**3GPP TSG RAN WG1 #102-e R1-2006716**

e-Meeting, August 17th – 28th, 2020

Source: Moderator (NTT DOCOMO, INC.)

Title: Summary on Rel-16 NR TEI related discussion

Agenda Item: 7.2.12

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

# **Introduction**

This contribution summarizes the NR Rel-16 TEI related and CLI/RIM related discussions and proposals in AI 7.2.12.

Based on contributions in AI 7.2.12, following six issues are identified.

* Flexible TRS bandwidth for BWP of 52 RBs [1, 2, 3, 4, 5, 7, 8]
* Aperiodic CSI-RS triggering with beam switching timing of 224 and 336 [2]
* Aperiodic TRS triggering with beam switching timing of 224 and 336 [2]
* UCI bit sequence generation [6]
* Dynamic UL skipping [7]

From the moderator’s perspective, similar to previous meetings, any new TEI proposal/topic should be deprioritized and RAN1 should focus on already agreed/endorsed TEI proposals/topics at this stage. Therefore, following is the suggested list of topics/proposals for this meeting considering above and the budget for email discussion threads for Rel-16 NR TEI.

**FL proposal of list of issues/proposals and priority for RAN1#102-e meeting:**

1. **Discussion point #1 for Flexible TRS bandwidth for BWP of 52 RBs**

* **Which one of following options should be adopted based on “up to 3RBs beyond either/both of the highest RB and lowest RB of the TRS”**
  + **Option 1: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3 RBs beyond either of the highest RB or lowest RB of the TRS, i.e., total number of RBs outside TRS bandwidth is up to 3 and RBs outside TRS are only on either side.**
  + **Option 2: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to X RBs beyond the highest RB and/or Y RBs beyond the lowest RB of the TRS, where X+Y<4, i.e., total number of RBs outside TRS bandwidth is up to 3 and RBs outside TRS can be on both sides.**
  + **Option 3: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3 RBs beyond both of the highest RB and lowest RB of the TRS, i.e., total number of RBs outside TRS bandwidth is up to 6 and RBs outside TRS can be on both sides.**
* **Whether TP should be provided for 5.1.6.1.1 only or for both 5.1.2.2 and 5.1.6.1.1**

1. **Discussion point #2 for aperiodic CSI-RS triggering with beam switching timing of 224 and 336**

* **TP in R1-2005453 for aperiodic CSI-RS triggering with beam switching timing of 224 and 336 is adopted for 38.214**

1. **Discussion point #3 for aperiodic TRS triggering with beam switching timing of 224 and 336**

* **Whether TP in R1-2005453 for aperiodic TRS triggering with beam switching timing of 224 and 336 is adopted for 38.214 or not**

## **1.1 Updated FL proposal based on preparation phase discussion**

**FL proposal of list of email discussions regarding TEI related discussion for RAN1#102-e meeting:**

**Email discussion/approval for Flexible TRS bandwidth for BWP of 52 RBs (17th-21st August)**

* **Which one of following options should be adopted based on “up to 3RBs beyond either/both of the highest RB and lowest RB of the TRS”**
  + **Option 1: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3 RBs beyond either of the highest RB or lowest RB of the TRS, i.e., total number of RBs outside TRS bandwidth is up to 3 and RBs outside TRS are only on either side.**
  + **Option 2: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to X RBs beyond the highest RB and/or Y RBs beyond the lowest RB of the TRS, where X+Y<4, i.e., total number of RBs outside TRS bandwidth is up to 3 and RBs outside TRS can be on both sides.**
  + **Option 3: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3 RBs beyond both of the highest RB and lowest RB of the TRS, i.e., total number of RBs outside TRS bandwidth is up to 6 and RBs outside TRS can be on both sides.**
* **Whether TP should be provided for 5.1.6.1.1 only or for both 5.1.2.2 and 5.1.6.1.1**

**Email discussion/approval for aperiodic CSI-RS/TRS triggering with beam switching timing of 224 and 336 (17th-21st August)**

* **TP in R1-2005453 for aperiodic CSI-RS triggering with beam switching timing of 224 and 336 is adopted for 38.214**
* **Whether TP in R1-2005453 for aperiodic TRS triggering with beam switching timing of 224 and 336 is adopted for 38.214 or not**

**FL proposal to discuss issues in other agenda**

* **Discuss R1-2006585 regarding UCI bit sequence generation under AI 7.1**
* **Discuss R1-2006837 regarding dynamic UL skipping under AI 7.1 (issue #29)**

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| Company | Comment |
| Moderator | Based on the feedbacks in Section 2-6, above updated FL proposals are made. |
| OPPO | Support Moderator’s proposals |
| Huawei, HiSilicon | Ok for the moderator’s proposals. |
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# **Flexible TRS bandwidth for BWP of 52 RBs**

At the RAN#88e, the following agreements were made.

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| * *Task RAN1 (cc: RAN2) to define TRS bandwidth sizes of 28, 32, 36, 40, 44, 48 RBs.*   + *All TRS configured for a given BWP with the newly defined TRS bandwidth sizes for a UE span the same set of RBs.*   + *All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3RBs beyond either/both of the highest RB and lowest RB of the TRS.*   + *Only supported for 10MHz UE channel bandwidth, 52 RB BWP size, and 15kHz SCS, in FDD bands.*   + *Note: No new performance requirement on UE is introduced here.* * *A “per-band” UE capability is to be defined for this optional UE feature, that indicates per band support for one of:*   + *“All newly defined TRS bandwidth sizes”.*   + *“All newly defined TRS bandwidth sizes except 28 RB size”.* * *Introduce from Release 16 as part of TEI16.* |

According to the above agreements, companies provided their views and/or text proposals as below.

In [1], it is proposed that the number of RBs for the PDSCH resource allocation is not expected to be 3RBs greater than the size of the number of RBs occupied by CSI-RS for tracking, and corresponding TPs for 38.214 5.1.2.2 and 5.1.6.1.1 are provided.

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| There is one ambiguity from the way forward whether “up to 3RBs beyond either/both of the highest RB and lowest RB of the TRS” should allow the configuration of TRS 3 RSs beyond both the highest RB and lowest RB.  One of the argument is that there should be flexibility for the network to configure TRS on a 4 RB granularity but could still be able to schedule PDSCH on both side with up to 3RBs beyond the occupied RBs of CSI-RS for tracking. We don’t think this is necessary since it is already flexible for the network to configure pointA. With such flexibility, it is not necessary to support PDSCH resource allocation with 4/5/6RB larger than the bandwidth of the CSI-RS for tracking since the network could always configure TRS and pointA in a way that leave at most 3RBs outside. Thus the number of RBs for the PDSCH resource allocation is not expected to be 3RBs greater than the size of the number of RBs occupied by CSI-RS for tracking.  **Proposal1: Adopt the following TP for 38.214**   |  | | --- | | <unchanged part omitted>  **5.1.2.2 Resource allocation in frequency domain**  Two downlink resource allocation schemes, type 0 and type 1, are supported. The UE shall assume that when the scheduling grant is received with DCI format 1\_0, then downlink resource allocation type 1 is used.  If the scheduling DCI is configured to indicate the downlink resource allocation type as part of the *Frequency domain resource assignment* field by setting a higher layer parameter *resourceAllocation* in *pdsch-Config* to 'dynamicswitch', for DCI format 1\_1 or setting a higher layer parameter *resourceAllocation-ForDCIFormat1\_2* in *pdsch-Config* to 'dynamicswitch' for DCI format 1\_2, the UE shall use downlink resource allocation type 0 or type 1 as defined by this DCI field. Otherwise the UE shall use the downlink frequency resource allocation type as defined by the higher layer parameter *resourceAllocation* for DCI format 1\_1 or by the higher layer parameter *resourceAllocation-ForDCIFormat1\_2* for DCI format 1\_2.  If a bandwidth part indicator field is not configured in the scheduling DCI or the UE does not support active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's active bandwidth part. If a bandwidth part indicator field is configured in the scheduling DCI and the UE supports active BWP change via DCI, the RB indexing for downlink type 0 and type 1 resource allocation is determined within the UE's bandwidth part indicated by bandwidth part indicator field value in the DCI. The UE shall upon detection of PDCCH intended for the UE determine first the downlink bandwidth part and then the resource allocation within the bandwidth part.  For a PDSCH scheduled with a DCI format 1\_0 in any type of PDCCH common search space, regardless of which bandwidth part is the active bandwidth part, RB numbering starts from the lowest RB of the CORESET in which the DCI was received; otherwise RB numbering starts from the lowest RB in the determined downlink bandwidth part.  If the bandwidth of the CSI-RS for tracking is configured to be one value among the set of {28, 32, 36, 40, 44, 48 RBs} in a BWP with equal to 52RBs, the resource allocation of PDSCH is expected to be confined within up to 3 RBs beyond the highest RB and lowest RB occupied by the CSI-RS for tracking. The number of RBs for the PDSCH resource allocation is not expected to be 3RBs greater than the number of RBs occupied by CSI-RS for tracking.  <unchanged part omitted> |   For other restrictions endorsed in the way forward, the following TP is proposed.  **Proposal2: Adopt the following TP for 38.214**   |  | | --- | | **5.1.6.1.1 CSI-RS for tracking**  <unchanged part omitted>  Each CSI-RS resource, defined in Clause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:  - the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of  - , , or for frequency range 1 and frequency range 2,  - , , , , ,  or  for frequency range 2.  - a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.*  - the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks, or is equal to resource blocks. For bands in paired spectrum, UE may indicate support of bandwidth {28, 32, 36, 40, 44, 48 RBs} for CSI-RS for tracking in a BWP with equal to 52RBs and *subcarrierSpacing* equal to 15kHz. UE is not expected to be configured with CSI-RS for tracking with different sets of occupied RBs in a BWP if the bandwidth of the CSI-RS for tracking is configured to be one value among the set of {28, 32, 36, 40, 44, 48 RBs} in a BWP with equal to 52RBs.  - the UE is not expected to be configured with the periodicity of  slots if the bandwidth of CSI-RS resource is larger than 52 resource blocks.  - the periodicity and slot offset for periodic NZP CSI-RS resources, as given by the higher layer parameter *periodicityAndOffset* configured b*y NZP-CSI-RS-Resource*, is one of slots where 10, 20, 40, or 80 and where µ is defined in Clause 4.3 of [4, TS 38.211].  - same *powerControlOffset* and *powerControlOffsetSS* given by *NZP-CSI-RS-Resource* value across all resources.  <unchanged part omitted> | |

In [2], same as in [1], it is proposed that a UE does not expect to be scheduled a PDSCH with more than 3 resource blocks outside the bandwidth of the CSI-RS resources, and corresponding TP for 38.214 5.1.6.1.1 is provided.

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| One remaining issue in the endorsed TEI on flexible TRS bandwidth is whether to allow PDSCH scheduling locate within up to 3RB on either side of the TRS bandwidth or both sides. Our understanding is if we allow 3RBs on both sides of TRS bandwidth, it will have maximum PDSCH scheduling BW 6 RBs larger than the TRS bandwidth. Then gNB can essentially configure a 4-RB larger TRS BW. Hence the reasonable restriction should be the bandwidth allowed for PDSCH scheduling should contain the TRS BW and be 3-RB larger than the TRS BW.  Thus we have the following TP suggestion.  ***TP 3:*** *For 38.214*   |  | | --- | | **5.1.6.1.1 CSI-RS for tracking**  <Unchanged parts are omitted>  - the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks, or is equal to resource blocks. For operation in paired spectrum, if the channel bandwidth is 10MHz, resource blocks, and the subcarrier spacing is 15kHz, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is 28, 32, 36, 40, 44 or 48 resource blocks, where all the CSI-RS resources configured for a given BWP occupy the same set of resource blocks, and a UE does not expect to be scheduled a PDSCH with more than 3 resource blocks outside the bandwidth of the CSI-RS resources.  <Unchanged parts are omitted> | |

In [3], same as in [1] and [2], it is proposed that the allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to a total number of 3RBs beyond both of the highest RB and lowest RB of the TRS, and corresponding TP for 38.214 5.1.6.1.1 is provided.

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| As agreed in RP-201333 [1], the new bandwidths of CSI-RS are with 4-PRB steps from 28 to 48 RBs. If a PDSCH has more 4 PRBs than TRS, then gNB should configure larger TRS bandwidth for better UE performance. Thus we have the following the proposal:  ***Proposal 1: Clarify that the allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to a total number of 3RBs beyond both of the highest RB and lowest RB of the TRS***  Based on RP-201333 and Proposal 1, we give the following text proposal   |  | | --- | | **In TS 38. 214 Section 5.1.6.1.1**  *<omitted text>*  A UE does not expect to be configured with a *NZP-CSI-RS-ResourceSet* configured both with *trs-Info* and *repetition*.  Each CSI-RS resource, defined in Clause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:  - the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of  - , , or for frequency range 1 and frequency range 2,  - , , , , ,  or  for frequency range 2.  - a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.*  - the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks, or is equal to resource blocks. For operation with the FDD bands where subcarrier spacing configuration is 0 and the maximum transmission bandwidth configuration NRB for UE channel bandwidth is 52 RBs [8, TS 38.101-1], *freqBand* configured by *CSI-RS-ResourceMapping* can be one of {28, 32, 36, 40, 44, 48}.  - the UE is not expected to be configured with the periodicity of  slots if the bandwidth of CSI-RS resource is larger than 52 resource blocks.  - the periodicity and slot offset for periodic NZP CSI-RS resources, as given by the higher layer parameter *periodicityAndOffset* configured b*y NZP-CSI-RS-Resource*, is one of slots where 10, 20, 40, or 80 and where µ is defined in Clause 4.3 of [4, TS 38.211].  - same *powerControlOffset* and *powerControlOffsetSS* given by *NZP-CSI-RS-Resource* value across all resources.  If *freqBand* configured by *CSI-RS-ResourceMapping* is one of {28, 32, 36, 40, 44, 48}, UE does not expect that the total number of PRBs allocated for PDSCH but not overlapped with the PRBs carrying CSI-RS for tracking is more than 3.  *<omitted text>* | |

In [4], same as [1], [2] and [3], it is proposed that the UE is not expected to receive a PDSCH allocation with more than 3 PDSCH RBs in total outside the configured TRS bandwidth, and corresponding TP for 38.214 5.1.6.1.1 is provided.

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| In the RAN#88e meeting, there is an open issue for the following condition:   * *All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3RBs beyond either/both of the highest RB and lowest RB of the TRS.*   The background for the condition is that, in the 10 MHz bandwidth case, the newly introduced TRS bandwidth is from 28 RBs (or from 32 RBs) to 48 RBs with the granularity of 4 RBs. However, the gNB may choose to schedule a maximum of 34 RBs (as an example) for PDSCH allocation, in which case the largest bandwidth of the PDSCH is not a multiple of 4 RBs. A principle for TRS bandwidth configuration is to match the configured bandwidth for transmission as much as possible, because the larger the bandwidth for TRS, then the better the performance for channel information tracking. For example, if the maximum scheduled bandwidth for PDSCH is 34 RBs, the TRS bandwidth could be configured as 32 RBs or 28 RBs, but the TRS with 32 RBs provides better performance than 28 RBs. So, it was agreed at RAN#88e to restrict the TRS bandwidth selection for each transmission band configuration such that the PDSCH RBs can only exceed the TRS bandwidth by up to 3 RBs.    Figure 1. TRS Band is no more than 3 RBs in total beyond PDSCH allocation  In the RAN#88e agreement, it may not be clear whether up to 3 RBs is permitted beyond each of the highest and lowest RB, or the up to 3 RBs is a limit in total considering both sides.  In our understanding, if both sides exceed the TRS bandwidth by up to 3 RBs, the total number of PDSCH RBs outside of TRS could be up to 6 RBs. It does not make sense to leave so many RBs without TRS tracking and QCL assumption. Since the granularity of the newly introduced TRS bandwidth is 4 RBs, 4 RBs within those 6 RBs could be used for TRS transmission. As an example, if the PDSCH allocation bandwidth is 34RBs, the TRS bandwidth can be 32RBs, but not for 28 RBs.  ***Proposal 1: When a UE is configured with a 10 MHz carrier with 52 RB BWP size, 15 kHz SCS and TRS of bandwidth*** s***ize among {28, 32, 36, 40, 44, 48} RBs in a FDD band, the UE is not expected to receive a PDSCH allocation with more than 3 PDSCH RBs in total outside the configured TRS bandwidth.***  ***Text proposal 1: In Section 5.1.6.1.1 of TS38.214***   |  | | --- | | Each CSI-RS resource, defined in Clause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:  - the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of  - , , or for frequency range 1 and frequency range 2,  - , , , , ,  or  for frequency range 2.  - a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.*  - the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. Based on the UE capability, for 10 MHz channel bandwidth, 52 RB BWP size, and 15 kHz SCS in a FDD band, the bandwidth of the CSI-RS resource can be configured with one of {28, 32, 36, 40, 44, 48} resource blocks by the higher layer parameter *freqBand* in *CSI-RS-ResourceMapping*; and the UE is not expected to receive a PDSCH allocation with more than 3 PDSCH RBs in total outside the configured TRS bandwidth where all TRS configured for a given BWP for a UE span the same set of RBs. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks, or is equal to resource blocks.  - the UE is not expected to be configured with the periodicity of  slots if the bandwidth of CSI-RS resource is larger than 52 resource blocks.  - the periodicity and slot offset for periodic NZP CSI-RS resources, as given by the higher layer parameter *periodicityAndOffset* configured b*y NZP-CSI-RS-Resource*, is one of slots where 10, 20, 40, or 80 and where µ is defined in Clause 4.3 of [4, TS 38.211].  - same *powerControlOffset* and *powerControlOffsetSS* given by *NZP-CSI-RS-Resource* value across all resources. | |

In [5], the TP for 38.214 5.1.6.1.1 is provided, and the TP includes the part “the UE does not expect to receive PDSCH in resource blocks of the active BWP which are more than 3 RBs above the highest resource block of the CSI-RS or more than 3 RBs below the lowest resource block of the CSI-RS” which may be same as above proposals and TPs from other companies.

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| **Proposal:** *Adopt the following TP for TS38.214 to address RP-201333 in RAN1*   |  | | --- | | 5.1.6.1.1 CSI-RS for tracking  <unchanged text parts omitted>  Each CSI-RS resource, defined in Clause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:  - the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of  - , , or for frequency range 1 and frequency range 2,  - , , , , ,  or  for frequency range 2.  - a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.*  - if carrier , , and the carrier is configured in paired spectrum, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is *X* resource blocks, where resources if the UE indicates *allTRS* for the *trs-BandwidthSize-15kHz* capability and if the UE indicates *allTRS-Except28PRB* for the *trs-BandwidthSize-15kHz* capability; in these cases, if the UE is configured with CSI-RS comprising X<52 resource blocks, the UE does not expect to receive PDSCH in resource blocks of the active BWP which are more than 3 RBs above the highest resource block of the CSI-RS or more than 3 RBs below the lowest resource block of the CSI-RS and all CSI-RS resource configurations shall span the same set of resource blocks. Otherwise, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks, or is equal to resource blocks.  <unchanged text parts omitted> | |

In [7], same as [1], [2], [3], [4] and [5], it is proposed that the option of extra 3RBs at both ends, giving a total of 6 excess RBs, is not needed. In addition, two sub-options are provided, whether PDSCH RBs outside TRS bandwidth are only on either side or can be on both sides.

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| The reason for allowing up to 3 RBs at either/both ends of the TRS is that the usable number of PDSCH RBs is not a multiple of 4 while the TRS BW is. The assumption has been that both the beginning and the end of the TRS is on a fixed 4 RB grid that can be up to 3 RBs offset from the start and end of the actual usable channel BW.  This; however, doesn’t consider the so-called Reference Point A, from which the common RB numbering starts, being itself settable. Therefore, the channel BW can be aligned at either end with the TRS start RB or the TRS end RB. Therefore, the option of extra 3 RBs at both ends, giving a total of 6 excess RBs, is not needed.  In order to streamline the configuration, we propose the following change:  **Proposal 1: Adopt either of the following options:**   * **Option 1: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3 RBs beyond either~~/both~~ of the highest RB ~~and~~or lowest RB of the TRS.** * **Option 2: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to X RBs beyond the highest RB and/or Y RBs beyond the lowest RB of the TRS, where X+Y<4.**   **Option 2 is preferred.** |

In [8], the TPs for 38.214 5.1.2.2 and 5.1.6.1.1 are provided, and the TP includes the part “the UE is not expected to receive a PDSCH allocation spanning more than 3RBs below the lowest RB and 3 RBs above the highest RB of the corresponding CSI-RS resource” which may or may not be same as above proposals and TPs from other companies.

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| <<START OF CHANGES>>  5.1.2.2 Resource allocation in frequency domain  ~  For operation in paired sprectrum with , = 52 , and reported UE capability *trsAdditionalBandwidth*, the UE is not expected to receive a PDSCH allocation spanning more than 3RBs below the lowest RB and 3 RBs above the highest RB of the corresponding CSI-RS resource as described in Clause 5.1.6.1.1.  <<SECTIONS SKIPPED>>  5.1.6.1.1 CSI-RS for tracking  ~  - for operation in paired sprectrum with , = 52 , and reported UE capability *trs-AdditionalBandwidth-r16*, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is minimum 28 or 32 resource blocks depending on whether the value of *trs-AdditionalBandwidth-r16* is set to *trs-AddBW-Set1* or *trs-AddBW-Set2*,and maximum resource blocks and all CSI-RS resource configurations shall span the same set of resource blocks, otherwise, the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks, or is equal to resource blocks.  ~  <<END OF CHANGES>> |

In summary, there are many companies interested in this issue according to the RAN agreements, and hence this issue should be addressed as high priority. Based on above contributions, following points should be discussed in RAN1#102-e meeting.

## **Discussion point #1**

* **Which one of following options should be adopted based on “up to 3RBs beyond either/both of the highest RB and lowest RB of the TRS”**
  + **Option 1: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3 RBs beyond either of the highest RB or lowest RB of the TRS, i.e., total number of RBs outside TRS bandwidth is up to 3 and RBs outside TRS are only on either side.**
  + **Option 2: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to X RBs beyond the highest RB and/or Y RBs beyond the lowest RB of the TRS, where X+Y<4, i.e., total number of RBs outside TRS bandwidth is up to 3 and RBs outside TRS can be on both sides.**
  + **Option 3: All allocated PDSCH RBs are confined within the bandwidth spanned by TRS + up to 3 RBs beyond both of the highest RB and lowest RB of the TRS, i.e., total number of RBs outside TRS bandwidth is up to 6 and RBs outside TRS can be on both sides.**
* **Whether TP should be provided for 5.1.6.1.1 only or for both 5.1.2.2 and 5.1.6.1.1**

Companies are encouraged to provide their views on the necessity/priority for this discussion point and suggested modification/addition of discussion point related to this issue if any.

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| Company | Comment |
| Ericsson | This should be discussed based on RAN plenary agreement.  The intention of the RAN agreement on the PDSCH bandwidth was that it shall be possible to schedule the PDSCH on all the resource blocks available to the operator even if the TRS bandwidth and starting position has a granularity of 4 resource blocks. As long as this is fulfilled, the actual solution is less important. Not that this should be possible without having to move the frequency location of the carrier and the 10 MHz BWP.  PDSCH resource allocation restriction should be in 5.1.2.2 and additional TRS bandwidths should be in 5.1.6.1.1. |
| Intel | Agree to discuss. |
| Nokia | The topic should be discussed as mandated by RAN #88e. points of discussion should be:   1. whether the PDSCH is allowed to be scheduled for up to 6 (up to 3 RBs on each side) or only up to 3 RBs outside the TRS BW. 2. placement of the new spec text within the TS38.214. We prefer to keep the change in one place, i.e. all restrictions are at the same place in the TS38.214. |
| ZTE | Agree to discuss it. We support option 2 in FL’s summary. In addition, to capture it in one place, i.e., sub-clause of CSI-RS for tracking, seems better. |
| vivo | Agree to discuss the two points. |
| Moderator | Thank you very much for the inputs!  The FL proposal 1 to include this discussion point #1 in the list of issues for RAN1#102-e seems fine for all. |
| OPPO | Support FL proposal. We also share the same view as Nokia that all restrictions are at the same place in the TS38.214. |
| Huawei, HiSilicon | Ok to be discussed.  For the Alternatives, we support Alt.2. TRS bands should be aligned with PDSCH to guarantee the performance of channel estimation for the case less than 10MHz bandwidth. Since the granularity of the additional TRS band is 4, the PDSCH RBs outside of TRS band should not be more than 3. So, we do not support Alt.3. Then, for Alt-1, seems not flexible as Alt.2, while PDSCH RBs may beyond both highest and lowest TRS RBs.  Then, for the TPs, the TP should be based on the agreed alternative, and all the conditions agreed in RANP should be clear captured. For the TP to be captured in Section 5.1.6.1.1 or separately in 5.1.6.1.1 and 5.2.2, we slightly prefer only in Section 5.1.6.1.1, which seems more clear on the conditions for the feature. |

# **Aperiodic CSI-RS triggering with beam switching timing of 224 and 336**

In [2], it is pointed that the endorsed TP for 38.214 in R1-2004831 was incorrectly captured in the editor CR for 38.214 in R1-2005162. Therefore, the TP based on R1-2004831 is provided.

|  |  |  |
| --- | --- | --- |
| In RAN1#101-e, based on the agreements mentioned in the Section 1, the following TP for TS 38.214 has been endorsed in R1-2004831 (also mentioned in the Chairman note [2]). But, unfortunately, this TP is incorrectly captured in the editor CR R1-2005162 and the corresponding specification TS 38.214.   |  | | --- | | -   If the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the   first symbol of the aperiodic CSI-RS resources in a *NZP-CSI-RS-ResourceSet* configured   without higher layer parameter *trs-Info* is smaller than the UE reported threshold *beamSwitchTiming,*as defined in [13,  TS 38.306], when the reported value is one of the values of {14, 28, 48} and *enableBeamSwitchTiming-r16* is not provided, or is smaller than 48 when the reported value of *beamSwitchTiming-r16* is one of the values of {224,   336} and *enableBeamSwitchTiming-r16* is provided.       -   if there is any other DL signal with an indicated TCI state in the same symbols   as the CSI-RS, the UE applies the QCL assumption of the other DL signal also   when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH   scheduled with offset larger than or equal to the threshold *timeDurationForQCL,*as   defined in [13, TS 38.306], aperiodic CSI-RS scheduled with offset larger   than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48} and *enableBeamSwitchTiming-r16* is not provided, aperiodic CSI-RS scheduled with offset larger than or equal to 48 when the reported value of *beamSwitchTiming-r16* is one of the values {224, 336} and *enableBeamSwitchTiming-r16* is provided, periodic CSI-RS, semi-persistent CSI-RS;      -   else, when receiving the aperiodic CSI-RS, the UE applies the QCL assumption used for   the CORESET associated with a monitored search space with the lowest *controlResourceSetId* in   the latest slot in which one or more CORESETs within the active BWP of the   serving cell are monitored.  -   If the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is equal to or greater than the UE reported threshold *beamSwitchTiming* when the reported value is one of the values of {14,28,48} and *enableBeamSwitchTiming-r16* is not provided, or is equal to or greater than 48 when the reported value of *beamSwitchTiming-r16* is one of the values of {224, 336} and *enableBeamSwitchTiming-r16* is provided, the UE is expected to apply the QCL assumptions in the indicated TCI states for the aperiodic CSI-RS resources in the CSI triggering state indicated by the CSI trigger field in DCI. |   Consequently, we have the following text proposals according to the endorsed TP in R1-2004831.  ***TP 1: {****38.214: 5.2.1.5.1 Aperiodic CSI Reporting/Aperiodic CSI-RS when the triggering PDCCH and the CSI-RS have the same numerology}*   |  | | --- | | - If the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources in a *NZP-CSI-RS-ResourceSet* configured without higher layer parameter *trs-Info* is smaller than the UE reported threshold *beamSwitchTiming,* as defined in [13, TS 38.306], when the reported value is one of the values of {14, 28, 48} and *enableBeamSwitchTiming-r16* is not provided, or is smaller than 48 when the reported value of *beamSwitchTiming-r16* is one of the values of {224, 336} and *enableBeamSwitchTiming-r16* is provided.  - if there is any other DL signal with an indicated TCI state in the same symbols as the CSI-RS, the UE applies the QCL assumption of the other DL signal also when receiving the aperiodic CSI-RS. The other DL signal refers to PDSCH scheduled with offset larger than or equal to the threshold *timeDurationForQCL,* as defined in [13, TS 38.306], aperiodic CSI-RS scheduled with offset larger than or equal to the UE reported threshold *beamSwitchTiming* when the reported value is one of the values {14,28,48} and *enableBeamSwitchTiming-r16* is not provided, aperiodic CSI-RS scheduled with offset larger than or equal to 48 when the reported value of *beamSwitchTiming-r16* is one of the values {224, 336} and *enableBeamSwitchTiming-r16* is provided, periodic CSI-RS, semi-persistent CSI-RS;  - else if at least one CORESET is configured for the BWP in which the aperiodic CSI-RS is received, when receiving the aperiodic CSI-RS, the UE applies the QCL assumption used for the CORESET associated with a monitored search space with the lowest *controlResourceSetId* in the latest slot in which one or more CORESETs within the active BWP of the serving cell are monitored;  - else if the UE is configured with [*enableDefaultBeamForCCS*] and when receiving the aperiodic CSI-RS, the UE applies the QCL assumption of the lowest-ID activated TCI state applicable to the PDSCH within the active BWP of the cell in which the CSI-RS is to be received.  - If the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is equal to or greater than the UE reported threshold *beamSwitchTiming* when the reported value is one of the values of {14,28,48} and *enableBeamSwitchTiming-r16* is not provided, or is equal to or greater than 48 when the reported value of *beamSwitchTiming-r16* is one of the values of {224, 336} and *enableBeamSwitchTiming-r16* is provided, the UE is expected to apply the QCL assumptions in the indicated TCI states for the aperiodic CSI-RS resources in the CSI triggering state indicated by the CSI trigger field in DCI. | |

Based on above, since it would just be a mistake and RAN1 endorsed the TP in R1-2004831, there should be no problem to check/agree on the TP provided in [2] for this issue with high priority.

## **Discussion point #2**

* **TP in R1-2005453 for aperiodic CSI-RS triggering with beam switching timing of 224 and 336 is adopted for 38.214**

Companies are encouraged to provide their views on the necessity/priority for this discussion point and suggested modification/addition of discussion point related to this issue if any.

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | Essential. |
| Intel | Agree to discuss. |
| Nokia | Agree to discuss |
| ZTE | Agree to discuss |
| vivo | Agree to discuss. |
| Moderator | Thank you very much for the inputs!  The FL proposal 2 to include this discussion point #2 in the list of issues for RAN1#102-e seems fine for all. |
| OPPO | Agree to discuss |
| Huawei, HiSilicon | Perhaps it would suffice to simply remind the editor about the mismatch, instead of dedicating one thread to discuss this. |

# **Aperiodic TRS triggering with beam switching timing of 224 and 336**

In [2], it is proposed to align the UE behavior for beam switching timing of 224 and 336 for aperiodic TRS with that for aperiodic CSI-RS, and the corresponding TP for 38.214 5.1.6.1.1 is provided.

|  |  |  |
| --- | --- | --- |
| In RAN1#101-e, the following agreements were reached for beam switching timing for aperiodic TRS in Rel-15. But, how to address this issue in Rel-16 is still FFS.  **Agreement**  The following text proposal is endorsed. Final CR is agreed in R1-2004910 (TS38.214, Rel-15, CR#0104, Cat. F).   |  | | --- | | Periodic CSI-RS resource in one set and aperiodic CSI-RS resources in a second set, with the aperiodic CSI-RS and periodic CSI-RS resource having the same bandwidth (with same RB location)and the aperiodic CSI-RS being 'QCL-Type-A' and 'QCL-TypeD', where applicable, with the periodic CSI-RS resources. For frequency range 2, the UE does not expect that the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is smaller than the UE reported*~~ThresholdSched-Offset~~beamSwitchTiming*. The UE shall expect that the periodic CSI-RS resource set and aperiodic CSI-RS resource set are configured with the same number of CSI-RS resources and with the same number of CSI-RS resources in a slot. For the aperiodic CSI-RS resource set if triggered, and if the associated periodic CSI-RS resource set is configured with four periodic CSI-RS resources with two consecutive slots with two periodic CSI-RS resources in each slot, the higher layer parameter *aperiodicTriggeringOffset* indicates the triggering offset for the first slot for the first two CSI-RS resources in the set. |  * FFS: How to address this issue in Rel-16   The UE behavior for beam switching timing of 224 and 336 for aperiodic TRS should be aligned with that for aperiodic CSI-RS straightforwardly. Consequently, we have the following TP.  ***TP 2: {****38.214: 5.1.6.1.1 CSI-RS for tracking}*   |  | | --- | | - Periodic CSI-RS resource in one set and aperiodic CSI-RS resources in a second set, with the aperiodic CSI-RS and periodic CSI-RS resource having the same bandwidth (with same RB location) and the aperiodic CSI-RS being 'QCL-Type-A' and 'QCL-TypeD', where applicable, with the periodic CSI-RS resources. For frequency range 2, the UE does not expect that the scheduling offset between the last symbol of the PDCCH carrying the triggering DCI and the first symbol of the aperiodic CSI-RS resources is smaller than the UE reported *beamSwitchTiming,* as defined in [13, TS 38.306], when the reported value is one of the values of {14, 28, 48} and *enableBeamSwitchTiming-r16* is not provided, or is smaller than 48 when the reported value of *beamSwitchTiming-r16* is one of the values of {224, 336} and *enableBeamSwitchTiming-r16* is provided. The UE shall expect that the periodic CSI-RS resource set and aperiodic CSI-RS resource set are configured with the same number of CSI-RS resources and with the same number of CSI-RS resources in a slot. For the aperiodic CSI-RS resource set if triggered, and if the associated periodic CSI-RS resource set is configured with four periodic CSI-RS resources with two consecutive slots with two periodic CSI-RS resources in each slot, the higher layer parameter *aperiodicTriggeringOffset* indicates the triggering offset for the first slot for the first two CSI-RS resources in the set. | |

Based on above, whether/how to address aperiodic TRS triggering with beam switching timing of 224 and 336 should be discussed in RAN1#102-e meeting.

## **Discussion point #3**

* **Whether TP in R1-2005453 for aperiodic TRS triggering with beam switching timing of 224 and 336 is adopted for 38.214 or not**

Companies are encouraged to provide their views on the necessity/priority for this discussion point and suggested modification/addition of discussion point related to this issue if any.

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | Necessary to discuss. |
| Intel | Agree to discuss. |
| Nokia | Agree to discuss |
| ZTE | Agree to discuss |
| vivo | Agree to discuss. |
| Moderator | Thank you very much for the inputs!  The FL proposal 3 to include this discussion point #3 in the list of issues for RAN1#102-e seems fine for all. |
| OPPO | Agree to discuss |
| Huawei, HiSilicon | OK to discuss |

# **UCI bit sequence generation**

In [6], it is pointed that the current text of subclause 6.3.1.1.1 and subclause 6.3.1.1.3 in TS 38.212 leads to , where are undefined because there are only SR bits, and corresponding TP is provided.

|  |  |  |  |
| --- | --- | --- | --- |
| According to the agreements reached in the RAN1#AH 1801 meeting [1] quoted below, the UCI bit sequence generation process for PUCCH formats 2/3/4 is that X bits of SR are appended to the end of HARQ-ACK bits and followed by CSI bits.   |  | | --- | | Agreements:   * If a UCI transmission on a PUCCH form a UE using format 2 or 3 or 4 overlaps in time with K PUCCH resources, each configured for a SR, X bits are used to represent a SR being indicated by the UE and appended to the end of the end of HARQ-ACK followed by CSI.   + Note: X is used to indicated both the presence or absence of SR and which of the K configured SR is embedded.     - FFS: X=ceil(log2(K+1)) * FFS PUCCH formats 0 & 1 |   In TS 38.212 [1], the UCI bit sequence generation process for PUCCH formats 2/3/4 is specified in Clause 6.3.1. When there are HARQ-ACK bits and SR bits to be transmitted on the PUCCH, the procedures in subclause 6.3.1.1.1 and subclause 6.3.1.1.3 apply (quoted below).   |  | | --- | | 6.3.1.1.1 HARQ-ACK/SR only  <Irrelevant parts are omitted.>  If only HARQ-ACK and SR bits are transmitted on a PUCCH, the UCI bit sequence  is determined by setting  for ,  for , and , where the HARQ-ACK bit sequence  is given by Clause 9.1 of [5, TS 38.213], and the SR bit sequence  is given by Clause 9.2.5.1 of [5, TS 38.213].  <Irrelevant parts are omitted.>  6.3.1.1.3 HARQ-ACK/SR and CSI  <Irrelevant parts are omitted.>  - if there is SR for transmission on the PUCCH, set  for , where the SR bit sequence  is given by Clause 9.2.5.1 of [5, TS 38.213]; if there is no SR for transmission on the PUCCH, set ;  <Irrelevant parts are omitted.>  - if there is SR for transmission on the PUCCH, set  for , where the SR bit sequence  is given by Clause 9.2.5.1 of [5, TS 38.213]; if there is no SR for transmission on the PUCCH, set ; |   As an example, assuming HARQ-ACK bits (denoted as ), SR bits (denoted as ), and no CSI bit leads to UCI bits, denoted as . **According to the agreements, should be , respectively.**  However, the indexing of the bit assignment process  for  in the current text of subclause 6.3.1.1.1 and subclause 6.3.1.1.3 in **TS 38.212 leads to , where are undefined because there are only SR bits.**  Therefore, we propose to adopt Text Proposal 1 to fix the indexing problem in UCI bit sequence generation process in TS 38.212.  **Text Proposal 1 (for TS 38.212 V16.2.0 specification subclause 6.3.1.1.1 and 6.3.1.1.3)**   |  | | --- | | 6.3.1.1.1 HARQ-ACK/SR only  If only HARQ-ACK bits are transmitted on a PUCCH, the UCI bit sequence  is determined by setting  for  and , where the HARQ-ACK bit sequence  is given by Subclause 9.1 of [5, TS38.213].  If only HARQ-ACK and SR bits are transmitted on a PUCCH, the UCI bit sequence  is determined by setting  for , for , and , where the HARQ-ACK bit sequence  is given by Subclause 9.1 of [5, TS 38.213], and the SR bit sequence  is given by Subclause 9.2.5.1 of [5, TS 38.213].  \*\*\* Unchanged text is omitted \*\*\*  6.3.1.1.3 HARQ-ACK/SR and CSI  If none of the CSI reports for transmission on a PUCCH is of two parts, the UCI bit sequence  is generated according to the following, where :  - if there is HARQ-ACK for transmission on the PUCCH, the HARQ-ACK bits are mapped to the UCI bit sequence , where  for , the HARQ-ACK bit sequence  is given by Subclause 9.1 of [5, TS38.213], and  is number of HARQ-ACK bits; if there is no HARQ-ACK for transmission on the PUCCH, set ;  - if there is SR for transmission on the PUCCH, set for , where the SR bit sequence  is given by Subclause 9.2.5.1 of [5, TS 38.213]; if there is no SR for transmission on the PUCCH, set ;  - the CSI fields of all CSI reports, in the order from upper part to lower part in Table 6.3.1.1.2-12, are mapped to the UCI bit sequence  starting with , where  is the number of CSI bits.  If at least one of the CSI reports for transmission on a PUCCH is of two parts, two UCI bit sequences are generated,  and , according to the following, where  and :  - if there is HARQ-ACK for transmission on the PUCCH, the HARQ-ACK bits are mapped to the UCI bit sequence , where  for , the HARQ-ACK bit sequence  is given by Subclause 9.1 of [5, TS38.213], and  is number of HARQ-ACK bits; if there is no HARQ-ACK for transmission on the PUCCH, set ;  - if there is SR for transmission on the PUCCH, set for , where the SR bit sequence  is given by Subclause 9.2.5.1 of [5, TS 38.213]; if there is no SR for transmission on the PUCCH, set ;  \*\*\* Unchanged text is omitted \*\*\* |   **Proposal 1: Adopt Text Proposal 1 to fix the indexing problem in UCI bit sequence generation process in TS 38.212 subclause 6.3.1.1.1 and 6.3.1.1.3.** |

Based on above, whether/how to address the UCI bit sequence generation issue should be discussed in RAN1#102-e meeting.

## **Discussion point #4**

* **Whether TP in R1-2006585 for UCI bit sequence generation is adopted for 38.214 or not**

Companies are encouraged to provide their views on the necessity/priority for this discussion point and suggested modification/addition of discussion point related to this issue if any.

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| --- | --- |
| Company | Comment |
| Ericsson | We support to adopt the CR.  This is a non-controversial issue which addresses an error in indexing which is important to be fixed from specification point of view. The CR was submitted last meeting in R1-2004375 where we shared the same view. |
| Intel | Should be the CR, not TEI. |
| Nokia | OK to discuss, but this is not a TEI and should have been submitted under AI 7.1 with a clear statement that this is intented for Rel-16. |
| ZTE | It’s better to treat it as a Rel-15 CR instead of Rel-16 TEI. So it should be discussed in AI 7.1. |
| vivo | Share the view this should be treated in AI 7.1. |
| Moderator | Thank you very much for the inputs!  According to the inputs so far, the issue should be discussed in RAN1#102-e, not as part of TEI but as part of CR under AI7.1.  Therefore, the updated FL proposal for this issue is to ask chairman/vice chairmen to treat R1-2006585 under AI 7.1. |
| ASUSTeK | We agreed to discuss this issue under AI 7.1 and we updated R1-2006585 to R1-2006964 with a clear statement that this is intented for Rel-16. |
| Huawei, HiSilicon | Basically, it is common understanding that SR bits are appended to HARQ bits when they are multiplexed in one PUCCH resource, and SR bits starts from first one, the change does not make any functional changes. |

# **Dynamic UL skipping**

In [7], it is proposed to specify the UE behavior for dynamic UL skipping in Rel-16.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| The Rel-15 dynamic UL skipping definition left it to the UE implementation whether to transmit PUSCH or PUCCH in the case of control multiplexing in PUSCH without MAC data. The intent was to specify the UE behavior in Rel-16.  In our view, the non-CA and CA cases should be discussed separately.  First, we discuss the case of no UL CA. When UL CA is not configured, but dynamic UL skipping is configured, and the MAC has not generated data for a PUSCH transmission, we propose that HARQ-ACK or CSI information (except A-CSI) should be transmitted in PUCCH.  **Proposal 2: When UL CA is not configured but dynamic UL skipping is configured and the MAC has not generated data for a PUSCH transmission, we propose that HARQ-ACK or CSI information (except A-CSI) should be transmitted in PUCCH.**    An additional problem with dynamic UL skipping in the UL CA case is that depending on the PUSCH dropping decision, there are multiple options as to where UCI would be multiplexed. This would require two-hypothesis decoding of every simultaneously granted PUSCH by the gNB. The scenario is illustrated in Figure 1.    **Figure 1. Illustration of UCI multiplexing ambiguity with UL CA and dynamic UL skipping**  In order to avoid this scenario, our proposal is that the PUSCH with UCI should dropped last. This can be realized with the following proposal:  **Proposal 3: When UL CA and dynamic UL skipping are both configured, the following procedure applies:**   * **Case 1 when there is no UCI multiplexed in any of a set of overlapping PUSCHs**   + **In this case, the MAC can choose any combination of PUSCH to drop or transmit** * **Case 2 when there is UCI to be multiplexed in a set of overlapping PUSCHs**   + **In this case, the UE first determines which PUSCH would carry the UCI if none of the PUSCHs was skipped, let us call this PUSCH\_0**   + **Case 2a: If MAC generates data for all PUSCHs, all PUSCH will be transmitted and UCI is multiplexed in PUSCH\_0**   + **Case 2b: If MAC generates data for none of the PUSCHs, none of the PUSCHs will be transmitted and UCI will be transmitted in PUCCH**   + **Case 2c: If MAC generates data only for a subset of the PUSCHs, that subset will be transmitted, and UCI will be multiplexed in PUSCH\_0. MAC always generates a PDU for PUSCH\_0, whether it is with padding or not.**   With proposal 3, it is sufficient for the gNB to attempt to decode every PUSCH with a single decoding hypothesis. In particular, the gNB decodes PUSCH\_0 with assuming UCI is multiplexed in it, and the gNB decodes all other PUSCH with assuming that PUSCH is not multiplexed in any of them. In addition, the gNB attempts to decode PUCCH. With this, the gNB can successfully decode every channel that was transmitted with any skipping decision made by the UE.  **Proposal 4: In order to enable Proposal 3, the Physical Layer should indicate it to MAC which UL grant is associated with a PUSCH with UCI multiplexing (assuming no skipping).**    Note that with a single priority level, the MAC can take advantage of the information about PUSCH\_0 and it can put data in PUSCH\_0 first. When there is LCH prioritization due to multiple priority levels, and the priority of PUSCH\_0 does not match the priority of the data available, the MAC can still follow the existing prioritization rules but it should generate a MAC packet with padding for PUSCH\_0. This will result in some suboptimality, but it is expected that the gNB can minimize the occurrences of unnecessary padding by taking appropriate scheduling choices.  It is expected that the UE can only take advantage of UL skipping if certain timeline conditions are satisfied; however, we don’t expect that a timeline for the MAC decision regarding UL skipping would need to be specified.  When the PUSCH is skipped, there are a number of side effects that should be clarified. In particular, it is important to clarify whether when the UE is required to transmit it actual PHR, the PHR should reflect the set of granted PUSCH (i.e. ignore UL skipping) or the PHR should reflect the actual transmitted PUSCH (i.e. the PHR should consider skipping). Our view is that in order to avoid the UE having to compute two different power control outcomes, the PHR should be based on only the actually transmitted PUSCH  **Proposal 5: When the UE has to report real (non-virtual) PHR, the PHR is determined based on the actually transmitted PUSCHs only, i.e. the effects of skipping are included.**  When a PUSCH is skipped, it can have side effects beyond the PHR determination. A similar topic was discussed in R1-2006759, “Discussion of the LS about cancelled ACK for MAC deactivation” [2]. Here we repeat the relevant aspects and relevant proposals.  In general, the standard defined multiple inter-connected requirements that define UE behavior for certain events. Some of these are events that take place due to an uplink transmission or due to a request for an uplink transmission. It needs to be clarified what the UE is required to do when the UL transmission is skipped.  In the following, we list a number of UE requirements that a given UL transmission has an effect on:   * TPC accumulation   + The PC command in the grant is included in the TPC accumulation * Power scaling on other CCs   + The transmit power on other CCs is scaled in case of power limitation due to the current transmission * MPR on other CCs (e.g. intra-band)   + The MPR on other CCs is changed by the presence of the current transmission * Half duplex handling   + The Rel-16 TEI on enhanced half-duplex conflict resolution takes into account the current transmission (What happens when the current transmission would be prioritized over DL Rx but that the current transmission is cancelled/dropped?) * NDI interpretation   + The NDI of the next grant is taken relative to the current transmission’s NDI * UCI multiplexing   + The current PUCCH/PUSCH transmission has UCI multiplexed that would be transported in other channels without the current transmission. (Will the UCI be moved to a different channel if the current transmission is cancelled/dropped?) * Supported max data rate   + The maximum number of info bits a UE can transmit is limited by the scaling factor signaled in the UE capability. (Does a cancelled transmission count in the total number of transmitted bits in a slot when comparing to the UE capability?) * CPU determination   + CSI Processing unit occupancy is reset due to the current PUCCH/PUSCH transmission when it carries the CSI report. (Will the CPU reset if the current transmission carrying the CSI is cancelled/dropped?) * Counting of active CSI resources   + Active CSI resource occupancy is counted until the current PUCCH/PUSCH transmission when it carries the CSI report. (Will the CPU reset if the current transmission carrying the CSI is cancelled/dropped?) * PHR in re-Tx   + When a PUSCH carrying PHR is retransmitted, the UE includes the same PHR in the retransmission as in the original transmission. (Should the UE include the original PHR when the original transmission was cancelled/dropped, or should it include a new PHR?) * HARQ out-of-order   + The current transmission may violate HARQ out-of-order rules, creating an error case. (What happens if the current UL transmission gets cancelled/dropped? Does the error case remain, or is the UE required to perform operation as normal?) * CA-based SRS switching preemption   + In CA-based SRS switching, the target SRS is dropped if the source CC would have higher priority transmission, such as PUCCH or PUSCH with UCI (What happens when the transmission on the source CC is cancelled/dropped?) * Interpretation of reserved MCS   + The TBS corresponding to the reserved MCS values (MCS=29, 30 31) refers to the previous transmission. (Should a cancelled/dropped transmission count as the previous transmission?) * UL Tx switching state   + The current transmission is taken into account in the Case 1 vs. Case 2 determination for Rel-16 UL Tx switching. * Determination of duplex direction   + The current transmission is taken into account in the Rel-15 duplex direction determination. (What will be the duplex direction when the current semi-static or dynamic UL transmission (semi-static or dynamic) would change a symbol from X to U but that UL transmission is cancelled/dropped?) * BWP inactivity timer   + The current transmission resets the timer used to determine when to switch back to the default UL BWP. (Should a cancelled/dropped transmission reset the BWP inactivity timer?) * DRX inactivity timer   + Defined by MAC. (Should a cancelled/dropped transmission reset the DRX inactivity timer?) * Data inactivity timer   + Defined by MAC. (Should a cancelled/dropped transmission reset the data inactivity timer?) * SCell deactivation timer   + Defined by MAC. (Should a cancelled/dropped transmission reset the SCell deactivation timer?) * RTT timer   + Defined by MAC. (Should a cancelled/dropped transmission start the RTT timer?) * HARQ attempt count   + Defined by MAC. (Should a cancelled/dropped transmission be counted as a HARQ attempt?) * BSR   + The current transmission is counted in the buffer status. (Should a cancelled/dropped transmission be counted?) * PHR calculation   + The current transmission impacts the PHR calculation, i.e. the power on other CCs may be changed due to MPR, or the current transmission changes the actual vs. virtual PHR decision. (Should the PHR be calculated after cancellation/dropping?)   Before describing our understanding of the UE requirements, we would like to discuss some aspects of the notation we used.  The UE requirements are denoted as either ‘T’, ‘N’ or ‘X’, which are defined as follows.  **Procedure ‘T’:**   * **The effect is the same as if cancellation did not occur, i.e. the transmission is considered to have taken place**   **Procedure ‘N’:**   * **The effect is the same as if the transmission has not been requested, i.e. the transmission is considered to not have taken place**   **Procedure ‘X’:**   * **The UE may follow either ‘T’ or ‘N’ based on UE implementation**   Note that in [2], we distinguished ‘Fast Cancellation’ and ‘Slow Cancellation’. However, we can categorize all UL skipping cases as slow cancellation because the UEs internal deadlines should allow full PUSCH cancellation for skipping.  Next, we summarize our understanding of the categorization of the UE procedures for each of the requirements listed before   |  |  |  | | --- | --- | --- | | **Procedure** | **Required UE behavior** | **Notes** | | TPC accumulation | T | In case of group TPC (after deadline), it is ‘X’ | | Power scaling on other CCs | N |  | | MPR on other CCs (e.g. intra-band) | N |  | | Half duplex handling | N |  | | NDI interpretation | T |  | | UCI multiplexing | T | Already specified in Rel-16, it is undefined in Rel-15 | | Supported max data rate | N | Already specified | | CPU determination | T | Already specified | | Counting of active CSI resources | T |  | | PHR in re-Tx | T |  | | HARQ out-of-order | T |  | | CA-based SRS switching preemption | N |  | | Interpretation of reserved MCS | T |  | | UL Tx switching state | N |  | | Determination of duplex direction | N |  | | BWP inactivity timer | N | Proposed specification change | | DRX inactivity timer | N | Proposed specification change | | Data inactivity timer | N | Proposed specification change | | SCell deactivation timer | N | Proposed specification change | | RTT timer | N |  | | HARQ attempt count | N |  | | BSR | N | Proposed specification change | | PHR calculation | N |  |   In order to ensure common understanding, we make the following proposals:  **Proposal 6: Discuss and clarify the UE requirements listed in the table above.**  **Proposal 7: Change the specification, so that when the processing time requirements are met, a skipped UL transmission is not taken into account in the determination of the following:**   * **BWP inactivity timer** * **DRX inactivity timer** * **Data inactivity timer** * **SCell deactivation timer** * **RTT timer** * **HARQ attempt count** * **BSR**   **Send an LS to RAN2 regarding the above.** |

Based on above, whether/how to specify the UE behavior on the dynamic UL skipping should be discussed in RAN1#102-e meeting.

## **Discussion point #5**

* **Whether/how to specify the UE behavior on the dynamic UL skipping in Rel-16 based on proposals in R1-2006837**

Companies are encouraged to provide their views on the necessity/priority for this discussion point and suggested modification/addition of discussion point related to this issue if any.

|  |  |
| --- | --- |
| Company | Comment |
| Ericsson | In general, we are fine with the proposals but would like to have a discussion to address the details, in particular with respect to timeline and potential RAN2 impact.  From the organization point of view, the same issue is discussed under 7.1, Issue 29.  It seems to be more appropriate to discuss the UL skipping under one thread, including the proposals in this contribution as well as other related contributions submitted under 7.1. |
| Intel | Should be handled under 7.1 |
| Nokia | Important to discuss, but should be discussed in 7.1 issue #29. |
| ZTE | Agree this should be discussed but in AI 7.1. |
| Moderator | Thank you very much for the inputs!  According to the inputs so far, the issue should be discussed in RAN1#102-e, not as part of TEI but as part of CR under AI7.1.  Therefore, the updated FL proposal for this issue is to ask chairman/vice chairmen to treat R1-2006837 under AI 7.1 (issue #29). |
| Huawei, HiSilicon | Agree moderator that the issue can be discussed in AI 7.1. More contributions from other companies in 7.1 would be discussed together. |

# **References**

[1] R1-2005362 Discussion on flexible NR bandwidth vivo

[2] R1-2005453 Maintenance of Rel-16 NR TEIs ZTE

[3] R1-2005982 Discussion on the introduction of new bandwidths of CSI-RS for tracking OPPO

[4] R1-2006408 Flexible TRS bandwidth configuration for 10 MHz in Rel-16 Huawei, HiSilicon

[5] R1-2006431 On remaining NR TEI issues Nokia, Nokia Shanghai Bell

[6] R1-2006585 Discussion on UCI bit sequence generation ASUSTeK

[7] R1-2006837 Discussion of flexible NR UE bandwidth TEI and UL skipping Qualcomm Incorporated

[8] R1-2006906 Introduction of Flexible TRS bandwidth for BWP of 52 RBs Vodafone