**3GPP TSG RAN WG1 #100bis-e R1-20xxxxx**

**e-Meeting, 20th – 30th April, 2020**

**Agenda item:** 7.2.11

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

**Title:** Summary on email discussion [100b-e-NR-UEFeatures-Remaining] NR TEI

**Document for:** Discussion and Decision

1. Introduction

This contribution summarizes the following email discussion in AI 7.2.11 regarding Rel-16 NR UE features.

[100b-e-NR-UEFeatures-Remaining] Email discussion/approval of remaining issues (especially the one identified as low priority items in FL’s summaries) starting no earlier than 4/30 till next meeting – Hiroki (DCM)/Ralf (ATT)

Companies are encouraged to check further updates for UE features list based on R1-2003073 shown below and provide feedback if any. Please note that the target of this email discussion is to reflect agreeable updates rather than solving any controversial discussion point. If there is any controversial discussion point, it should be discussed in the next RAN1 meeting.

1. NR TEI

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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 (indicating component 1 value larger than component 2 value),  16-2a (Multi-DCI based multi-TRP) | 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. Indicates whether the UE supports PDSCH Type B scheduling of length 9 and 10 OFDM symbols with DMRS shift due to CRS collision | 5-6a (PDSCH mapping type B) | Yes | N/A |  | FFS: [Per band or Per UE] | [N/A or No] | [N/A or No] (FR1 only) | N/A | For DSS  FG10-8 covers PDSCH type B mapping without DMRS shift due to CRS collision. | FFS: [Mandatory with capability signailng or 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 | No TRS can be configured when no two consecutive slots are indicated as downlink slots by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigDedicated | 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.  FFS: relationship with maxBurstLength for FG2-51 | Optional with capability signalling |
| 14. NR TEI | 14-4 | SRS Tx switch with allowing downgrading configuration | 1) Support SRS Tx port switch  [2] Report whether the uplink Tx switching impact to downlink receiving in a band]  [3] Report whether the UL Tx is switched together with UL Tx in another band]  [Define affected DL and UL bands by using txSwitchImpactToRx and txSwitchWithAnotherBand for the new (downgraded) entries] | 2-55 | Yes | N/A |  | FFS: [Per BC or Per FS or Per FSPC] | 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  FFS: whether components 2 and 3 are necessary or not | 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, 6-6, simultaneousRxTxInterBandCA not supported | Yes | N/A |  | FFS: [Per BC or Per FS or Per UE] | [N/A or No] (TDD only) | [N/A or Yes or No] | [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 | FFS: [Mandatory with capability signaling for intra-band CA band and for inter-band CA in band combination without RAN4 FG 2-5 capability or Optional with capability signaling] |
| 14. NR TEI | [14-5a] | Half-duplex UE behaviour in TDD CA with different SCS | 1. Support for directional collision handling between reference and other cell(s) for half-duplex operation in CA with different SCS | TBD | Yes | N/A |  | FFS: [Per BC or Per FS or Per UE] | [N/A or No] (TDD only) | [N/A or Yes or No] | [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 | FFS: [Mandatory with capability signaling for intra-band CA band and for inter-band CA in band combination without RAN4 FG 2-5 capability or 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 | [48 is used as the beam switching threshold for Ues reporting 224 or 336  When using 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.] | TBD  [2-28] | Yes | N/A |  | Per band | N/A | N/A (FR2 only) | N/A | FFS: relationship with beamSwitchTiming for FG2-28  Agreements:  ・48 is used as the beam switching threshold for Ues reporting 224 or 336  When 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] | Active BWP when receiving the CSI triggering DCI and when receiving the associated CSI-RS | 1. For a given CSI report, whether UE supports to receive the CSI triggering DCI in a different active DL BWP from receiving the associated CSI-RS, in the carrier of the serving cell expecting to receive the associated CSI-RS. | TBD | Yes | N/A |  | Per UE | No | No | N/A |  | Optional with capability signaling |

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| Company | Comment |
| MediaTek | FG14-2:   * Type: Per band * TDD/FDD differentiation: No * FR1/FR2 differentiation: N/A (FR1 only) * M/O: Optional with capability signaling   FG14-4:   * Remove brackets for technical component 2) & 3) * Type: ~~Per BC~~Same as Rel-15 FG2-55 “SRS Tx switch”   FG14-5:   * Type: Per BC * TDD/FDD differentiation: N/A (TDD only) * FR1/FR2 differentiation: N/A * M/O: Optional with capability signaling   FG14-5a:   * Remove brackets for FG14-5a * Type: Per BC * TDD/FDD differentiation: N/A (TDD only) * FR1/FR2 differentiation: N/A * M/O: Optional with capability signaling   Remove brackets for FG14-7 & FG14-8 |
| Ericsson | FG14-1a:   * 16-2a (Multi-DCI based multi-TRP) is more proper prerequisite for 14-1a. We suggest accepting the change and updating the description to “**14-1 indicating component 1 value larger than component 2 value, 16-2a**”   FG14-2:   * Type **Per UE**, this is a DSS feature, it unnecessarily complicates the procedure if define the FG as Per Band. * **NO** FDD TDD differentiation, the FG is needed for both FDD and TDD though the initial discussion was mainly focused on TDD. * **FR1** * **Mandatory with capability signaling**   FG14-3:   * 2-51 on maxBurstLength UE can report {1, “both 1 and 2”}, and UE mandated to report “both 1 and 2”. Whichever value UE reports should be fine for 14-3.   FG14-5:   * Type **Per UE**   FG14-7:   * OK to keep.   FG14-8:   * Need more discussion or remove. |
| ZTE | Regarding 14-2, it should be optional with capability signaling and should be per UE. Since the FG is related LTE band, it should be only for FR1.  Regarding 14-4, for xTxR configurations, e.g. 1T1R, 2T2R, there is no switching impact for DL and UL. So components 2 and 3 are not needed for those configurations.  For other Tx modes where switching impact to DL and UL can be inherited from Rel-15 report, components 2 and 3 are not needed as well.  Regarding [14-7], firstly, we slightly prefer not to introduce a new RRC for enabling this feature. It is due to the fact that the UE also can realize whether the gNB is Rel-16 or Rel-15 according to the system information message, e.g., SIB1-> SIB1-v16xy-Ies -> idleModeMeasurements-r16; SIB1-> SIB1-v16xy-Ies ->posSI-SchedulingInfoList-r16；SIB2-> relaxedMeasurement-r16.# for measurement relaxation of power saving；or SIB11. When realizing that it accesses the rel-16 gNB, the UE can report one out of {224, 336}. It is the reason that reusing Rel-15 UE capability is sufficient.  Then, even if a new Rel-16 capability is introduced e.g. beamSwitchTiming-r16, the current description of beamSwitchTiming feature above is sufficient. Finally, Rel-16 gNB will only check this new Rel-16 capability parameter to obtain A-CSI-RS beamswitching timing. Except the parameter name, we do not need to do any other changes in RAN1 spec.  Regarding [14-8], we are fine with the above text. We don’t think an FG is needed for the critical correction of allowing CSI trigger states containing inactive BWP, for which the spec impact of UE not supporting is not clear. |
| Intel | 14-2   * Per UE, applicable to FR1, optional with capability signalling   14-4   * As commented earlier more clarification is needed for components 2 and 3. If the FG has pre-requisite of 2-55, the corresponding parameter should be already available for {t1r2} in {t1r1, t1r2, t1r4} combination from Rel-15 capability of the associated t14r. Other downgraded configuration doesn’t support physical switching of the antenna and should not have impact on other DL or UL bands. This should be clarified in TS 38.306. Regarding granularity. It is already BC in TS 38.306.   14-7   * Remove brackets and to revise description as follows:  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | ~~[~~14-7~~]~~ | New capability for beamSwitchTiming values of 224 and 336 | ~~1. 48 is used as the beam switching threshold for Ues reporting 224 or 336~~  ~~2. When using 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.~~   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’*.*   NOTE: UE indicating *beamSwitchTiming-16* and *beamSwitchTiming* for the same band shall set *beamSwitchTiming* to 48 | ~~[~~2-28~~]~~ | ~~FFS: [per UE or per band]~~  Per band | ~~FFS: whether this FG is necessary or not~~  ~~FFS: relationship with beamSwitchTiming for FG2-28~~  Component 1: candidate values {224, 336}  NOTE: UE indicating *beamSwitchTiming-16* and *beamSwitchTiming* for the same band shall set *beamSwitchTiming* to 48  Agreements:  48 is used as the beam switching threshold for Ues reporting 224 or 336  When 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. |   14-8   * Remove brackets for 14-8. Although the feature is important, it should be made with capability signalling (mandatory or optional) to provide more time for implementation. |
| Apple | **FG 14-1**  On the minor note, if the second component is about non-overlapping CRS, i.e. number of LTE CC overlapping with NR CC, why in the Note “Reporting of values of Component 1 larger than three is only applicable when reporting values of Component 2 larger than one.”, shouldn’t it be “two”?  **FG 14-1a**   * mTRP in MIMO will have the same FG, i.e. 16-2a-5, we do not need two FG for the same purpose * Similarly, note can be enhanced by adding “UE reporting component 1 for 14-1 larger than three is only applicable when UE also reports that it supports FG 14-1a.   **FG 14-2**   * It is per band * Regarding DMRS shift for DSS. Below is our opinion   + For licensed band, DMRS shift is an optional feature similar as FG2-6b. We prefer not to reuse FG2-6b. We can either introduce a new component or a new FG. We also think DMRS shift only applies to 15kHz SCS NR   + For unlicensed band, DMRS shift does not apply.   **FG 14-3**   * It is per band and needs xDD/FRx differentiation   + We believe this only applies to certain TDD band where operator has special alternative D/U slot TDD deployment. It is only for FR1 since FR2 has no such limitation * Clarify the case with flexible slots   **FG 14-4**   * We prefer to design FG 14-4 similar as FG2-55, however, we think it is better to be per FSPC   + Even for intra-band CA, depending on the number of CC configured, UE PA or even antenna capability can be different which is also the reason why maximum MIMO layers is per FSPC capability.   **FG 14-7**   * We support to have this separate FG * Similar as FG2-28, the new FG is per band and only applies to FR2 * The following limitation might need to be addressed which is not allowed by the specification now   + When UE swtiches to domant panel, i.e. for Rx beam sweap, UE needs 224 symbols   + When UE swtiches to active panel, i.e. for all the other BM, UE needs 28 symbols |
| Huawei, HiSilicon | OK with the proposed change in the above table for   * + FG 14-1, 14-1a, 14-2, 14-4, 14-5, 14-6 on prerequisite feature   Additionally,  For 14-2: **per UE,** since the FG is a separate UE capability for PDSCH mapping type B with 9 and 10 OFDM symbols along with FG 10-8;  For 14-4, **Component-2/3** should be kept, since with the down-grading, the combined candidate values are not the same, e.g., {t1r1, t1r2, t2r2, t2r4} is not the same as {t2r4}in Rel-15, the different switching may different impact on RX and TX..  **Per band combination** is preferred to align the R15 SRS switching feature;  For 14-5, Per Band combination is preferred.  For 14-5a, fine to keep this row. And per Band combination report;  For 14-7, If introduce a new UE capability for 224/336 in Rel-16, then the following issues should be addressed:   * + The current spec for R16 is already based on reusing the UE capability in Rel-15, if new row introduced, then the beamswitching timing in current 38.306 need to be updated accordingly.   + Aligned with Rel-15, it should be per Band.   If the beam-switching timing in R15 and R16 are reported with different values, how to handle the miss-match. |
| Moderator (NTT DOCOMO) | It seems that proposed updates are agreeable.  In addition, following further updates according to feedbacks would also be fine.   * 16-2a as prerequisite FG for 14-1a (instead of 16-2) * “larger than three” is replaced by “larger than two” in Note for 14-1   Other discussion points mentioned by companies are already marked as yellow and should be discussed in next meeting. |
| Qualcomm | **FG 14-1**   * Should be per band * 14-1 ~~(indicating component 1 value larger than component 2 value)~~, the limitation on reported component 1 / 2 combination is not needed as prerequisite   **FG 14-2**   * Needs to be optional, do not understand the motivation to make FG 14-2 mandatory * Should be per band because it is unlikely that the feature would be introduced at the same time for licensed and unlicensed, while IODT differentiation is necessary. Per band signaling enables deployment in unlicensed without being tested in licensed and vice versa   **FG 14-3**   * Should be per band because it is unlikely that the feature would be introduced at the same time for licensed and unlicensed, while IODT differentiation is necessary. Per band signaling enables deployment in unlicensed without being tested in licensed and vice versa * Would like to undesrstand applicability when all slots are indicated flexible   **FG 14-4**   * Should be per FSPC. Rel-15 SRS Tx switching capability should (or should have been) FSPC. The same xTyR capability doesn’t work in a band combination that has both a 2Rx and a 4Rx band. Then to be consistent, the Rel-16 downgraded capability should also FSPC. * Components 2 and 3 should be ideally separately signaled from the Rel-15 component 2 and 3, however, this could only provide benefit if the Rel-16 signaling were a ‘list of lists’ of impacted bands, e.g. a separate list for each xRyR case. This seems complicated.   **FG 14-5**   * Needs to be optional, was already agreed in Rel-15 * Should be per BC   **FG 14-5a**   * FG 14-5a can be removed. We believe that different SCS is unlikely for the time being, since half-duplex should only occur between TDD bands within FR1, where SCS 30kHz is the prevalent option.   **FG 14-6**   * Should be per FSPC   **FG 14-7**   * Should be per band and FR2 only * In the column: “Capability interpretation for mixture of FDD/TDD and/or FR1/FR2”, add “the per band capability is from the perspective of the scheduled cell in case of cross-carrier scheduling” * FG 14-7 should be separate from FG 2-28 * There should be an RRC configuration parameter added to indicate whether 48 symbol or less is assumed by the gNB   **FG 14-8**   * Should be optional with capability signaling |
| OPPO | **FG 14-2**   * Per band * FR1 only * Optional with capability signaling   **FG 14-4**   * Tend to agree that this FG should be per FSPC by considering the comments of Apple and QC * Component 2/3: Open to delete or keep them, but slightly prefer to remove them based on the following reason: If UE reports a same configurartion (e.g., {t1r2} for Rel-15, {t1r1, t1r2} for Rel-16 ) , but with different values for Component 2/3, gNB may be confused when configure antenna swtiching of 1T2R   **FG 14-7**   * Keep it * FR2 only   **FG 14-8**   * Keep it since this Rel-16 new feature should not be mandatory. Rel-15 UE behavior should be the baseline, and the new Rel-16 feature is an add-on feature. * Optional with capability signaling |