in study item incompletion.**

|  |  |  |
| --- | --- | --- |
| **Company** |  **Y/N** | **Comments** |
| TIM | Yes, with adding sentence |  |
| Ericsson | Yes | We are fine with this as a compromise. |
| Huawei, HiSilicon | Yes |  |
| Nokia, NSB | Yes |  |
| LG | Yes |  |
| OPPO | Yes | Fine as final compromise. |
| Futurewei | Yes |  |
| ZTE,sanechips | Yes | Fine with the compromise. |
| Samsung | Yes |  |
| Qualcomm | Yes |  |
| Intel | yes | As a compromise |

# 12. Conclusion

**[FL10] Q 12-2: Which of listed Option 1 and Option 2 can be captured the following four paragraphs into TR 38.875 clause 12 for PDCCH monitoring:**

|  |
| --- |
| Option 1: Based on the study, it is recommended by RAN1 to specify PDCCH monitoring reduction scheme(s) to obtain smaller BD numbers, with target for zero increment PDCCH blocking rate in Rel-17 to avoid the network scheduling impact.  Option 2: There is no consensus in RAN1 to recommend specifying reduced PDCCH monitoring reduction scheme(s) in Rel-17.  |

**If one option is preferred but needs some modification, please indicate it explicitly to add it into TR 38.875.**

* **For example, ‘Option 1, with following modification …” into comment column.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Sharp | Option 1 |
| vivo | *Option 1 with slight modification*Option 1: Based on the study, it is recommended by RAN1 to specify PDCCH monitoring reduction scheme(s) to obtain smaller BD numbers, with target for ~~zero~~ minimized increment PDCCH blocking rate in Rel-17 to avoid the network scheduling impact.   |
| ZTE,sanechips | Option1, with following modification.On one hand, zero increment is totally unnecessary for some delay tolerant UEs. On the other hand, for some cases, the negligible increase,e.g.,0.01% is also acceptable. Therefore, we prefer the original version with “minimized increment” instead of “zero increment”.  |
| Huawei, HiSilicon | Option1. We think it is ‘target for zero increment’. Therefore, ‘Zero increment’ is essential for the conclusion. |
| MediaTek | We support Option 2. The power saving by BDs limit reduction can be already achieved using existing R15/16 configurations (e.g., PDCCH candidates and DCI sizes to monitor) without an impact to the system performance.Regarding the suggestions to have “minimized increment” in Option-1, this is very generic recommendation and every company will have its own understating of meaning of “minimized increment”. Thus, we are not supportive of such generic wording in general. |
| Samsung | Option 1 and support vivo’s modification.Minimized PDCCH blocking is sufficient.  |
| Fraunhofer | Option 1. Vivo’s suggestion seems reasonable to us. |
| Qualcomm | Option 1, agreed with companies that “zero increment” is too extreme and should be removed. Probably we can use “marginal increment”. |
| InterDigital | Option 1. Vivo’s change seems ok to us. Zero increment looks too strict. |
| Intel | Option 1 with modification. In general, “zero increment” sounds neither practical nor inclusive of different schemes studied. It seems we are not recommending any specific scheme at this point. Vivo’s or QC’s suggestion is fine and looks more general. |
| Futurewei | Option 1 as proposed by FL. If we target zero and get 0.01% in the end it is OK as we still targeted zero, thus no need to modify FL wording. |
| LG | Option 2From our perspective, the power saving gain less than 10% is not enough to recommend for RedCap WI. Also, the power saving gain by BD reduction can be achieved by existing Rel-15/16 network configuration. |
| Ericsson | Option 2. We highlight below some of our reasons for choosing Option 2.1. The power saving benefit of BD reduction is limited. The power saving gain, even with 50% BD reduction, is less than 6% in most cases in FR1. It is also worth noting that these results are based mostly on DL-only traffic.
2. The equivalent power saving due to BD reduction (with/without reduced DCI size budget) can already be achieved using existing Rel-15/16 configuration parameters without any new specified restriction for RedCap UEs.
3. BD reduction can also lead to other network impacts, in addition to impacts on scheduling flexibility and blocking probability. For instance, if the RedCap UEs support few BDs, it can limit the possibility of the network to configure several ALs. Therefore, to ensure coverage the network would have to always use the high AL, leading to reduction in PDCCH capacity.
4. BD reduction with additional DCI size budget reduction might also prevent enabling of more promising DCI-based UE power saving features, e.g., search **space set group switching, PDCCH skipping, cross-slot scheduling, WUS (the former two are currently being considered in the Rel-17 power saving WI) for RedCap.**
5. If it becomes mandatory for the network to implement the new BD restriction in order to support RedCap UEs, this may delay the successful timely deployment of RedCap UEs in the networks.
6. Several operators have expressed concerns in this email discussion on the RAN1 email reflector that should be considered when deciding on the RAN1 recommendation.
 |
| DOCOMO | We can live with Option 1 proposed by FL, i.e., without modification of “target for minimized/marginal increment”. Any relaxation techniques should be designed considering NW impact, and the modification of “target for minimized/marginal increment” makes the design target ambiguous. “target for zero increment” would be proper statement. |
| CATT | Option 1 without change. Zero increment is the target doesn’t mean blockage cannot increase compared to the current mechanism. ‘Minimized’ or something else is rather unclear as different companies may have different understanding on ‘minimized’.  |
| Spreadtrum | Option 1. We support vivo’s modification. |
| OPPO | Option 1. Or, we are fine for vivo’s modification. Further is seems the reasonable goal is avoid the blocking for Normal UE, instead of RedCap UE which is not sensitive to latency.Option 1: Based on the study, it is recommended by RAN1 to specify PDCCH monitoring reduction scheme(s) to obtain smaller BD numbers, with target for minimized increment PDCCH blocking rate for normal capability UEs in Rel-17 to avoid the network scheduling impact.   |

**Summary of 10th round of email discussions**

|  |  |  |
| --- | --- | --- |
|  | Companies  | # of companies  |
| Option 1 | Sharp, vivo (Modification), ZTE, Sanechips (vivo version), Huawei, HiSilicon, Samsung (vivo version), Fraunhofer (vivo version), Qualcomm (vivo version), InterDigital (vivo version), Intel (vivo version), Futurewei, DOCOMO, CATT, Spreadtrum (vivo version), OPPO (vivo modification) | 16 |
| Option 2 | MediaTek, LG, Ericsson, Nokia, NSB  | ~~3~~ 5 |

Clearly, all responses except 3 responses indicate to support Opt.1. Among 16 responses, 10 responses indicate that target for zero increment PDCCH blocking rate is too extreme and restrictive. It was suggested to reword like “minimized”, ‘marginal’. On the other hand, 6 companies believe it is essential to keep “zero increment” target as part of conclusion.

Given the current situation, targeting for ‘zero increment’ seems something in the middle to compromise between two sides, e.g., modified Option 1 and Option 2 by putting certain restrictions. In addition, technically it is also reasonable and desirable to address operator/intra-vendors concern on scheduling flexibility, which should be always seriously considered as one critical design criteria.

Having said that, let’s take a last try with focusing on the option 1 and please compromise at most to make progress

**[FL11] Q 12-3: Adopt the following into TR 38.875 clause 12 for PDCCH monitoring:**

|  |
| --- |
| Based on the study, it is recommended by RAN1 to specify PDCCH monitoring reduction scheme(s) to obtain smaller BD numbers, with target for zero increment PDCCH blocking rate in Rel-17 to avoid the network scheduling impact.   |

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| TIM | N | TIM supports option 2 |
| MediaTek | N | As we highlighted previously, the proposed recommendation is not acceptable to us.The power saving by BDs limit reduction can be already achieved using existing R15/16 configurations.Also, it is worth mentioning that RAN1 has already made the following agreement in the power saving WI, which in our view covers Scheme#3. Thus, Scheme#3 shouldn’t be discussed further as part of RedCap.

|  |
| --- |
| Agreements:* **Specify at least one of the following options for Rel-17 dynamic PDCCH adaptation ~~in time-domain~~ for active time,**
	+ **Option 1: Search space set group switching,e.g., ~~potential adjustments/enhancements for~~including explicit and implicit search spaceset group switching ~~specified in R16 for NR-U~~**
	+ **Option 2: PDCCH skipping for a certain duration / DRX cycle**
* **FFS: which option(s)~~(e.g. taking into account additional gain of option 1 over option 2, or vice-versa)~~**
* **Candidate DCI formats for dynamic PDCCH adaptation include DCI formats 1\_1(including scheduling and non-scheduling DCI), 0\_1, 1\_2, 0\_2, 2\_0, 2\_6.**
* **Note:**
	+ **Companies are encouraged to provide analysis on specification impact, power saving benefit and system impact (e.g., packet latency, system overhead)**

**FFS: other schemes are not precluded for further study** |

 |
| Ericsson | N | The updated recommendation has not addressed our concerns highlighted in our earlier response. However, as a compromise, a potential way forward can be as follows (using similar wording as some of the 8.6.1 agreements):Proposal: Down-select between the following options at RAN plenary* + - Option 1a: For RedCap, specify PDCCH monitoring reduction scheme(s) to obtain smaller BD numbers, with target for zero increment PDCCH blocking rate in Rel-17 to avoid the network scheduling impact.
		- Option 2a: For RedCap, do not specify PDCCH monitoring reduction scheme(s) in Rel-17.
 |
| Huawei, HiSilicon | Y | We support FL’s proposal. |
| Nokia, NSB | N | We support the original option 2 or Ericsson’s revised Option 2a. As others have pointed out already, we believe that power saving by BDs limit reduction can be already achieved using existing R15/16 configurations. |
| LG | N | We support the original option 2. PDCCH monitoring reduction scheme has limited power saving gain and it can be already achieved by existing Rel-15/16 network configurations. |
| OPPO | Y | This can be agree as a compromise in 8.2.5 together. |
| Futurewei | Y | We are also OK to support Ericsson’s compromised proposal (but only okay with the zero target) |
| ZTE,sanechips | Y | It is suggested to reword like “minimized”, instead of “zero”. However, for sake of progress, maybe we also can follow the majority if the majority are fine with the final compromise. |
| Samsung | Y | We are fine with zero increment as compromise.  |
| Qualcomm | Y |  |
| Intel | Y | We would have still preferred to revise “zero” to “minimal”. In general, for any reduced PDCCH monitoring, it is physically not possible to guarantee “zero increment in blocking” for the same offered traffic.However, we can accept FL11 proposal as a compromise since this is interpreted as a “target”.  |