**3GPP TSG RAN WG1 #107-e R1-2112666**

**e-Meeting, Nov. 11 – Nov. 19, 2021**

**Source: Moderator (MediaTek)**

**Title: Summary for [107-e-NR-7.1CRs-11] #18 PUSCH DMRS with UCI Only**

**Agenda item: 7.1**

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

Introduction

In RAN1#107-e meeting, two contributions [1, DOCOMO] and [2, MTK] are submitted to clarify the UE behavior when a DCI scheduling a PUSCH without UL-SCH indicates FDM between UL-SCH and DM-RS.

As guided by the Chairman, this contribution provides summary of the submitted contributions (Section 4), discussion points (Section 2), and possible RAN1 conclusion during this meeting (Section 3, TBD).

[107-e-NR-7.1CRs-11] Issue#18: Clarification on PUSCH with UCI Only and DMRS Multiplexing by Nov 17 – ??? (MediaTek)

* Only to draw a possible conclusion on Issue#18

Discussion points (phase 1 until 12-Nov)

Based on the submitted contributions [1, DOCOMO] and [2, MTK], both companies strive to clarify the UE behaviour when a DCI scheduling a PUSCH without UL-SCH indicates FDM between UL-SCH and DM-RS and propose that

* ***Proposal 1: UE does not transmit any bits for non-DMRS RE(s) in DMRS symbol(s) when a DCI format 0\_1 includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.***

The proposal above corresponds to Interpretation #1 as shown in Figure 1 (a) below:

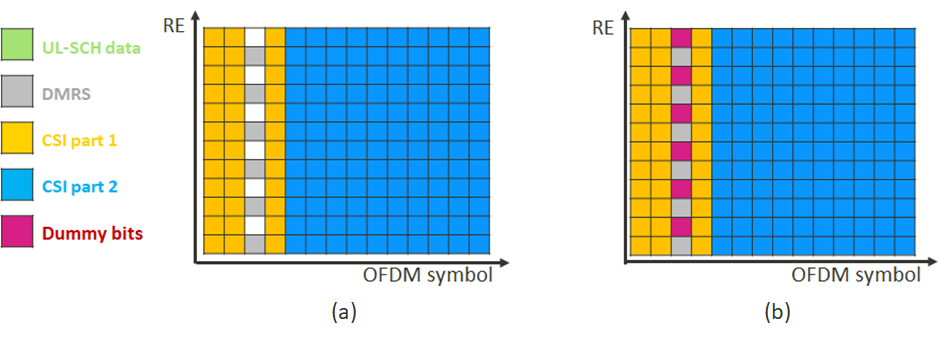


Figure 1. Two possible UE behaviours: Interpretation #1 in (a) and Interpretation #2 in (b)

In the preparation phase summary for AI 7.1 during RAN1 #107e [3], RAN1 Chairman’s initial assessment is

* + Seems the **current specification is written in a way to reflect interpretation1**. Seems no further spec change is necessary

and companies’ stands in [3] are

* + **Interpretation1:** MTK, Nokia, CATT, Samsung, Huawei, Futurewei, vivo, Ericsson, Intel, Apple
  + **Up to UE implementation, this case can be avoided by gNB:** Qualcomm

**Discussion point 1:**

**To draw a possible conclusion in this meeting as guided by Chairman, do you agree to take the following proposal as RAN1 conclusion:**

* ***Proposal 1: UE does not transmit any bits for non-DMRS RE(s) in DMRS symbol(s) when a DCI format 0\_1 includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.***

**If your answer is “No”, please try to provide a way forward in comment if possible, to address the concern raised by [1, DOCOMO]**

* **gNB might schedule a PUSCH with UL-SCH indicator = 0 that is indicated to perform FDM between UL-SCH and DMRS, since there is no spec text preventing gNB from doing this. Prohibiting this case will be NBC from gNB’s perspective.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| MTK | Yes | We think this conclusion is needed to align behaviour between UE and gNB, and prevent NBC issue for gNB. |
| Ericsson | Yes | We are fine with the conclusion. Another issue need to be clarified is the DM-RS power boosting, shall UE follow the DM-RS power boosting as defined in Table 6.2.2-1 from 38.214 or could UE boost the DMRS power if the REs between DM-RS is empty? |
| OPPO | Yes | The conclusion is aligned with current spec. |
| ZTE | Yes |  |
| NTT DOCOMO | Yes | Unless it is prohibited that a UL grant indicates “without UL-SCH” and “FDM between UL-SCH and DM-RS”, we are fine with this direction.  One comment is that this proposal should be updated as follows since if we only uses “transmit” for this proposal, then UE might generate bits for the REs but not transmit them. This aspect would have impacts on signalling generation, e.g. PUSCH scrambling. This update is needed to avoid such misinterpretation.   * ***Proposal 1: UE does not generate and transmit any bits for non-DMRS RE(s) in DMRS symbol(s) when a DCI format 0\_1 includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.*** |
| Sharp | Yes | We think the proposal is aligned with the current specification. |
| QC | No | We think current specification does not cover this case. UE behaviour is unspecified in this case. The proposed conclusion is NBC to spec.  Regarding the concern from DCM, the question is why gNB would indicate conflicting information in DCI? Can’t gNB just indicate NOT FDM to avoid this issue? We don’t see why this is NBC to gNB implementation? As this is just a few bits in DCI content, gNB can always set the bits to different value to avoid this issue. |
| vivo |  | We can accept the conclusion if it is the majority’s view. It is aligned with the current spec. In addition, we don’t think it is NBC to prevent gNB from doing this. NBC should be from UE’s perspective. gNB shouldn’t have such scheduling. |
| Samsung | Yes | Current spec is clear and implies Interpretation 1. We are fine with proposed conclusion. |
| HW, HiSi | Y | Ok with the proposal |
| Moderator |  | According to the inputs I received so far, for approval of the proposal **as RAN1 conclusion**:   * UE does not generate and transmit any bits for non-DMRS RE(s) in DMRS symbol(s) when a DCI format 0\_1 includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.   The companies’ stand seems to be:   * Yes: **MTK**, **E///**, **OPPO**, **ZTE**, **DOCOMO**, **Sharp**, **Samsung**, **Huawei**, [**vivo**] (**8**) * No: **Qualcomm** (**1**)   @DOCOMO:   * Regarding QC’s comment:   + “**Why gNB would indicate conflicting information in DCI?** Can’t gNB just indicate NOT FDM to avoid this issue? We don’t see why this is NBC to gNB implementation? As this is just a few bits in DCI content**, gNB can always set the bits to different value to avoid this issue.**”   Can you briefly explain why gNB can not set the bits to different value to avoid this issue?  @Qualcomm:   * You mentioned:   + “**UE behaviour is unspecified in this case. The proposed conclusion is NBC to spec.**”   However, to my understanding, there is no spec text to prevent gNB from scheduling a PUSCH with UL-SCH indicator = 0 that is indicated to perform FDM between UL-SCH and DMRS.  Since this issue is observed from field, would it be possible for you to be flexible to accept the conclusion if there is really some reason for gNB to perform this configuration? Leaving UE behaviour unspecified may cause implementation difficulties from gNB side. |
| Intel | Yes | We are fine with the proposed conclusion to make it clear. We also do not think this is NBC issue as this is allowed in the specification, however, gNB may not consider such scheduling. |
| LG | Yes | We are also fine with the proposed conclusion made based on Interpretation 1 which is aligned with the current spec. |
| NTT DOCOMO | Yes | Thanks for discussions.  We checked this issue internally again since this issue was raised quite previously, and our current decision is that gNB can avoid the scheduling.  From spec perspective, we still think that this is not NBC issue of UE but just confirmation of the current spec. There is no text to prohibit the scheduling and no text to generate any bits for the REs. However based on the internal check, now we have flexibility on this issue. |
| Moderator2 |  | For the previous moderator proposal of **taking Interpretation 1 as RAN1 conclusion**, companies’ stands in the latest [v013](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Inbox/drafts/7.1/%5B107-e-NR-7.1CRs-11%5D/R1-21xxxxx%20%5B107-e-NR-7.1CRs-11%5D%20%2318%20PUSCH%20DMRS%20with%20UCI%20Only_v013_LG_DCM.docx) are:   * Yes: **MTK**, **E///**, **OPPO**, **ZTE**, **DOCOMO**, **Sharp**, **Samsung**, **Huawei**, [**vivo**], **Intel**, **LG** * No: **Qualcomm**   Although a majority of companies say yes, the proposal may not be agreeable due to QC’s strong concern on UE NBC issue.  Another possibility of **resolving spec ambiguity** is counting on gNB to avoid the following setting which gives conflicting information in DCI:   * **UL-SCH indicator = 0** and **indication of FDM between UL-SCH and DMRS** in DCI format 0\_1   With DOCOMO’s kind check that it’s possible for their gNB to avoid the conflicting setting above, I would like to try another proposal as RAN1 conclusion:   * ***Proposal 2: UE does not expect the case where a DCI format 0\_1 includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.*** |

**Discussion point 2:**

**To draw a possible conclusion in this meeting as guided by Chairman, do you agree to take the following proposal as RAN1 conclusion:**

* ***Proposal 2: UE does not expect the case where a DCI format 0\_1 includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.***

**If your answer is “No”, please assist to provide an argument why gNB needs to indicate this conflicting information in DCI.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| MTK | Yes | Given the NBC issue to UE mentioned by QC, and the ambiguity on whether/how UE should boost the DMRS power if the REs between DM-RS is empty, it may be one way to resolve spec ambiguity by avoiding this configuration. |
| vivo | Yes | Given the NBC issue to UE mentioned by QC, we think the issue should be avoided by gNB. |
| QC | Yes | We thank DCM for their flexibility. We support the FL proposal to let gNB avoid this issue.  One minor editorial comment: this case should be avoided in all DCI formats, not just format 0\_1. We suggest to delete “format 0\_1” in the proposal. |
| Intel | Yes | We are fine with the original proposal 2 from FL.  For QC suggestion, our understanding is that this does not apply for DCI format 0\_0 as UL-SCH indicator is not included. |
| Spreadtrum | Yes | We support the proposal. |
| QC2 |  | To Intel: how about DCI format 0\_2? My understanding is this conclusion is for both Rel-15 and Rel-16 so format 0\_2 needs to be covered. |
| Moderator3 |  | Considering QC’s reasonable suggestion, a small revision for Proposal 2:   * ***Proposal 2\_v2: UE does not expect the case where an UL DCI ~~format 0\_1~~ includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.***   @Intel: Thanks for providing the good comment. Since DCI format 0\_2 also has “UL-SCH indicator” field, I tend to think the updated version may be appropriate. |
| NTT DOCOMO | OK | We are fine with the latest version. |
| HW, HiSi | N | We don't think this needs to be prevented by restricting network restriction.  The alternative to us could be leaving to UE implementation. |
| Samsung | Y | We are okay with Proposal 2 v2. |
| CATT | Y | We are fine with proposal 2 v2. |
| Ericsson | OK | We are fine with the latest revision for Proposal 2. |
| Moderator4 |  | For the latest moderator proposal:   * ***Proposal 2\_v2: UE does not expect the case where an UL DCI ~~format 0\_1~~ includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.***   companies’ stands in the latest [v026](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Inbox/drafts/7.1/%5B107-e-NR-7.1CRs-11%5D/R1-21xxxxx%20%5B107-e-NR-7.1CRs-11%5D%20%2318%20PUSCH%20DMRS%20with%20UCI%20Only_v026_CATT_Ericsson.docx) are:   * Yes: **MTK**, **vivo, QC, Intel, Spreadtrum, DOCOMO, Samsung, CATT, E///, ZTE (10)** * No: **Huawei (1)**   + No need to impose network restriction. Can be UE implementation.   @Huawei:   * Can you provide an argument why gNB needs to indicate this **conflicting information (UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS)** in DCI? Leaving an unspecified case with conflicting information may cause mis-understanding between NW and UE in the field/test and more efforts for calibration. |
| ZTE | Yes | We are fine with the latest revision for Proposal 2. |
| Huawei |  | We’d like to understand what is the concern for the case if it is scheduled as such – since a gNB can schedule UL-SCH=0 and indicate FDM, the specification does not tell UE anywhere how the REs not available for data/DMRS transmission shall be scrambled, there does not seem to be confusion from UE side whatever it does, actually. A smart gNB certainly will not attempt to decode a PUSCH with UCI only considering non-DMRS REs scrambled with any bits.  On the other side, imposing the restriction is NBC for network, and it does not resolve any issue that already occurs on site today, if really happens.  So leaving it to UE implementation is just fine for now, although we support to clarify the UE behavior assuming it is the common sense – unfortunately, which is not the case.  If your concern is the test/calibration effort, we could additionally state that no test is expected for this case. This may be easily for RAN5 to do. But not sure others view about this. |
| QC |  | To relieve Huawei’s concern, let’s not state it as “UE does not expect …” nor “it is an error case”. Maybe we can try the following softer conclusion?   * ***Proposal 2\_v2:  It is up to UE implementation to handle the case where an UL DCI ~~format 0\_1~~ includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.***   Is the above acceptable to Huawei?  To me, closing the email thread without any conclusion is equivalent to say it is up to implementation to handle this case. I still think it is better to document this discussion with a conclusion in Chairman’s notes. |
| Huawei |  | Thanks, Yi (QC). It is of course fine with us. |
| Moderator5 |  | According to the current status, **I would try to present the following proposal to Chairman as RAN1 conclusion**:   * ***Proposal 2\_v3:  It is up to UE implementation to handle the case where an UL DCI ~~format 0\_1~~ includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.*** |

RAN1 conclusion (phase 2)

**Conclusion (Endorsed by RAN1 Chairman in 17th Nov 23:57 UTC by email)**

It is up to UE implementation to handle the case where an UL DCI ~~format 0\_1~~ includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.

Summary of contribution inputs

**Summary for [1, DOCOMO]:**

In [1], it mentions that in NR Rel-15/16, when UCI is multiplexed on a PUSCH, the UCI cannot be FDMed with PUSCH DM-RS.

|  |
| --- |
| **38.212 (16.6.0)** 6.2.7 Data and control multiplexing ...  Denote  as the set of resource elements, in ascending order of indices , available for transmission of UCI in OFDM symbol , for . Denote  as the number of elements in set . Denote  as the -th element in . For any OFDM symbol that carriers DMRS of the PUSCH, . For any OFDM symbol that does not carry DMRS of the PUSCH, .  ... |

**Meanwhile, UL-SCH can be FDMed with PUSCH DM-RS**. In current spec, **UE behavior is unclear when a DCI scheduling a PUSCH without UL-SCH indicates FDM between UL-SCH and DM-RS**. Two points should be discussed:

* Point 1: Whether this FDM indication is possible or not
* Point 2: Whether dummy bits are generated on non-DMRS RE(s) in DMRS symbol(s)
  + Note: this aspect would have impacts on signal generation, e.g. PUSCH scrambling

For Point 1, in our understanding, **there is no text to prohibit that gNB indicates the situation**. That is, **gNB might schedule a PUSCH without UL-SCH that is indicated to perform FDM between UL-SCH and DMRS**. **If the prohibition is added, it will be NBC from gNB perspective**. Therefore, we believe that no additional agreement/conclusion on Point 1 is necessary. Regarding Point 2, it seems that there is no text in any specification to generate dummy bits for the non-DMRS RE(s) in this situation. In this sense, the correct UE behavior based on the specifications is not to generate any bits for the non-DMRS(s), and for example PUSCH scrambling specified in clause 6.3.3.1 of 38.211 is applied to the bit sequence without any bit corresponding to the non-DMRS RE(s).

**Observation:**

* *Current specifications do not prohibit a UL grant indicating ‘without UL-SCH’ and ‘FDM between UL-SCH and DM-RS’.*
* *Current specifications do not allow any bits generation for non-DMRS RE(s) in DMRS symbol(s) in the above situation.*

**Proposal for conclusion:**

* *UE does not generate any bits for non-DMRS RE(s) in DMRS symbol(s) when a DCI format 0\_1 includes UL-SCH indicator = 0 and an indication of FDM between UL-SCH and DMRS.*

**Summary for [2, MTK]:**

In [2], it is mentioned that in AH #1801 meeting, the following agreement regarding the multiplexing of PUSCH and DMRS when UCI is piggybacked on PUSCH was made.

Agreements:

* It is clarified that based on previous agreements, when UCI is piggybacked on PUSCH, UCI is not FDMed with DMRS
  + This applies to the case regardless of whether UL-SCH is present on PUSCH or not

It indicates that UCI is not FDMed with DMRS no matter when UL-SCH is present on PUSCH or not. However, there is ambiguity on whether PUSCH with UCI only can be FDMed with DMRS or not. If it is possible, then it is not clear in TS 38.212 about what data to be transmitted on non-DMRS RE(s) in the DMRS symbol(s).

Moreover, when UL-SCH is **NOT** present on PUSCH, i.e., ‘UL-SCH indicator’ in DCI format 0\_1 is 0, there is ambiguity on what to be transmitted on non-DMRS RE(s) in the DMRS symbol(s) if the network indicates data is FDMed with DMRS. Two possible interpretations on UE behaviour are as follows.

* **Interpretation #1:** UE does not transmit anything on non-DMRS RE(s) in the DMRS symbol(s) – see Figure 1(a)
* **Interpretation #2:** UE generates and transmits dummy bits on non-DMRS RE(s) in the DMRS symbol(s) – see Figure 1(b)

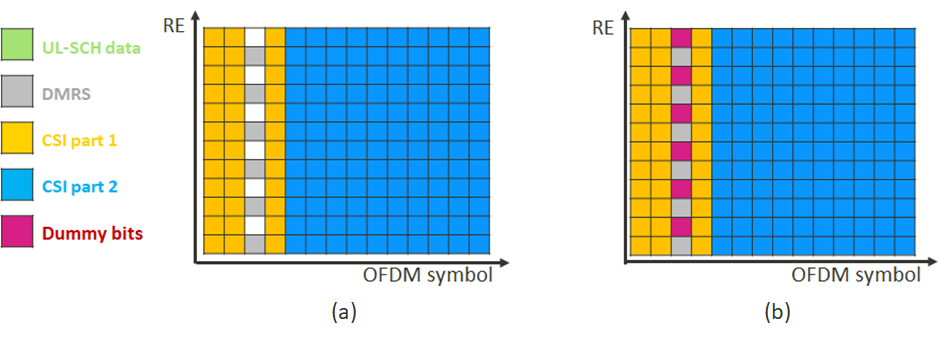


Figure 1. Two possible UE behaviours if PUSCH with UCI only is allowed to be FDMed with DMRS

**Proposal**: **RAN1 to adopt Interpretation #1 since it is more consistent with the spirit of the agreement in AH #1801. Additionally, how to generate the dummy bit(s) as depicted in Interpretation #2 is undefined in current specification.**

References

[1] R1-2112088 Discussion on PUSCH without UL-SCH and with FDM indication, NTT DOCOMO, INC., RAN1 #107e

[2] R1-2112293 Clarification on PUSCH with UCI Only and DMRS Multiplexing, MediaTek, RAN1 #107e

[3] R1-21xxxxx RAN1#107-e\_NR\_CRs\_7.1\_summary\_v16\_Apple\_Moderator, [download link](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Inbox/drafts/7.1/Preparation%20Phase/RAN1%23107-e_NR_CRs_7.1_summary_v16_Apple_Moderator.xlsx), RAN1, RAN1 #107e