**3GPP TSG RAN WG1 #102e R1-2006714**

**e-Meeting, August 17th – 28th, 2020**

**Source: Moderator (NTT DOCOMO, INC.)**

**Title:** **Summary on UE features for TEIs**

**Agenda Item:** **7.2.11**

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

1. Introduction

This contribution summarizes the discussions and proposals in AI 7.2.11 regarding UE features for NR TEI.

Based on the discussions summarized in Section 2, followings are parts of the suggested email discussions/approvals for AI 7.2.11.

**FL proposal of email discussion/approval:**

**Email discussion/approval on UE features for NR TEI (17th – 20th August)**

* **How to define new FG for TRS bandwidth sizes smaller than 50RBs according to agreements in RAN#88e**
* **Whether to change type of FG14-2 to “per UE” and to apply the DSS bands the UE support or not**

**Email discussion/approval on mandatory/optional for NR TEI (after the completion of above email discussion)**

* **Whether the FG14-8 is mandatory with capability signaling or optional with capability signaling, including possibility of mandatory for UEs supporting with 4 or more carriers**

Companies are encouraged to check above FL proposal and to provide feedback if any in below.

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| Company | Comment |
| Ericsson | We are fine with the discussion order proposed by FL. Hopefully we could resolve all those issues on this meeting. |
| vivo | For the new TRS bandwidth, since the LS is also sent to RAN2, is it correct understanding that RAN2 would design the signaling directly based on the LS from RANP? Maybe we don’t need discussion in this email thread to avoid repeated discussion in RAN1 and RAN2 simultaneously. |
| Nokia, NSB | We agree with the discussions as proposed by FL. Regarding the new TRS bandwidth, there is a risk that RAN2 will wait for a RAN1 definition on the feature, and that misunderstanding should be avoided. It is fine to leave it to RAN2 if there is a direct confirmation from RAN2 that they will in fact handle the issue without waiting for RAN1 input first. |
| OPPO | Fine with FL proposal. Regarding the first email discussion, we share the same view as Nokia. |
| Huawei, HiSilicon | Fine with moderator’s proposal. |
| Apple | We are fine with the discussion. But FG14-2 should be per band which is similar as other DSS feature in Rel-15 and FG14-8 should not be mandatory feature. |

1. Discussion on NR Rel-16 UE features for TEI
   1. New FG for TRS bandwidth sizes smaller than 50RBs

In [3], following proposal is made.

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| In RAN#88-e the following way forward has been endorsed [6]:   * 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   Hence, corrensponding capability signalling needs to be added for the functionality listed above, as proposed in [7, 8, 9].  **Proposal: Add a new FG under TEI16 as follows:**   * **FG**: TRS bandwidth sizes smaller than 50RBs * **Component**: Support limited TRS bandwidth for 10 MHz operation under 15 kHz SCS * **Pre-requisite FG**: 2-50 * **Need for gNB to know if the feature is supported:** yes * **Type**: per band * **Note**:   + Only applicable for 10MHz UE channel bandwidth, 52 RB BWP size, and 15kHz SCS, in FDD bands.   + Candidate values: {(28, 32, 36, 40, 44, 48), (32, 36, 40, 44, 48)} RBs * **Mandatory/optional:** Optional with capability signalling |

**Discussion point #1**

* **How to define new FG for TRS bandwidth sizes smaller than 50RBs according to agreements in RAN#88e**
  1. FG14-2

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| 14. NR TEI | 14-2 | PDSCH Type B mapping of length 9 and 10 OFDM symbols | 1. support of PDSCH Type B scheduling of length 9 and 10 OFDM symbols 2. support of DMRS shift for length-10 symbols | 5-6a (PDSCH mapping type B) | Yes | N/A |  | Per band | N/A | N/A (FR1 only) | N/A | For DSS  FG10-8 covers PDSCH type B mapping without DMRS shift due to CRS collision. | Optional with capability signaling |

In [4], following proposal is made.

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| We prefer **FG-14-2 PDSCH Type B mapping of length 9 and 10 OFDM symbols FG** to signalled as per UE indication and applies to all potential DSS bands the UE support since this functionality is not band dependent. Hence, we propose:  **FG 14-2 signalled as “per UE” and applies to the DSS bands the UE support** |

**Discussion point #2**

* **Whether to change type of FG14-2 to “per UE” and to apply the DSS bands the UE support or not**
  1. FG14-8

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| 14. NR TEI | 14-8 | CSI trigger states containing non-active BWP | 1. CSI trigger states containing non-active BWP |  | Yes | N/A |  | Per UE | No | No | N/A | Agreements:  TEI – “CSI trigger states containing non-active BWP”  ・When a UE is triggered with a CSI report for a DL BWP that is non-active, the UE is not expected to report the CSI for the non-active BWP and the CSI report associated with the BWP is omitted.  ・When a UE is triggered with aperiodic CSI-RS in a DL BWP that is non-active, the UE is not expected to measure the aperiodic CSI-RS.  ・The above non-active BWP is the non-active BWP when receiving the associated CSI-RS with the following relaxation for UE processing.  In the CC of the associated CSI-RS, if the active BWP when receiving the CSI-RS is different from the active BWP when receiving the triggering DCI  The last symbol of the PDCCH span of the DCI carrying the BWP switching shall be no later than the last symbol of the PDCCH span of the CSI trigger DCI, irrespective of whether they are in the same CC or not and irrespective of whether they are in the same SCS or not.  The UE is not expected to have any other BWP switching in that CC after the last symbol of the PDCCH span covering CSI trigger DCI and before the first symbol of the triggered CSI-RS resource.  ・Note: the UE is not required to measure P/SP-CSI-RS in the non-active BWP per current specification | [Mandatory or Optional] with capability signaling |

Following proposals are made in contributions.

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| [2] | One remaining issue on Rel-16 NR TEI is whether the following 14-8 is mandatory with capability signalling or optional with capability signalling.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | 14. NR TEI | 14-8 | CSI trigger states containing non-active BWP | 1. CSI trigger states containing non-active BWP | [Mandatory or Optional] with capability signaling |   Per RAN1 common understanding, this feature is critical to NW’s operation involving multiple carriers or BWPs. The reason that companies want to introduce this FG is to reserve time for UE vendors to implement and test this feature. To make it mandatory with capability signalling will resolve companies’ concern on product timeline. After the IoT test of the features to enable multi-carrier/BWP operation, this feature should be mandatorily supported to ensure the NW works well. Hence, we support to make it mandatory with capability signalling.  ***Proposal 5:*** *Support to make 14-8 mandatory with capability signalling.* |
| [4] | We prefer **FG 14-8 CSI trigger states containing non-active BWP** to be **mandatory with capability signalling.** We realize thatthis might be too challenging to some low performance UEs, but since the feature is essential for supporting deployment with large number of component carriers, we the FG to be conditionally mandatory for such UEs. For UEs supporting less than X carriers in CA this feature can be optional. X can for instance be 4.   1. FG 14-8 is “mandatory with capability signalling feature” for UEs supporting CA with 4 or more carriers and optional for UEs supporting less than 4 carrier CA. |

**Discussion point #3**

* **Whether the FG14-8 is mandatory with capability signaling or optional with capability signaling, including possibility of mandatory for UEs supporting with 4 or more carriers**

Reference

[1] R1-2006462 Updated RAN1 UE features list for Rel-16 NR Moderators (AT&T, NTT DOCOMO, INC.)

[2] R1-2005423 Discussion on NR Rel-16 UE Features ZTE

[3] R1-2006677 Remaining aspects of Rel-16 UE features Nokia, Nokia Shanghai Bell

[4] R1-2006874 Remaining details of Rel-16 NR UE features Ericsson

Appendix: UE features list for NR TEI in [1]

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| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (V2X WI only)”. | **Consequence if the feature is not supported by the UE** | **Type**  **(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC)** | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 14. NR TEI | 14-1 | Multiple LTE-CRS rate matching patterns | 1. Maximum number of LTE-CRS rate matching patterns in total within a NR carrier using 15 kHz SCS 2. Maximum number of LTE-CRS non-overlapping rate matching patterns within a NR carrier using 15 kHz SCS | 5-28 (Rate-matching around LTE CRS) | Yes | N/A |  | Per band | N/A | N/A (FR1 only) | N/A | For DSS  The number of the additional CRS rate matching patterns reported in Rel-16 is accounted in the total number of rate matching pattern reported by the UE for Rel-15 by using pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot and pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot  UE reporting component 1 for 14-1 also reports component 2.  Reporting of values of Component 1 larger than two is only applicable when reporting values of Component 2 larger than one. | Optional with capability signalling  Component 1:{2, 3, 4, 5, 6}  Component 2: {1, 2, 3} |
| 14. NR TEI | 14-1a | Two LTE-CRS overlapping rate matching patterns within a part of NR carrier using 15 kHz overlapping with a LTE carrier | 1. Support of two LTE-CRS overlapping rate matching patterns within a part of NR carrier using 15 kHz SCS overlapping with a LTE carrier | 14-1 | Yes | N/A |  | Per band | N/A | N/A (FR1 only) | N/A | For DSS  The number of the additional CRS rate matching patterns reported in Rel-16 is accounted in the total number of rate matching pattern reported by the UE for Rel-15 by using pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot and pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot | Optional with capability signaling |
| 14. NR TEI | 14-2 | PDSCH Type B mapping of length 9 and 10 OFDM symbols | 1. support of PDSCH Type B scheduling of length 9 and 10 OFDM symbols 2. support of DMRS shift for length-10 symbols | 5-6a (PDSCH mapping type B) | Yes | N/A |  | Per band | N/A | N/A (FR1 only) | N/A | For DSS  FG10-8 covers PDSCH type B mapping without DMRS shift due to CRS collision. | Optional with capability signaling |
| 14. NR TEI | 14-3 | One slot periodic TRS configuration for FR1 | 1. UE can be configured with one-slot periodic TRS configuration only when no two consecutive slots are indicated as downlink slots by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigDedicated | 2-51 (CSI-RS for tracking) | Yes | N/A |  | Per band | N/A (TDD only) | N/A (FR1 only) | N/A | UE can be configured with one-slot periodic TRS configuration only when no two consecutive slots are indicated as downlink slots by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigDedicated.  This FG is not also applicable for the case that all slots are indicated as flexible | Optional with capability signalling |
| 14. NR TEI | 14-4 | SRS Tx switch with allowing downgrading configuration | 1) Support SRS Tx port switch | 2-55 | Yes | N/A |  | Per BC (same reporting type as srs-TxSwitch in Rel-15) | N/A | N/A | N/A | Agreement:  •Rel-16 UE capability design for SRS antenna switching in conjunction with the existing Rel-15 UE capability should allow UE to indicate support of one of the following combinations  o{t1r1, t1r2}  o{t1r1, t1r2, t1r4}  o{t1r1, t1r2, t2r2, t2r4}  o{t1r1, t2r2}  o{t1r1, t2r2, t4r4}  o{t1r1, t1r2, t2r2, t1r4, t2r4}  oNote: Detailed signaling design is up to RAN2 | Optional with capability signalling  Component 1: Candidate value set:  {  o{t1r1, t1r2}  o{t1r1, t1r2, t1r4}  o{t1r1, t1r2, t2r2, t2r4}  o{t1r1, t2r2}  o{t1r1, t2r2, t4r4}  o{t1r1, t1r2, t2r2, t1r4, t2r4}  }  Component2: Candidate value set: {yes, no}  Component 3: Candidate value set: {yes, no} |
| 14. NR TEI | 14-5 | Half-duplex UE behaviour in TDD CA for same SCS | 1. Support for directional collision handling between reference and other cell(s) for half-duplex operation in CA with same SCS | 6-5 and simultaneousRxTxInterBandCA not supported | Yes | N/A |  | Per BC | N/A (TDD only) | N/A | N/A | Half duplex UEs that do not indicate this capability should still be able to operate half-duplex TDD CA (i.e. simultaneousRxTxInterBandCA not supported) per Rel15 specifications if network ensures same transmission direction across all the serving cells | Optional with capability signaling |
| 14. NR TEI | 14-6 | New RACH configuration for FR1 TDD | 1. new RACH configuration entries with subframe number 2 and/or 7 for RACH periodicity longer than 10 ms |  | No | N/A |  | N/A | N/A (TDD only) | N/A (FR1 only) | N/A | Agreement:  •A new UE capability is not introduced for this TEI, i.e., it is a mandatory UE feature for Rel-16. | Mandatory without capability signalling |
| 14. NR TEI | 14-7 | New capability for beamSwitchTiming values of 224 and 336 | 1. Indicates the minimum number of required OFDM symbols {224, 336} between the DCI triggering aperiodic CSI-RS and the corresponding aperiodic CSI-RS transmission in a CSI-RS resource set configured with repetition ‘ON’  * Candidate values: {224, 336} | 2-28 | Yes | N/A |  | Per band | N/A | N/A (FR2 only) | N/A | Agreements:  ・48 is used as the beam switching threshold for Ues reporting 224 or 336  ØWhen using the higher values of the feature (sym224 and sym336), beamSwitchTiming indicates the minimum number of OFDM symbols between the DCI triggering of aperiodic CSI-RS and aperiodic CSI-RS transmission in a CSI-RS resource configured with repetition ‘ON’ to apply TCI indication in CSI-RS triggering DCI. | Optional with capability signaling |
| 14. NR TEI | 14-8 | CSI trigger states containing non-active BWP | 1. CSI trigger states containing non-active BWP |  | Yes | N/A |  | Per UE | No | No | N/A | Agreements:  TEI – “CSI trigger states containing non-active BWP”  ・When a UE is triggered with a CSI report for a DL BWP that is non-active, the UE is not expected to report the CSI for the non-active BWP and the CSI report associated with the BWP is omitted.  ・When a UE is triggered with aperiodic CSI-RS in a DL BWP that is non-active, the UE is not expected to measure the aperiodic CSI-RS.  ・The above non-active BWP is the non-active BWP when receiving the associated CSI-RS with the following relaxation for UE processing.  In the CC of the associated CSI-RS, if the active BWP when receiving the CSI-RS is different from the active BWP when receiving the triggering DCI  The last symbol of the PDCCH span of the DCI carrying the BWP switching shall be no later than the last symbol of the PDCCH span of the CSI trigger DCI, irrespective of whether they are in the same CC or not and irrespective of whether they are in the same SCS or not.  The UE is not expected to have any other BWP switching in that CC after the last symbol of the PDCCH span covering CSI trigger DCI and before the first symbol of the triggered CSI-RS resource.  ・Note: the UE is not required to measure P/SP-CSI-RS in the non-active BWP per current specification | [Mandatory or Optional] with capability signaling |