3GPP TSG RAN WG1 #105-e R1-210xxxx

e-Meeting, May 10th – 27th, 2021

**Agenda Item: 7.1**

**Source: Moderator (Sharp)**

**Title: Summary of email discussion [105-e-NR-7.1CRs-06]: Correction on channel properties assumption of UL transmission**

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

# Introduction

This contribution provides the summary of the following email discussion in RAN1#105-e, which was triggered by the draft CR in [R1-2105625](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2105625.zip) [1].

[105-e-NR-7.1CRs-06] Issue#16: Correction on channel properties assumption of UL transmission – Liqing (Sharp) by May 25

# Background

Channel properties assumption of UL transmission related to intra-slot frequency hopping (FH) is stated in clause 6.2 of TS38.211.

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| **TS38.211 V15.8.0**  If intra-slot frequency hopping is not enabled by higher layer parameter for a physical channel, the UE transmission shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed if the two symbols correspond to the same slot.  If intra-slot frequency hopping is enabled by higher layer parameter for a physical channel, the UE transmission shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to the same frequency hop, regardless of whether the frequency hop distance is zero or not. |

According to the current description, whether intra-slot FH is enabled or not for a physical channel is based on higher layer parameter. However, as pointed out in [1], intra-slot FH can be enabled not only by higher layer parameter but also by a DCI field or by a predefined rule in specification. UL transmissions related to whether intra-slot FH is enabled or is not enabled in Rel-15 were summarised as below.

**Case 1:** PUSCH transmission scheduled by RAR UL grant and Msg3 retransmission. Intra-slot FH is or isn’t enabled for the PUSCH transmission NOT by higher layer parameter but by a ‘frequency hopping flag’ field in the RAR UL grant or DCI format 0\_0.

**Case 2:** PUSCH transmission scheduled by DCI format and Type 2 PUSCH transmission. Higher layer parameter would first enable one of two FH modes, i.e. intra-slot FH and inter-slot FH. Even if intra-slot FH is enabled by higher layer parameter, whether intra-slot FH is enabled or not for PUSCH transmission is eventually based on ‘frequency hopping flag’ field in scheduling DCI format or activation DCI format.

**Case 3:** Type 1 PUSCH transmission. Intra-slot FH is or isn’t enabled by higher layer parameter for Type 1 PUSCH transmission.

**Case 4:** Common PUCCH transmission. Intra-slot FH is always enabled for PUCCH transmission in common PUCCH resources. It has nothing to do with higher layer parameter.

**Case 5:** Dedicated PUCCH transmission. Intra-slot FH is or isn’t enabled by higher layer parameter for PUCCH transmission in dedicated PUCCH resources.

Therefore, the current description of channel properties assumption for UL transmission in clause 6.2 of TS38.211 only covers **Cases 3** and **5** (i.e. intra-slot FH is enabled or is not enabled by higher layer parameter) and fail to cover other **Cases** above (i.e. intra-slot FH is or is not enabled by DCI field or a predefined rule in specification). Consequently, the current specification would lead to unclear UE/gNB behaviors when intra-slot FH is enabled or is not enabled for a physical channel either by DCI field or by predefined rule in specification.

# Email Discussions

## First Round

As observed in [R1-2105625](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2105625.zip) [1], for a physical channel with UL transmission in Rel-15, intra-slot frequency hopping can be enabled by either higher layer parameter (i.e. **Case 3** and **Case 5**) or DCI field (i.e. **Case 1** and **Case 2**) or predefined rule in specification(i.e. **Case 4**). According to the current description in clause 6.2 of TS38.211, it seems that **Cases 1, 2** and **4**, i.e. those cases where intra-slot frequency hopping is enabled by DCI field or predefined rule in specification, are not covered by the current spec description. Consequently, the current specification would lead to unclear UE/gNB behaviours when intra-slot frequency hopping is enabled for a physical channel by DCI field or by a predefined rule in specification.

**Question 1: Companies please provide your views on whether you agree with the issue, i.e. some cases (i.e. Cases 1, 2 and 4) are not covered by the current spec description. If not, please explain why.**

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| **Company** | **Agree or not** | **Comments** |
| NTT DOCOMO | Agree |  |
| ZTE | Agree |  |
| Intel | Agree |  |
| Nokia | Agree |  |
| vivo |  | We are fine with the update but we don’t think it is necessary to say that current specification misses anything. It just may create some ambiguity. |
| Samsung | Agree |  |
| Qualcomm |  | Agree with vivo |
| CATT | Agree |  |

According to companies views during preparations phase, all companies agreed to discuss the issue. One company commented that draft CR might introduce potential NBC issue for Rel-15. According to current specification, **behaviour 1** is described for UL transmission for which the intra-slot frequency hopping is enabled by higher layer parameter while **behaviour 2** is described for UL transmission for which the intra-slot frequency hopping is not enabled by higher layer parameter. gNB side expects the UE implements corresponding behaviour for UL transmission and exploits corresponding properties of UE behaviour in channel estimation of UL transmission.

* **Behaviour 1**: The UE is required to keep the phase continuity for the UL transmission within each frequency hop and is not required to keep the phase continuity across frequency hops.
* **Behaviour 2**: The UE is required to keep the phase continuity for the UL transmission within a same slot.

Given the current specification only states properties of the signal the UE transmitted only for cases where intra-slot frequency hopping is enabled by higher layer parameter, it leads to unclear UE behaviours for cases where intra-slot frequency hopping is enabled by DCI field or by predefined rules in specification. In our understanding, as long as the frequency position of UL transmission is changed, phase discontinuity in the transmitted signal is expected and UE is not required to maintain the phase continuity across frequency hops of the UL transmission. The UE behaviour for UL transmission should be assumed to be same, regardless of how intra-slot frequency hopping is enabled. Therefore, it seems to us that the current specification description just fail to capture all the intended Cases related to intra-slot frequency hopping. However, different companies may have different interpretations for these cases (i.e. the intra-slot frequency hopping is enabled for a physical channel by DCI fields or predefined rules in specification) not covered by the current specification. Therefore, companies are encouraged to share their views on the questions below.

**Question 2: Do you agree that UE behaviour for UL transmission where intra-slot frequency hopping is enabled by DCI field or predefined rule in spec should be considered the same way as that for UL transmission where intra-slot frequency hopping is enabled by higher layer parameter. If not, please explain why and which UE behaviour is implemented for those cases which are not covered in the current Rel-15 specification.**

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| **Company** | **Agree or not** | **Comments** |
| NTT DOCOMO | Agree | In my memory, the motivation of the text is to clarify when UE shall keep phase continuity and the main target was that frequency hopping = enabled and the hop distance = 0. In the discussions, there was no distinction among FH enabled by RRC parameter/DCI field/predefined.  In that sense, ‘by higher layer parameter’ is just an editorial issue, and UE would follow this rule in any case. |
| ZTE | Agree |  |
| Intel | Agree |  |
| Nokia | Agree | Have the same understanding as DOCOMO, the description was supposed to tell the UE that if there is a frequency hop, then phase continuity is not required, but when there is no frequency hop phase continuity is required. This text was not supposed to take any stand on what leads to the frequency hop. |
| Samsung | Agree |  |
| CATT | Agree |  |

**Question 3: Companies please provide your views on whether specification change is necessary to reflect all cases above related to intra-slot frequency hopping.**

* **If yes, whether the intention of the draft CR in** [**R1-2105625**](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2105625.zip) **[1], i.e. remove unnecessary limitation ‘by higher layer parameter’, can be supported.**
* **If no, please explain why.**

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| **Company** | **Spec change is necessary or not** | **Comments** |
| NTT DOCOMO | YES (necessary) | The draft CR seems OK. |
| ZTE | Yes | We think the CR just fixes the editorial issue without functionality change |
| Intel | Yes | We are fine with the draft CR. |
| Nokia | OK with the change | The draft CR makes sense, and goes to the direction of what the paragraphs are supposed to do. |
| vivo | Fine with the update. | The reason is to remove potential ambiguity. |
| Samsung | Necessary | We support to adopt the draft CR which can make the spec covering all conditions to enable intra-slot frequency hopping. |
| Qualcomm |  | With the deletion of “by higher layer parameter”, the condition “intra-slot frequency hopping enabled/not enabled” would become vague. However, as long as we have the same understanding, including the understanding that the hop distance zero does NOT mean “intra-slot frequency hopping is not enabled”, we could live with the change.  Apart from the proposed change, we would like to point out that the two paragraphs do not take into account the fact that the UE may transmit multiple channels in one slot. We propose to add a clarification that this continuity of channel properties is limited in (a hop of) the same channel of a slot.  *… the UE transmission shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed if the two symbols correspond to the same channel of a slot.*  *…the UE transmission shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to the same frequency hop of the same channel, regardless of whether the frequency hop distance is zero or not.* |
| CATT | Yes | We also agree with the clarification from Qualcomm to consider multiple UL transmission within a slot. |
| Huawei | Y | To QC  Is there frequency hopping belongs to different channels? Our understanding of multiple transmission of different channels in a slot with different frequency location is not called hopping. Perhaps an example can be provided. |

## Second Round

Based on companies comments during the first round discussion, the situation was summarized below.

* Regarding **Question 1,** 8 companies provided feedback. 6 companies agreed that current description in subclause 6.2 of TS38.211 do not cover some cases where intra-slot frequency hopping is enabled by DCI field or predefined rule in specification. 2 companies do not see a necessity to say specification miss something but fine to update specification to remove ambiguity.
* Regarding **Question 2**, all replied companies agreed UE behavior should be same for all cases related to intra-slot frequency hopping. 2 companies NTT DOCOMO and Nokia pointed out the main intention and main target of the current specification description in subclause 6.2 of TS38.211, that is, the current specification description should not be supposed to take any stand on what leads to frequency hop and there should be no UE behavior distinction among various frequency hopping cases.
* Regarding **Question 3**, it seems that most companies agreed specification change is necessary and are fine with the draft CR in [R1-2105625](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2105625.zip) [1] to make the specification cover all conditions used for enabling intra-slot frequency hopping and remove potential ambiguity. One company could also live with the change in the draft CR as long as it is the understanding that the hop distance zero does NOT mean “intra-slot frequency hopping is not enabled”. From our view, wording ‘regardless of whether the frequency hop distance is zero or not’ in the current specification implies that the frequency hop distance can be zero or not when intra-slot frequency hopping is enabled. Furthermore, as pointed out by NTT DOCOMO and Nokia, the main target of the current specification description in subclause 6.2 of TS38.211 was for frequency hopping is enabled and the hop distance =0. Therefore, it should be the RAN1 common understanding that the hop distance zero does NOT mean “intra-slot frequency hopping is not enabled”.

According to companies comments received from the first round, it seems there is consensus on the changes with removing “by higher layer parameter” as proposed in the draft CR in [R1-2105625](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2105625.zip) [1]. Companies please check the following proposal and provide comments.

**Proposal: Adopt to remove “by higher layer parameter” as in** [**R1-2105625**](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2105625.zip) **for Rel-15 and Rel-16.**

Companies please provide comments if there is any concern regarding the proposal.

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| **Company** | **Comments** |
| Apple | We are fine with the Proposal. |
| Samsung | Support |
| Qualcomm | OK |
| CATT | Support |
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In addition, two companies prefer to further clarify the continuity of channel properties is limited in a same channel by considering multiple channels would be transmitted within one slot. Then there may be a risk that the channel might be interpreted as multiple channels within one slot. On the other hand, another view was that frequency hopping belongs to an independent channel and does not cross multiple channels. Actually, there is similar discussion during [104b-e-NR-L1enh-URLLC-03] on PUSCH enhancements for NR eURLLC, although discussion there was intended to solve PUSCH repetition Type B issue on how to assume the channel property of an actual repetition of PUSCH repetition Type B. During that discussion, people's interpretation was that the specification description related to the frequency hopping specifies the procedure focusing on a single PUSCH (a single TB transmission) in a slot irrespective of whether the slot contains the single PUSCH or multiple PUSCHs. A summary was available in [R1- 2104106](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104b-e/Docs/R1-2104106.zip). Given companies may have different views, it is important for us to reach a same understanding on this aspect and the following question is prepared to collect companies view on this aspect.

**Question 4: Companies please provide your views on**

* **whether there is an ambiguity in the current specification that the channel in the text below may be interpreted as multiple channels transmitted by a UE within one slot,**
* **whether to support to add the following clarifications in the current spec or other alternatives to remove the ambiguity if any.**

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| **TS38.211 V15.8.0**  If intra-slot frequency hopping is not enabled by higher layer parameter for a physical channel, the UE transmission shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed if the two symbols correspond to the same channel of a slot.  If intra-slot frequency hopping is enabled by higher layer parameter for a physical channel, the UE transmission shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to the same frequency hop of the same channel, regardless of whether the frequency hop distance is zero or not. |

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| **Company** | **Ambiguity (Yes or not)** | **Clarification is need or not?** | **Comments** |
| Apple | N | N | In current spec, it is already specified the hopping is enabled or not for a physical channel. Thus, there is no ambiguity, and additional clarification is not needed.  *If intra-slot frequency hopping is not enabled for a physical channel, the UE transmission shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed if the two symbols correspond to the same slot.* |
| Samsung | No | No need | We are not sure what is the ambiguity. Although there are multiple transmissions of different channels with different frequency location in a slot, those are not obviously frequency hopping. |
| Qualcomm | Yes | Yes | The spec is written in the following way:  If intra-slot frequency hopping is not enabled “for a physical channel”, the UE shall keep the channel properties over “two symbols correspond to the same slot”.  🡺 The two symbols could belong to different channels, but the spec enforces to keep the channel properties between the two symbols.  If intra-slot frequency hopping is enabled “for a physical channel”, the UE shall keep the channel properties over “two symbols correspond to the same frequency hop”, where according to 6.3.1, there are two hops for each channel; first hop and second hop.  🡺 The two symbols could belong to first fop of different channels, but the spec enforces to keep the channel properties between the two symbols. |
| CATT | Yes | Yes | Although the condition is that frequency hopping is enabled or not for a physical channel, the second half of the sentence does not mention the physical channel and can be interpreted as multiple channels.  To avoid potential confusion, we think clarification is needed. Regarding the proposal from Qualcomm, we think there is still a risk to interpret the physical channel in the first half of the sentence and the channel in the second half of the sentence as two different channels. Therefore, we would like to propose the following addition and would like to hear companies’ views.  If intra-slot frequency hopping is not enabled by higher layer parameter for a physical channel, the UE transmission of the physical channel shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed if the two symbols correspond to the same slot.  If intra-slot frequency hopping is enabled by higher layer parameter for a physical channel, the UE transmission of the physical channel shall be such that the channel over which a symbol on the antenna port used for uplink transmission is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only if the two symbols correspond to the same frequency hop, regardless of whether the frequency hop distance is zero or not. |
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# Conclusion

To be updated with the outcome of the email discussion.

# References

1. [R1-2105625](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_105-e/Docs/R1-2105625.zip) “Correction on channel properties assumption of UL transmission”, RAN1#105e, Sharp.