**3GPP TSG RAN WG1 #112bis-e R1-23xxxxx**

**E-meeting, April 17th – April 26th, 2023**

**Agenda Item: 7.2**

**Source: Moderator (China Telecom)**

**Title: [112bis-e-R17-CovEnh-01] FL summary of maintenance issues for Rel-17 NR coverage enhancements**

**Document for: Discussion**

1. Introduction

This contribution is a summary of the following email discussion on maintenance issues for Rel-17 NR coverage enhancements.

[112bis-e-R17-CovEnh-01] Email discussion on Rel-17 Coverage Enh maintenance by April 21 – Jianchi (China Telecom)

1. Initial discussion

## Issue #1: Correction on unified TCI state with DMRS bundling

[1] has the following proposal:

**Proposal:** Treat the beam switching via the indicated TCI state during repetition as an event breaking the power consistency and phase continuity.

This issue was discussed in RAN1#112. The latest TP is as follows [2]:

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| 6.1.7 UE procedure for determining time domain windows for bundling DM-RS< Unchanged parts are omitted >Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:< Unchanged parts are omitted >- A different *TCI-State* and/or *TCI-UL-State* is indicated by DCI for uplink according to Clause 5.1.5.< Unchanged parts are omitted > |

**Companies are encouraged to answer the following question:**

1. **Is it an essential issue to be discussed in RAN1#112bis-e?**
2. **If the answer to the first question is “yes”, please provide comments on the above proposal and TP.**

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| Company | Comments |
| ZTE | Ok to discuss in this meeting. Considering no consensus was reached to make an explicit conclusion/agreement for TCI update within repetitions in MIMO session, we are also ok to leave it as implementation for the conjunction of DMRS bundling here. Regarding the TP, it’s not clear whether the event is a semi-static event or not. If treated as semi-static event according to the following agreement, additional spec changes for the last paragraph of Clause 6.1.7 are needed. **Agreement:**If DMRS bundling and UL beam switching for multi-TRP operation are configured simultaneously, UL beam switching for multi-TRP operation is regarded as a semi-static event. |
| Sharp | 1. Yes.2. We support the above proposal and TP. This is because the indicated joint/UL TCI state is potentially updated during PUSCH/PUCCH repetition due to the beam application time that has up to 336 OFDM symbols. |
|  Xiaomi | We are open to discuss it  |
| NTT DOCOMO | 1. Yes. Rel-17 TCI state is a fundamental technique which can replace Rel-15 TCI state. If this issue exists, the DMRS bundling cannot be applied with any system applying Rel-17 TCI state. In the last meeting, the update of TCI state by MAC CE was brought up in the discussion. However, there is no common understanding about whether that update can be applied over repetition like Rel-17 TCI sate. Hence, the TCI state update by MAC CE can be decoupled from this issue.2. TP is about the dynamic event. If the clarification is necessary, “dynamic” can be added in front of event in TP. In our view, the event timing is “the time to apply the indicated TCI state” not “the time receiving the indication”. Hence, we prefer capturing it as follows.- Applying a TCI-State and/or TCI-UL-State by DCI that is different from the previously indicated one according to Clause 5.1.5. |
| Intel | This issue was discussed in the last meeting. Our understanding is that this needs the support of two features including joint TCI framework and DMRS bundling at the same time. Given this is very late in the Rel-17 maintenance phase, it is not clear to us whether we need to reopen the discussions.  |
| Ericsson | OK to discuss.  |
| QC | We are open to clarifying this. Can Docomo clarify the timelines for TCI state activation? If I recall correctly, the new state comes into effect 3ms after the MAC-CE is received. But we also have the case where MAC-CE indicates more than one TCI state. In this case which TCI state is applied and when to the remaining repetitions?  |
| NTT DOCOMO | @Qualcomm We think TCI state update by MAC CE should be decoupled with this issue, as there is no common understanding about whether TCI state update by MAC CE is strictly applied over repetitions. On the other hand, it was acknowledged in MIMO discussion that the TCI state indicated by DCI was strictly updated even within repetitions in the unified TCI state. The application timing of the indicated TCI state by DCI is BAT symbols after the last symbol of the PUCCH or the PUSCH carrying the HARQ-ACK information.@Intel We do not think it is a good idea to ignore the combination of DMRS bundling and Rel-17 TCI state framework, as Rel-17 TCI state framework is an essential and convenient technique that can override Rel-15 TCI state. If the majority prefers to ignore this combination, RAN 1 should at least make the conclusion that Rel-17 DMRS bundling is not workable with Rel-17 TCI state framework, which we think it is not a reasonable approach though. |
| Samsung | OK to discuss. |

## Issue #2: Correction on RRC parameters for DMRS bundling in TS38.213

[3] points out that RRC parameter names *PUCCH-DMRS-Bundling, PUCCH-Frequencyhopping-Interval* and *PUCCH-TimeDomainWindowLength* in TS38.214 are not aligned with TS38.331.

[3] proposes the following TP.

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| 9.2.6 PUCCH repetition procedure**<Unchanged text is omitted>**For $N\_{PUCCH}^{repeat}>1$, - the UE repeats the PUCCH transmission with the UCI over $N\_{PUCCH}^{repeat}$ slots - a repetition of the PUCCH transmission in each of the $N\_{PUCCH}^{repeat}$ slots has a same number of consecutive symbols, as provided by *nrofSymbols*- a repetition of the PUCCH transmission in each of the $N\_{PUCCH}^{repeat}$ slots has a same first symbol, as provided by *startingSymbolIndex* if *subslotLengthForPUCCH* is not provided; otherwise mod(*startingSymbolIndex*, *subslotLengthForPUCCH*)- the UE is configured by *interslotFrequencyHopping* whether or not to perform frequency hopping for repetitions of the PUCCH transmission in different slots- if the UE is configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is not provided *pucch-DMRS-Bundling* = ‘enabled’- the UE performs frequency hopping per slot- the UE transmits the PUCCH starting from a first PRB, provided by *startingPRB*, in slots with even number and starting from a second PRB, provided by *secondHopPRB*, in slots with odd number. The slot indicated to the UE for the first repetition of the PUCCH transmission has number 0 and each subsequent slot until the UE transmits the PUCCH in $N\_{PUCCH}^{repeat}$ slots is counted regardless of whether or not the UE transmits the PUCCH in the slot- the UE does not expect to be configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot- if the UE is configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is provided *pucch-DMRS-Bundling* = ‘enabled’ - the UE performs frequency hopping per interval of $N\_{PUCCH}^{interval}$ consecutive slots, that start from a slot indicated to the UE and where the UE would transmit a first repetition of the PUCCH, where $N\_{PUCCH}^{interval}$ is the value of *pucch-FrequencyHoppingInterval*, if provided; otherwise, $N\_{PUCCH}^{interval}$ is the value of *pucch-TimeDomainWindowLength*- the UE transmits the PUCCH over intervals until the UE transmits the PUCCH in $N\_{PUCCH}^{repeat}$ slots, where the first interval has number 0 and each subsequent interval is counted regardless of whether or not the UE transmits the PUCCH in a slot- the UE transmits the PUCCH starting from a first PRB, provided by *startingPRB*, in intervals with even number and starting from a second PRB, provided by *secondHopPRB*, in intervals of frequency hopping intervals with odd number- the UE does not expect to be configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot- if the UE is not configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot, the frequency hopping pattern between the first PRB and the second PRB is same within each slot **<Unchanged text is omitted>** |

**Companies are encouraged to provide comments on the above TP.**

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| Company | Comments |
| ZTE | Ok to leave to editor.  |
| Sharp | Support |
| Xiaomi | Fine with the TP |
| Intel | Can be considered for alignment CR |
| Ericsson | Can be given to editor for alignment CR. |
| Samsung | Support – can be an alignment CR |

## Issue #3: Correction on RRC parameters for DMRS bundling in TS38.214

[4] points out that RRC parameter names *PUCCH-DMRS-Bundling, PUSCH-DMRS-Bundling, PUSCH-Frequencyhopping-Interval,* *PUCCH-TimeDomainWindowLength* and *PUSCH-TimeDomainWindowLength* in TS38.214 are not aligned with TS38.331.

[4] proposes the following TP.

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| 6.1.7 UE procedure for determining time domain windows for bundling DM-RSFor PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, PUSCH repetition Type A with a configured grant, PUSCH repetition Type B and TB processing over multiple slots, when *pusch-DMRS-Bundling* is enabled, and for PUCCH transmissions of PUCCH repetition, when *pucch-DMRS-Bundling* is enabled, the UE determines one or multiple nominal TDWs, as follows:- For PUSCH transmissions of repetition Type A, PUSCH repetition Type B and TB processing over multiple slots, the duration of each nominal TDW except the last nominal TDW, in number of consecutive slots, is:- Given by *pusch-TimeDomainWindowLength*, if configured.- Computed as min (*maxDurationDMRS-Bundling*, M), if *pusch-TimeDomainWindowLength* is not configured, where *maxDurationDMRS-Bundling* is maximum duration for a nominal TDW subject to UE capability [13, TS 38.306], M is the time duration in consecutive slots of $N∙K$ PUSCH transmissions, and where:- For PUSCH transmissions of PUSCH repetition Type A, N=1 and K is the number of repetitions, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.- For PUSCH transmissions of PUSCH repetition Type B, N=1 and K is the number of nominal repetitions, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.- For PUSCH transmissions of TB processing over multiple slots, N is the number of slots used for TBS determination and K is the number of repetitions of the number of slots N used for TBS determination, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.- For PUCCH transmissions of PUCCH repetition, the duration of each nominal TDW except the last nominal TDW, in number of consecutive slots, is:- Given by *pucch-TimeDomainWindowLength*, if configured.- Computed as min (*maxDurationDMRS-Bundling*, M), if *pucch-TimeDomainWindowLength* is not configured, where *maxDurationDMRS-Bundling* is maximum duration for a nominal TDW subject to UE capability [13, TS 38.306], M is the time duration in consecutive slots from the first slot determined for PUCCH transmissions of PUCCH repetition to the last slot determined for PUCCH transmissions of PUCCH repetition according to clause 9.2.6 of [6, TS 38.213].- For PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2 and PUSCH repetition Type A with a configured grant, when *AvailableSlotCounting* is enabled, and for TB processing over multiple slots:- The start of the first nominal TDW is the first slot determined for the first PUSCH transmission.- The end of the last nominal TDW is the last slot determined for the last PUSCH transmission.- The start of any other nominal TDWs is the first slot determined for PUSCH transmission after the last slot determined for PUSCH transmission of a previous nominal TDW.**<Unchanged text is omitted>**6.3 UE PUSCH frequency hopping procedure6.3.1 Frequency hopping for PUSCH repetition Type A and for TB processing over multiple slots**<Unchanged text is omitted>**In case of inter-slot frequency hopping and when *pusch-DMRS-Bundling* is not enabled, or for inter-slot frequency hopping for a PUSCH scheduled by RAR UL grant or DCI format 0\_0 with CRC scrambled by TC-RNTI, the starting RB during slot  is given by: , where  is the current slot number within a system radio frame, where a multi-slot PUSCH transmission can take place,  is the starting RB within the UL BWP, as calculated from the resource block assignment information of resource allocation type 1 (described in Clause 6.1.2.2.2) and is the frequency offset in RBs between the two frequency hops.In case of inter-slot frequency hopping and when *pusch-DMRS-Bundling* is enabled, and when a PUSCH is not scheduled by RAR UL grant or DCI format 0\_0 with CRC scrambled by TC-RNTI, the starting RB during slot  is given by:  $RB\_{start}\left(n\_{s}^{μ}\right)=\left\{\begin{array}{c}RB\_{start}\\\left(RB\_{start}+RB\_{offset}\right)modN\_{BWP}^{size}\end{array}\genfrac{}{}{0pt}{}{\left⌊\frac{n\_{s}^{μ}}{N\_{FH}}\right⌋ mod 2=0}{\left⌊\frac{n\_{s}^{μ}}{N\_{FH}}\right⌋ mod 2=1}\right.$where $n\_{s}^{μ}$ is the current slot number within a system radio frame, $N\_{FH}$ is the value of the higher layer parameter *pusch-FrequencyHoppingInterval*,  is the starting RB within the UL BWP, as calculated from the resource block assignment information of resource allocation type 1 (described in Clause 6.1.2.2.2) andis the frequency offset in RBs between the two frequency hops.**<Unchanged text is omitted>** |

**Companies are encouraged to provide comments on the above TP.**

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| Company | Comments |
| ZTE | Ok to leave to editor.  |
| Sharp | Support |
| Xiaomi | Fine with the TP |
| Intel | Can be considered for alignment CR |
| Ericsson | Can be given to editor for alignment CR. |
| Samsung | Support – can be an alignment CR |

1. Proposals

**FL comments: For issue#1, as DOCOMO explained, it’s better to clarify whether/how unified TCI framework and DMRS bundling can be supported simultaneously. Based on the discussion, there are following alternatives:**

* **Alt 1:** Unified TCI framework and DMRS bundling can be supported simultaneously. Adopt the following TP to TS38.214.

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| 6.1.7 UE procedure for determining time domain windows for bundling DM-RS< Unchanged parts are omitted >Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:< Unchanged parts are omitted >- Applying a TCI-State and/or TCI-UL-State by DCI that is different from the previously indicated one according to Clause 5.1.5.< Unchanged parts are omitted > |

* **Alt 2:** Unified TCI framework and DMRS bundling can be supported simultaneously based on implementation.
* **Alt 3:** Unified TCI framework and DMRS bundling cannot be supported simultaneously in Rel-18.

**Companies are encouraged to check DOCOMO’s comments and provide comments on the above alternatives.**

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| Company | Comments |
| Xiaomi | One question on Alt 3: Whether it should be “… not supported simultaneously in ‘Rel-17’ ”?Alt 1 and Alt 3 have some spec impact, but they are clear for the gNB on how to perform channel estimation. And, by this way, the behavior between the UE side and the gNB side can keep alignment. So, we suggest to down-select between Alt.1 and Alt.3. |
| OPPO | Prefer Alt2 and Alt3.According to the following description in TS 38.214.

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| if the indicated TCI State is different from the previously indicated one, the indicated TCI-State and/or TCI-UL-State should be applied starting from the first slot that is at least beamAppTime symbols after the last symbol of the PUCCH or the PUSCH. |

Does it mean the gap between the first slot and the last symbol of the PUCCH or the PUSCH is not a fixed value (e.g. beamAppTime symbols)? It may be larger than beamAppTime symbols depends on implementation.Considering the unfixed value of the gap, the slot applied the indicated TCI-State may be different in UE and gNB’s understanding. We prefer alt2 and alt3, i.e. not have spec impact. |
| Apple | We think we need a conclusion on this issue. For Alt 2, if it means gNB scheduling could avoid the TCI state update during the TDW, it’s fine for us. Otherwise, Alt 1 can be considered.  |

**FL comments: Since all companies are fine with TPs for alignment CR for issue#2 and issue#3, no further discussion is needed. Proposal 2 and proposal 3 are for email approval.**

**Proposal 2:**

* Adopt the following TP to TS 38.213 for alignment CR.

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| 9.2.6 PUCCH repetition procedure**<Unchanged text is omitted>**For $N\_{PUCCH}^{repeat}>1$, - the UE repeats the PUCCH transmission with the UCI over $N\_{PUCCH}^{repeat}$ slots - a repetition of the PUCCH transmission in each of the $N\_{PUCCH}^{repeat}$ slots has a same number of consecutive symbols, as provided by *nrofSymbols*- a repetition of the PUCCH transmission in each of the $N\_{PUCCH}^{repeat}$ slots has a same first symbol, as provided by *startingSymbolIndex* if *subslotLengthForPUCCH* is not provided; otherwise mod(*startingSymbolIndex*, *subslotLengthForPUCCH*)- the UE is configured by *interslotFrequencyHopping* whether or not to perform frequency hopping for repetitions of the PUCCH transmission in different slots- if the UE is configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is not provided *pucch-DMRS-Bundling* = ‘enabled’- the UE performs frequency hopping per slot- the UE transmits the PUCCH starting from a first PRB, provided by *startingPRB*, in slots with even number and starting from a second PRB, provided by *secondHopPRB*, in slots with odd number. The slot indicated to the UE for the first repetition of the PUCCH transmission has number 0 and each subsequent slot until the UE transmits the PUCCH in $N\_{PUCCH}^{repeat}$ slots is counted regardless of whether or not the UE transmits the PUCCH in the slot- the UE does not expect to be configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot- if the UE is configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is provided *pucch-DMRS-Bundling* = ‘enabled’ - the UE performs frequency hopping per interval of $N\_{PUCCH}^{interval}$ consecutive slots, that start from a slot indicated to the UE and where the UE would transmit a first repetition of the PUCCH, where $N\_{PUCCH}^{interval}$ is the value of *pucch-FrequencyHoppingInterval*, if provided; otherwise, $N\_{PUCCH}^{interval}$ is the value of *pucch-TimeDomainWindowLength*- the UE transmits the PUCCH over intervals until the UE transmits the PUCCH in $N\_{PUCCH}^{repeat}$ slots, where the first interval has number 0 and each subsequent interval is counted regardless of whether or not the UE transmits the PUCCH in a slot- the UE transmits the PUCCH starting from a first PRB, provided by *startingPRB*, in intervals with even number and starting from a second PRB, provided by *secondHopPRB*, in intervals of frequency hopping intervals with odd number- the UE does not expect to be configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot- if the UE is not configured to perform frequency hopping for repetitions of a PUCCH transmission across slots and the UE is configured to perform frequency hopping for a repetition of the PUCCH transmission within a slot, the frequency hopping pattern between the first PRB and the second PRB is same within each slot **<Unchanged text is omitted>** |

**Proposal 3:**

* Adopt the following TP to TS 38.214 for alignment CR.

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| 6.1.7 UE procedure for determining time domain windows for bundling DM-RSFor PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, PUSCH repetition Type A with a configured grant, PUSCH repetition Type B and TB processing over multiple slots, when *pusch-DMRS-Bundling* is enabled, and for PUCCH transmissions of PUCCH repetition, when *pucch-DMRS-Bundling* is enabled, the UE determines one or multiple nominal TDWs, as follows:- For PUSCH transmissions of repetition Type A, PUSCH repetition Type B and TB processing over multiple slots, the duration of each nominal TDW except the last nominal TDW, in number of consecutive slots, is:- Given by *pusch-TimeDomainWindowLength*, if configured.- Computed as min (*maxDurationDMRS-Bundling*, M), if *pusch-TimeDomainWindowLength* is not configured, where *maxDurationDMRS-Bundling* is maximum duration for a nominal TDW subject to UE capability [13, TS 38.306], M is the time duration in consecutive slots of $N∙K$ PUSCH transmissions, and where:- For PUSCH transmissions of PUSCH repetition Type A, N=1 and K is the number of repetitions, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.- For PUSCH transmissions of PUSCH repetition Type B, N=1 and K is the number of nominal repetitions, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.- For PUSCH transmissions of TB processing over multiple slots, N is the number of slots used for TBS determination and K is the number of repetitions of the number of slots N used for TBS determination, as defined in Clause 6.1.2.1 or in Clause 6.1.2.3.- For PUCCH transmissions of PUCCH repetition, the duration of each nominal TDW except the last nominal TDW, in number of consecutive slots, is:- Given by *pucch-TimeDomainWindowLength*, if configured.- Computed as min (*maxDurationDMRS-Bundling*, M), if *pucch-TimeDomainWindowLength* is not configured, where *maxDurationDMRS-Bundling* is maximum duration for a nominal TDW subject to UE capability [13, TS 38.306], M is the time duration in consecutive slots from the first slot determined for PUCCH transmissions of PUCCH repetition to the last slot determined for PUCCH transmissions of PUCCH repetition according to clause 9.2.6 of [6, TS 38.213].- For PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2 and PUSCH repetition Type A with a configured grant, when *AvailableSlotCounting* is enabled, and for TB processing over multiple slots:- The start of the first nominal TDW is the first slot determined for the first PUSCH transmission.- The end of the last nominal TDW is the last slot determined for the last PUSCH transmission.- The start of any other nominal TDWs is the first slot determined for PUSCH transmission after the last slot determined for PUSCH transmission of a previous nominal TDW.**<Unchanged text is omitted>**6.3 UE PUSCH frequency hopping procedure6.3.1 Frequency hopping for PUSCH repetition Type A and for TB processing over multiple slots**<Unchanged text is omitted>**In case of inter-slot frequency hopping and when *pusch-DMRS-Bundling* is not enabled, or for inter-slot frequency hopping for a PUSCH scheduled by RAR UL grant or DCI format 0\_0 with CRC scrambled by TC-RNTI, the starting RB during slot  is given by: , where  is the current slot number within a system radio frame, where a multi-slot PUSCH transmission can take place,  is the starting RB within the UL BWP, as calculated from the resource block assignment information of resource allocation type 1 (described in Clause 6.1.2.2.2) and is the frequency offset in RBs between the two frequency hops.In case of inter-slot frequency hopping and when *pusch-DMRS-Bundling* is enabled, and when a PUSCH is not scheduled by RAR UL grant or DCI format 0\_0 with CRC scrambled by TC-RNTI, the starting RB during slot  is given by:  $RB\_{start}\left(n\_{s}^{μ}\right)=\left\{\begin{array}{c}RB\_{start}\\\left(RB\_{start}+RB\_{offset}\right)modN\_{BWP}^{size}\end{array}\genfrac{}{}{0pt}{}{\left⌊\frac{n\_{s}^{μ}}{N\_{FH}}\right⌋ mod 2=0}{\left⌊\frac{n\_{s}^{μ}}{N\_{FH}}\right⌋ mod 2=1}\right.$where $n\_{s}^{μ}$ is the current slot number within a system radio frame, $N\_{FH}$ is the value of the higher layer parameter *pusch-FrequencyHoppingInterval*,  is the starting RB within the UL BWP, as calculated from the resource block assignment information of resource allocation type 1 (described in Clause 6.1.2.2.2) andis the frequency offset in RBs between the two frequency hops.**<Unchanged text is omitted>** |

1. Reference
2. R1-2303693, Discussion on the remaining issues for joint channel estimation, NTT DOCOMO, RAN1#112bis-e, April 17th – April 26th, 2023.
3. R1-2301942, FL summary of discussion on joint channel estimation for Rel-17 NR coverage enhancements, Moderator (China Telecom), February 27th – March 3rd, 2023.
4. R1-2303843, Corrections on RRC parameter name for DMRS bundling in TS38.213, Sharp, RAN1#112bis-e, April 17th – April 26th, 2023.
5. R1-2303844, Corrections on RRC parameter name for DMRS bundling in TS38.214, Sharp, RAN1#112bis-e, April 17th – April 26th, 2023.