**3GPP TSG RAN WG1 Meeting #108-e R1-22xxxxx**

**E-meeting, February 21st – March 3rd, 2022**

**Source: Moderator (Qualcomm Incorporated)**

**Title:** **Summary of [108-e-NR-CRs-13]: Clarification on PDCCH monitoring for Case 1-2**

**Agenda Item:** **7.1**

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

# **Introduction**

This document is the summary of email discussion regarding the proposal in [1].

[108-e-NR-CRs-13] Issue#15 Clarification on PDCCH monitoring for Case 1-2 – Fred (Qualcomm)

* Relevant tdoc: R1-2202113
* Check point on February 23

# **Background**

At the RAN1#91 meeting, following agreements have been made:

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| --- |
| **Agreements:**   * For information, the following cases are clarified:   + Case 1: PDCCH monitoring periodicity of 14 or more symbols     - Case 1-1: PDCCH monitoring on up to three OFDM symbols at the beginning of a slot     - Case 1-2: PDCCH monitoring on any span of up to 3 consecutive OFDM symbols of a slot       * For a given UE, all search space configurations are within the same span of 3 consecutive OFDM symbols in the slot   + Case 2: PDCCH monitoring periodicity of less than 14 symbols     - Note: this includes the PDCCH monitoring of up to three OFDM symbols at the beginning of a slot |

The Case 1-2 was intended to support DSS operations. In DSS, LTE-CRS is mapped on some symbols and these symbols are not available for NR-PDCCH monitoring. Therefore, Case 1-2 enables a UE to monitor PDCCH on a single span of three contiguous OFDM symbols that is not limited to the first three consecutive OFDM symbols in a slot. The corresponding UE capability, *pdcch-MonitoringSingleOccasion*, has been specified for SCS 15kHz in TS 38.306 as follows [1].

| ***pdcch-MonitoringSingleOccasion***  Indicates whether the UE supports receiving PDCCH in a search space configured to be monitored within a single span of any three contiguous OFDM symbols in a slot with the capability of supporting at least 44 blind decodes in a slot for 15 kHz subcarrier spacing. | UE | No | No | FR1 only |
| --- | --- | --- | --- | --- |

# **Problem description**

[1] pointed out that *pdcch-MonitoringSingleOccasion* is beyond what is necessary.

* According to TS 38.213 Table 13-11, the first symbol index of a PDCCH monitoring occasion for Type-0 CSS set in FR1 is {0, 1, 2, or }, where is the number of symbols for CORESET #0. Therefore, as long as the UE monitors Type-0 CSS set in this cell (i.e., PCell), there is no case where the UE is configured with PDCCH monitoring other than the first 6 OFDM symbols of a slot.
* In DSS scenarios, LTE-CRS is present on some OFDM symbols and these symbols are not available for NR-PDCCH.

Considering the above two aspects, desired feature for Case 1-2 in DSS scenario is, in reality, limited to the followings – up to the 4th OFDM symbol of a slot.

 

(a) LTE-CRS 2 ports (b) LTE-CRS 4 ports

Fig.1 Symbols available for NR-PDCCH monitoring on a DSS carrier

In order to meet the market demand for NR-PDCCH monitoring other than the first 3 OFDM symbols in a slot in DSS operation in Rel-16, [1] proposes to update the description of *pdcch-MonitoringSingleOccasion* in Rel-16 spec as follows. With the change, a UE can declare support of the feature if the UE implements, and is tested with, PDCCH monitoring occasion within the first four OFDM symbols in a slot.

| ***pdcch-MonitoringSingleOccasion***  Indicates whether the UE supports receiving PDCCH in a search space configured to be monitored within a single span of any three contiguous OFDM symbols that are within the first four OFDM symbols in a slot with the capability of supporting at least 44 blind decodes in a slot for 15 kHz subcarrier spacing. | UE | No | No | FR1 only |
| --- | --- | --- | --- | --- |

# **Comments received during preparation phase**

During the preparation phase, following comments have been received for the proposal in [1]:

* The proposed change is NBC (ZTE)
* Spec is not broken and the change is not essential (Nokia, Intel)
* Case 1-2 is not limited to DSS use-case (Intel)
* Scheduling flexibility is restricted (Samsung)
* Case 1-2 can be configured on SCell, in which case Type-0 CSS set is not relevant (Huawei)

# **1st round discussion**

Q1: Do you agree that there is a need to support PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot for DSS on PCell in Rel-16?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| DOCOMO | Yes |  |
| Intel | Yes | It is a valid use-case and is currently possible to be supported via more than one means. |
| Huawei, HiSilicon | Yes | Our understanding is that the existing definition of “pdcch-MonitoringSingleOccasion” allows the gNB to configure PDCCH monitoring within a single span of **any** three contiguous OFDM symbols in a slot. Therefore, we don’t see an issue with the current definition to support the use case of DSS on PCell and we don’t see the need to change the definition of such UE capability in Rel-16. |
| Ericsson1 | Yes | Support of PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot on PCell is useful for DSS. |
| MTK | Yes |  |
| Qualcomm | Yes | There is a market need of supporting PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot in Rel-16. |
| ZTE | Yes | It is a valid use-case. |
| Samsung | Yes | The case is valid |
| vivo | Yes | The case is (already) supported by the current FG *pdcch-MonitoringSingleOccasion* from Rel-15, as it does not limit where the span should be located. |

Q2: Do you agree that the current description of *pdcch-MonitoringSingleOccasion* “single span of any three consecutive OFDM symbols in a slot” requires UE to support, and be tested with, various PDCCH monitoring occasions that are not within the first four OFDM symbols in a slot?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| DOCOMO | Yes | “Any” three consecutive symbols in a slot needs to be tested from the current description. |
| Intel | Yes | Certainly, the UE is required to support as the capability is described; exact cases (whether all possible cases, etc.) to be tested is out of RAN1 scope. |
| Huawei, HiSilicon | Yes | We don’t see this as an issue given the current definition. |
| Ericsson1 |  | Indication of *pdcch-MonitoringSingleOccasion* implies UE supports PDCCH monitoring occasions covered by the capability. What combinations are tested/not is somewhat outside scope of RAN1. |
| MTK | Yes |  |
| Qualcomm | Yes | Due to this over flexibility of span configuration in this description, declaring the support of this feature is difficult as no ecosystem would enable this “any three consecutive OFDM symbols in a slot”. |
| ZTE | Yes | From specification perspective, dcch-MonitoringSingleOccasion implies that UE can support a single span of any three consecutive OFDM symbols in a slot. |
| Samsung | Yes | Based on description of *pdcch-MonitoringSingleOccasion*, any 3 consecutive OFDM symbols in a slot need to be tested |
| vivo | Yes |  |

Q3: Do you agree that a capability signalling that can indicate support of PDCCH monitoring within a single span of any three contiguous OFDM symbols that is within the first four OFDM symbols in a slot for DSS on PCell is necessary in Rel-16?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| DOCOMO |  | Not necessary from spec point of view as nothing is broken. On the other hand, we understand the monitoring flexibility may complicate the test, which would delay deployments of DSS. Therefore, we could be fine with the proposed change unless there is any real NBC issue. |
| Intel | No | As mentioned in response to Q1, such capabilities are already covered by existing capabilities in current specs. Whether there exists reason to introduce a new one should be a separate discussion, not part of maintenance (see our response to Q8). |
| Huawei, HiSilicon | No | See our reply to Q1. This use case can be supported based on the existing UE capability. |
| Ericsson1 |  | Support of PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot on PCell is useful for DSS. On capability issue, please see responses to Q4, Q6. |
| MTK | Yes, but … | We emphasize that limiting the capability to the first four OFDM symbols simplifies UE implementation and testing, so we kind of agree. However, if in some scenarios one gNB really requires PDCCH monitoring after the first four OFDM symbols, then adding this constraint do have impact to legacy implementation. We are open to hear more views. |
| Qualcomm | Yes |  |
| ZTE | No | Considering that there is already a FG to indicate a single span of any symbol, additionally having a FG to indicate a single span of any three contiguous OFDM symbols that is within the first four OFDM symbols in a slot is similar like a UE in-capability. We should avoid such a FG. |
| Samsung |  | Strictly speaking, the current capability, *pdcch-MonitoringSingleOccasion*, includes the case so that nothing is broken.  The intention of this proposal seems to limit UE capability based on the valid use cases. We are open to hear more views on the valid use cases and any potential issues such as NBC. |
| vivo |  | The question is not clear to us. The current FG *pdcch-MonitoringSingleOccasion* already supports this operation. Is it asking whether a new FG is needed to restrict that the span can only be within the first four symbols? |

Q4: Do you see the need of PDCCH monitoring with single span of any three consecutive OFDM symbols in a slot on SCell? If so, please explain the use-case and benefit.

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| --- | --- | --- |
| Company | Yes/No | Comment |
| Intel | Yes, in general. | Up to gNB implementation and particular use-cases/deployments, e.g., if a UE reports the capability, it is up to the NW to decide to utilize it in appropriate ways. For instance, it is not clear why this use-case may not be feasible.  We do not see the relevance of this question as it aims to retroactively impose restrictions on an existing feature on the basis of “lack of use-cases”. If we go this route, there can be lots of discussions to change features that may not have been implemented so far. |
| Huawei, HiSilicon | Yes | Carrier aggregation has been supported in NR since Rel-15 involving bands where LTE is deployed. Therefore, it is crucial to support NR CA with a given SCell which may share the spectrum with LTE to maximize the spectrum efficiency for the operator.  In addition, as the definition of UE capability implies, the gNB can configure PDCCH monitoring in any three consecutive OFDM symbols for UEs indicating the support of pdcch-MonitoringSingleOccasion. This provides better flexibility for gNB and the PDCCH capacity within one slot can also be increased. We fail to see the motivation to preclude such possibilities. |
| Ericsson1 | Yes | Above is enabled already by current Rel-15 signalling and provides more options for configuring NR PDCCH. Prefer to not preclude this. |
| MTK |  | No strong opinion |
| Qualcomm | No | We do not see a strong use-case so far. |
| ZTE | Yes | This has been supported by the Rel-15 RRC signalling already. Network may or may not configure the span outside the first 4 symbols. |
| Samsung |  | We do not see a strong use case for this case, but it is up to gNB implementation in general. |
| vivo | Yes | It may be possible depending on the network deployments, e.g., for beam sweeping of CORESET on SCell, inter-cell interference coordination, or URLLC deployment. |

Q5: Do you see the need of PDCCH monitoring with single span of any three consecutive OFDM symbols in a slot for non-DSS scenarios on PCell? If so, please explain the use-case and benefit.

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| --- | --- | --- |
| Company | Yes/No | Comment |
| Intel | Yes, in general. | Case 1-2 is more flexible than Case 1-1 and both have been specified since Rel-15. Having a capability that offers more scheduling flexibility than the baseline can be utilized to expand the possible use-cases in general to multiplex PDCCH with other DL/UL channels.  For similar reasons, we do not tie use-cases to specifications.  More importantly, to repeat our response to Q4, we do not see the relevance of this question as it aims to retroactively impose restrictions on an existing feature on the basis of “lack of use-cases”. If we go this route, there can be lots of discussions to start modifying/removing NR features that may not have been implemented so far. |
| Huawei, HiSilicon | Yes | See our reply to Q4. As a matter of fact, regardless of whether it is for DSS and non-DSS use case, the UE capability of PDCCH monitoring with single span of any three consecutive OFDM symbols provides better flexibility and larger PDCCH capacity. |
| MTK |  | No strong opinion |
| Qualcomm | No | We do not see a strong use-case so far. |
| vivo | Yes | In NR it is possible that CORESET #0 is deployed in symbols after the first four symbols, and the CORESET is used also for search space other than type-0. |

Q6: Do you agree that the description of *pdcch-MonitoringSingleOccasion* in Rel-16 spec should be updated to “Indicates whether the UE supports receiving PDCCH in a search space configured to be monitored within a single span of any three contiguous OFDM symbols that are within the first four OFDM symbols in a slot with the capability of supporting at least 44 blind decodes in a slot for 15 kHz subcarrier spacing.”?

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| Company | Yes/No | Comment |
| DOCOMO |  | **Could be fine with the proposed change unless there is any real NBC issue.**  The original intention of this capability is to support Case 1-2 for DSS scenario and it should be the common understanding among the group. Although the proposed change will lead to scheduling restriction, we don’t think the restriction becomes problematic in actual deployments and contradicts to the original intention of the capability. Therefore, we could be fine with the proposed change unless there is any real NBC issue. If anything valid is brought up by other companies in Q7, we would prefer to have a different new UE capability as in Q8 or no change to the current spec. |
| Intel | No | While we do not deny the possible benefit of introducing a variant of *pdcch-MonitoringSingleOccasion* with additional constraints that can best cater to DSS use-cases, we do not agree to retroactively changing an existing feature since past two releases based on reasoning of use-cases or lack thereof when there is no technical issue with the current feature or specs.  In this regard, we would be open to considering a new capability (cf. Q8) that should be discussed in context of DSS as a new feature and not as part of maintenance. |
| Huawei, HiSilicon | No | First of all, we don’t see an issue with the current definition to support DSS use case.  Secondly, making update to the definition of pdcch-MonitoringSingleOccasion in Rel-16 will lead to more issues. A Rel-15 gNB cannot differentiate Rel-15 UEs that are capable of PDCCH monitoring within a single span of any three contiguous OFDM symbols from Rel-16 UEs that are only capable of PDCCH monitoring within a single span of any three contiguous OFDM symbols that are within the first four OFDM symbols. |
| Ericsson1 |  | As indicated for Q1, Q3 monitoring within first four symbols is useful for DSS.  If need is seen for UE to specifically indicate only the ‘within first four symbols’ case, another option (compared to modifying existing capability definition of *pdcch-MonitoringSingleOccasion*) is to introduce a separate UE capability for indication of such specific case. |
| MTK |  | Could be fine with the proposal |
| Qualcomm | Yes | We see a demand of supporting PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot in Rel-16.  We do not think changing the description of *pdcch-MonitoringSingleOccasion* does cause any issue. However, we are also open to go with a new Rel-16 capability if it is preferable by majority. |
| ZTE | No | As we commented previously, the NR specification has already supported the flexibility of a span in any symbols. |
| Samsung |  | We would keep the original description since nothing is broken. But, we can accept the proposed change if no issues (e.g., NBC issue) are identified and the first 4 symbols are only used for PDCCH monitoring for DSS case. |
| vivo | No | With this change, the same UE FG in Rel-16 becomes more restrictive than Rel-16. It would be risky for a Rel-16 UE with the updated FG enters a Rel-15 network coverage. |

Q7: Do you have a real NBC issue if the description of *pdcch-MonitoringSingleOccasion* is changed as in Q6? If so, please explain examples where the change causes NBC issue.

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| --- | --- | --- |
| Company | Yes/No | Comment |
| Intel | Possibly | Technically, it would be NBC if we change existing features at this stage if gNB is implemented for PDCCH case 1-2 following current specs, thus, expecting the UE to support current version.  Whether or not it’s a “real NBC issue” cannot be conclusively determined in this forum. |
| Huawei, HiSilicon | Yes | The proposal requires a basic function change that would require update of the UEs in the market. As replied to Q6, a Rel-15 gNB cannot differentiate Rel-15 UEs and Rel-16 UEs indicating the same UE capability. Therefore, the Rel-15 gNB may not provide a proper configurations for Rel-16 UEs. |
| Ericsson1 |  | From UE side, there may be no NBC impact since the proposed update restricts UE capability compared to legacy definition. From gNB side impact depends on presence of UEs already indicating this capability. |
| ZTE |  | From network side, if there is already UEs indicating support of this capability, then there will be NBC issue. |
| vivo |  | Not sure what “real NBC issue” means, but a possible case (as described in Q6) is a Rel-16 UE (with the updated capability) enters a Rel-15 network coverage. It would be problematic when the network configures a CORESET after the first four symbols to the UE. |

Q8: If you see a real NBC issue, do you accept to introduce a new UE capability indicating support of PDCCH monitoring within a single span of any three contiguous OFDM symbols that are within the first four OFDM symbols in a slot in Rel-16?

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| --- | --- | --- |
| Company | Yes/No | Comment |
| Intel |  | We can be open to introduction of a new UE capability to this effect.  However, we do not think introducing new UE capabilities to better cater to certain use-cases is strictly in scope of maintenance since nothing is broken.  Whether to introduce a new UE feature for Rel-16 DSS should more appropriately be discussed as part of DSS enhancements. |
| Huawei, HiSilicon | No | As replied to Q1, we don’t see an issue with the current definition and we don’t see the need to introduce a “*reduced*” UE capability in Rel-16. |
| Ericsson1 |  | Compared to changing description of existing capability, this is more preferable. |
| MTK |  | We are fine with a new UE capability if necessary, for DSS application. |
| Qualcomm | Accept | We are also OK with this option, if companies prefer. The discussion cannot automatically belong to DSS enhancements, as DSS enhancements is Rel-17 while the discussion here is Rel-16. |
| ZTE |  | This can be discussed in UE feature session. |
| vivo | Yes | We can accept to introduce a new UE capability. |

# **2nd round discussion**

Following are summary of the 1st round discussion:

* 10 companies (DOCOMO, Intel, Huawei, HiSilicon, Ericsson, MTK, Qualcomm, ZTE, Samsung, vivo) agreed that there is a need to support PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot for DSS on PCell in Rel-16.
* 9 companies (DOCOMO, Intel, Huawei, HiSilicon, MTK, Qualcomm, ZTE, Samsung, vivo) agreed that enabling of *pdcch-MonitoringSingleOccasion* with the current description requires UE to support, and be tested with, various PDCCH monitoring occasions that are not within the first four OFDM symbols in a slot.
  + 2 companies (Intel, Ericsson) pointed out whether tested or not is not the scope of RAN1.
* 4 companies (DOCOMO, MTK, Qualcomm, Samsung) are OK with changing the description of *pdcch-MoonitoringSingleOccasion*, while 6 companies (Intel, Huawei, HiSilicon, Ericsson, ZTE, vivo) have concern on it due to potential NBC issue.
* 8 companies (DOCOMO, Intel, Ericsson, MTK, Qualcomm, ZTE, Samsung, vivo) are OK to consider a new Rel-16 UE capability for PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot in Rel-16.
  + Among them, 5 companies (DOCOMO, MTK, Ericsson, Qualcomm, vivo) show acceptance of the new Rel-16 capability.
* 2 companies (Huawei, HiSilicon) are not OK to discuss a new Rel-16 UE capability for PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot in Rel-16.

Given the above results, follow-up questions are provided below.

2nd round question: please indicate your preference. According to the 1st round discussion, the most of concerns are regarding NBC of changing the existing description. Therefore, if Opt.3 is preferred, please indicate the reason other than potential NBC issue.

* Opt.1: Support a new Rel-16 UE capability for PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot in Rel-16
  + Details to be discussed after the check point of this email discussion (Feb 23)
* Opt.2: Further discuss whether to support a new Rel-16 UE capability for PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot in Rel-16 after the check point of this email discussion (Feb 23)
* Opt.3: Do not support/discuss a new Rel-16 UE capability for PDCCH monitoring with a single span of three contiguous OFDM symbols that is within the first four OFDM symbols in a slot in Rel-16

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| Qualcomm | Opt.1 | Since we had enough discussion already in the 1st round of this email discussion, we prefer to go with Opt.1. Details can still be discussed after the check point. |
| Nokia, NSB |  | We’d be open for a new Rel-16 capability if that is considered as enabling UE base that was supposed to be available with Rel-15 already. |
| AT&T | Opt.1 | Apologies for missing the first round deadline. Our view, however, is aligned with the direction of the second round. In Rel. 15 there was a capability where the UE monitors for PDCCH on every symbol. Rather than changing that capability, two new span based capabilities were introduced. We think, RAN1 should thus not change the existing Rel. 15 capability of any span in a slot to limit it to the first four symbols. Introducing a new capability for the first four symbols in addition is more in line with what RAN1 did for Rel. 15 URLLC and can also address most of the concerns brought up in the preparation phase.  As pointed out by Nokia, such a new capability could significantly increase the likelihood that UEs implement this DSS feature that’s been there since Rel. 15 for good reasons. Control channel capacity continues to be an issue of extremely high importance for DSS deployments around the world as evident by the work in Rel. 17 and now Rel. 18. The Rel. 15 DSS feature at hand, in our view, remains the most promising solution, and 3GPP should agree this proposal to reflect the urgency of the problem in today’s 5G NR deployments that rely on DSS. Procedurally, as said before, this change is very similar to what happened to the “on any symbol” PDCCH feature in Rel. 15 and DSS is a major deployment mode of 3GPP 5G technologies around the world and the issue this would help address is very much acknowledged as evident by 3GPP’s Rel. 17 and Rel. 18 work. If this can help alleviate the issue earlier and accelerate time-to-market and market penetration of a solution, it is worth implementing it now. Thank you. |
| Vodafone | Opt.2 | We share the views expressed by AT&T, however we support having further discussion on the introduction of the new capability. One of the concerns that we think needs to be addressed is the point raised by vivo (having a R16 UE that support this new capability accessing a R15 network which configures a CORESET after the first four symbols to the UE). If it can be addressed in this 2nd round, we |
| Intel |  | As indicated before, we are open to introducing new UE capability.  However, our concern lies with the procedural aspects – it should be clear that this is not maintenance work. We are not fixing anything but may be introducing a new feature/capability. This seems like handling a sort of a TEI issue under maintenance.  Thus, the decision on introduction of a new UE capability for Rel-16 should not be coupled with maintenance work.  At the minimum, the scope of introducing new UE capability should be clarified clearly as a decision separate from maintenance, following the first check-point. |
| Spreadtrum | Opt 1 | We support a new Rel-16 UE capability of within the first four OFDM symbols. It is a good method for use cases flexibility and UE PDCCH monitoring.  Also fine with Opt 2 for further discsussion. |
| Huawei, HiSilicon |  | We still have a fundamental question on whether there is no need to go with either Opt.1 or Op.2 given that the intended use case can already be covered by the existing UE capability. If the existing UE capability can support the use case, what needs to be fixed?  We also don’t quite understand the concerns on PDCCH capacity. With the existing UE capability definition (Rel-15), the gNB has full flexibility to configure the PDCCH monitoring occasions and of course configuring the PDCCH monitoring occasions within the first 4 OFDM symbols is also possible.  In addition, if we go with Opt.1, a Rel-15 gNB cannot understand the Rel-16 UE capability report while a Rel-16 gNB has to handle two kinds of UEs with different capabilities, i.e. Rel-15 capability and Rel-16 capability. This bring additional complexity to the NW implementation. |

# **Summary and conclusion**

# **Reference**

1. R1-2202113, Clarification on PDCCH monitoring for Case 1-2, Qualcomm Incorporated