**3GPP TSG RAN WG1 #100bis-e R1-2002890**

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

Title: Summary on Email discussion [100b-e-NR-UEFeatures-TEIs-02]

Agenda Item: 7.2.11.12

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

# **Introduction**

This contribution summarizes the following email discussion in AI 7.2.11.12 regarding UE features for NR TEIs.

[100b-e-NR-UEFeatures-TEIs-02] Email discussion/approval on issues with capability signaling impacts for NR TEI (dates TBD) – Hiroki (DCM)

* Discuss whether/how to report capability signaling for the component 2 “Up to 3 LTE-CRS non-overlapping rate matching patterns within a NR carrier” of FG14-1
	+ Alt.1: UE reporting component 1 for 14-1 also reports component 2 from {1, 2, 3}.
	+ Alt.2: UE reporting component 1 for 14-1 also reports component 2 from {2, 3}.
	+ Alt.3: UE does not report component 2, i.e., UE reporting component 1 larger than 2 supports component 2 (up to 3 patterns within a NR carrier), and UE reporting component 1 as 2 supports up to 2 patterns within a NR carrier
* Discuss whether FG14-2 is reported per band or per UE
* Discuss whether FG14-3 is reported per UE or per band
* Discuss followings for FG14-4
	+ Whether or not FG14-4 includes component 2 and 3
	+ Whether or not component 1 for FG14-4 i.e., signaling of xTyR configuration in Rel-16, only supports downgraded xTyR configurations which are decoupled from highest xTyR reported in Rel-15
* Discuss whether FG14-5 (and FG14-5a if defined) is reported per band combination or per UE
* Discuss followings for FG14-7 (if the bracket for FG14-7 is removed)
	+ What is the component(s) of FG14-7
	+ Whether the FG14-7 is per band or per UE
* Confirm following updates
	+ For 14-1 and [14-1a]
		- The bracket for the note “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” can be removed.
		- For “Need of FR1/FR2 differentiation”, it can be clarified that FG14-1 is only for FR1, i.e., “N/A (FR1 only)”.
	+ The FG14-4 is reported per band combination.
	+ For 14-5 and [14-5a]
		- For “Need of FDD/TDD differentiation”, it can be clarified that FG14-5 is only for TDD, i.e., “N/A (TDD only)”.
		- For “Need of FR1/FR2 differentiation”, it can be “N/A” in case that “type” is per band or can be “No” in case that “type” is per UE.
	+ For “Need of FR1/FR2 differentiation” of FG14-6, “N/A (FR1only]” should be revised to “N/A (FR1 only)”.

In the email discussion [100b-e-NR-UEFeatures-URLLC/IIoT-05], following agreements were made.

**Agreements:**

* FG14-1 is kept.
	+ Component 1 is kept with candidate values {2,3,4,5,6}
	+ Component 2 is kept with candidate values {1,2,3}
* FG14-1a is kept.
* FG14-2 is kept.
* FG14-3 is kept.
* FG14-4 is kept.
* FG14-5 is kept at least for same SCS case.
* FG[14-5a] is kept with bracket.
* FG14-6 is kept
* FG[14-7] is kept with bracket

# **14-1: Multiple LTE-CRS rate matching patterns**

Based on agreements and [1], FG14-1 can be defined as below.

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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
2. Maximum number of LTE-CRS non-overlapping rate matching patterns within a NR carrier
 | 5-28 (Rate-matching around LTE CRS) | Yes | N/A |  | Per band | N/A | N/A | 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 signallingComponent 1:{2, 3, 4, 5, 6}[Component 2: {1, 2, 3}] |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| Company | Comment |
| Qualcomm | We support Alt.1 - Alt.1: UE reporting component 1 for 14-1 also reports component 2 from {1, 2, 3}The reason is to enable signaling the following UE capability: * The UE supports CRS in a single LTE CC (i.e. does not support non-overlapping CRS), and
* The UE supports two overlapping CRS within one LTE CC

This UE can use the following signaling: * FG 14-1: Comp\_1= 2; Comp\_2= 1
* FG 14-1a: Supported
 |
| Intel | 1. We have slight preference on Alt 1. 2. Confirm updates proposed by FL, i.e. remove brackets from note and should be applicable to FR1 only. |
| Ericsson | This is fine and UE must report both components, but perhaps we need to add a note “Reporting of values of Component 1 larger than three is only applicable when reporting values of Component 2 larger than one”. Fine with using N/A for TDD/FDD and FR1/FR2 fields. Also fine with confirming the updates listed below. |
| Apple | We support Alt 1. It was agreed to introduce MDCI MTRP based CRS rate matching related capability in Rel-16 eMIMO feature discussion.However, it is still important to note that when UE reports component 1 = 4 and UE supports MDCI MTRP CRS rate matching, whether UE supports 3 + 1 or 1 + 3, or only 2+2. There are certain combinations that do not make sense, but normal UE would not report irregular capability.Note that, this applies only to 15kHz SCS |

Following views are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-1.**

* **Confirm following updates**
	+ **For 14-1**
		- **The bracket for the note “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” can be removed.**
		- **For “Need of FR1/FR2 differentiation”, it can be clarified that FG14-1 is only for FR1, i.e., “N/A (FR1 only)”.**

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| [4] | MediaTek Inc. | For FG14-1 and FG14-1a, clarify that they are for FR1 only in the column of “Need of FR1/FR2 differentiation”.

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| 14-1 | Multiple LTE-CRS rate matching patterns | 1. Maximum number of LTE-CRS rate matching patterns in total within a NR carrier
 | 5-28 (Rate-matching around LTE CRS) | Yes | N/A |  | Per band | N/A | N/A (FR1 only) |  | 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 signallingComponent 1:{2, 3, 4, 5, 6} |

 |
| [6] | Ericsson | The FSS proposal to add “Up to 3 LTE-CRS non-overlapping rate matching patterns within a NR carrier” is ok |
| [7] | Qualcomm Incorporated | For FG 14-1 Multiple LTE-CRS rate matching patterns, enable signaling a capability of supporting 2 overlapping CRS within a single LTE CC.

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| 14-1 | Multiple LTE-CRS rate matching patterns | 1. Maximum number of LTE-CRS rate matching patterns in total within a NR carrier

[2] Up to 3 LTE-CRS non-overlapping rate matching patterns within a NR carrier] | 5-28 (Rate-matching around LTE CRS) | Yes | N/A |  | Per band | N/A | 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 signallingComponent 1: {2, 3, 4, 5, 6}Component 2: {1, 2, 3}] |

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| [8] | Huawei, HiSilicon | Current description in the component column is missing the maximum number of LTE-CRS non-overlapping rate matching patterns within a NR carrier. Thus, we feel it is necessary to add a bullet as “Up to 3 LTE-CRS non-overlapping rate matching patterns within a NR carrier”

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| 14-1 | Multiple LTE-CRS rate matching patterns | 1. Maximum number of LTE-CRS rate matching patterns in total within a NR carrier

~~[2]~~ 2) Up to 3 LTE-CRS non-overlapping rate matching patterns within a NR carrier~~]~~ | 5-28 (Rate-matching around LTE CRS) | Per band | 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 signallingComponent 1:{2, 3, 4, 5, 6}~~[Component 2: {2, 3}]~~ |

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# **14-1a: Multiple LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier**

Based on agreements and [1], FG14-1a can be defined as below.

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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 | 14-1a | Multiple LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier | 1. Up to two LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier
 | 14-1 (Multiple LTE-CRS rate matching patterns),16-2 (mTRP support) | Yes | N/A |  | Per band | N/A | N/A | 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 |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| --- | --- |
| Company | Comment |
| Qualcomm | FG 14-1 should be per bandFG 14-1a should be per band |
| Intel | Confirm updates proposed by FL, i.e. remove brackets from note and should be applicable to FR1 only. |
| Ericsson | The prerequisite can be more precise stating that UE should report component 2 in 14-1 with a value larger than one. Also fine with confirming the updates listed below. Do we really need to say “multiple” in the FG description and “up to two” in the component? Isn’t it better to be precise and say “Two LTE CRS….” Since this FG 14-1a is all about additional (on top of 14-1) support of two overlapping LTE CRS patterns.  |
| Apple | This capability seems to be duplicated with the capability agreed in Rel-16 eMIMO regarding MDCI MTRP based CRS rate matching, we need further discussion.Note that, this applies only to 15kHz SCS |

Following views are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-1.**

* **Confirm following updates**
	+ **For 14-1a**
		- **The bracket for the note “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” can be removed.**
		- **For “Need of FR1/FR2 differentiation”, it can be clarified that FG14-1a is only for FR1, i.e., “N/A (FR1 only)”.**

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| [4] | MediaTek Inc. | Without FG14-1a, it’s difficult for the network to know whether a UE can support 14-2 capability or not. Furthermore, there is no strong linking between multi-TRP and DSS, i.e. supporting multi-TRP doesn’t mean that 14-2 should be supported and supporting DSS doesn’t mean that 14-2 should be supported.For FG14-1 and FG14-1a, clarify that they are for FR1 only in the column of “Need of FR1/FR2 differentiation”.

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| 14-1a | Multiple LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier | 1. Up to two LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier
 | 14-1 (Multiple LTE-CRS rate matching patterns),16-2 (mTRP support) | Yes | N/A |  | Per band | N/A | N/A (FR1 only) |  | 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]FFS: whether this FG is necessary or not | Optional with capability signaling |

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| [6] | Ericsson | There is no need for this FG since 14-1 already captured 2 to 6 patterns and at most 3 non-overlapping as captured in the basic functionality (if “Up to 3 LTE-CRS non-overlapping rate matching patterns within a NR carrier” is added in 14-1) |
| [8] | Huawei, HiSilicon | As for the FFS of FG 14-1a, we feel this FG should be kept. Because BS station cannot determine whether the UE supports multiple LTE-CRS rate matching patterns within a LTE carrier or across different LTE carriers only with the help of capability report (14-1).

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| ~~[~~14-1a~~]~~ | Multiple LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier | 1. Up to two LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier
 | 14-1 (Multiple LTE-CRS rate matching patterns),16-2 (mTRP support) | Per band | 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]~~FFS: whether this FG is necessary or not~~ | Optional with capability signaling |

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# **14-2: PDSCH Type B mapping of length 9 and 10 OFDM symbols**

In [1], FG14-2 is captured as below.

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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 | 14-2 | PDSCH Type B mapping of length 9 and 10 OFDM symbols | Indicates whether the UE supports PDSCH Type B scheduling of length 9 and 10 OFDM symbols | 5-6a (PDSCH mapping type B) | Yes | N/A |  | FFS: [Per band or Per UE] | [N/A or No] | [N/A or No] | [N/A] | For DSS | FFS: [Mandatory with capability signailng or Optional with capability signaling] |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| Company | Comment |
| Qualcomm | 14-2 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. At the same time, we think that if the UE indicates the support of FG 14-2 in unlicensed, then the DM-RS pattern shift should not apply. Either this fact should be clearly described, or the DM-RS pattern shift should be a separate row with capability bit. |
| Intel | Per UE |
| Ericsson | No FDD/TDD differentiation (use No). The feature needs to be applicable for both FDD and TDD.N/A for FR1 and FR2 differentiation (since it is FR1 only)Reporting should be per UE; it is unclear why UE only support this feature in one band but not in another (we are not considering the unlicensed band here and is open for discussion). |
| Apple | It should be per band. Regarding DMRS shift for DSS. Below is our opinion * For licensed band, we need a separate FG similar as FG2-6b. We prefer not to reuse FG2-6b and DMRS shift is an optional feature even in Rel-15

For unlicensed band, DMRS shift does not apply or the above capability is per FS as FG2-6b in Rel-15  |

Following views are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-2.**

* **whether FG14-2 is reported per band or per UE**

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| [4] | MediaTek Inc. | FG14-2 is mainly for DSS enhancements in FR1 so we don’t see why it should be a mandatory FG when other DSS-related FGs are optional with capability signalling.

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| 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
 | 5-6a (PDSCH mapping type B) | Yes | N/A |  | Per band | [N/A or No] | [N/A or No] |  | For DSS |  Optional with capability signaling |

 |
| [6] | Ericsson | * FDD/TDD differentiation should be “No”
	+ Note that the main use case and motivation is for TDD and 30 kHz subcarrier spacing in which case the UE is not aware that DSS is in operation. So FDD/TDD differentiation should be No, and “DSS” in the note should be interpreted as for information only. For example, it must be ensured that the RAN1 interpretation is that this feature is not restricted to be dependent that LTE-CRS rate matching pattern is configured (i.e. FDD,15 kHz).
* The signalling should be per UE
* The feature group should be mandatory with capability signalling
 |
| [8] | Huawei, HiSilicon | For FG 14-2, since it is a separate UE capability for PDSCH mapping type B with 9 and 10 OFDM symbols along with FG 10-8, then FG 14-2 should also be per UE instead of per band. |

# **14-3: One slot periodic TRS configuration for FR1**

In [1], FG14-3 is captured as below.

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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 | 14-3 | One slot periodic TRS configuration for FR1 | 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 UE | 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 |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| --- | --- |
| Company | Comment |
| Qualcomm | 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. Separately, would like to get a clarification on the following: when all slots are indicated as flexible, we understand that single slot TRS can be configured (if supported by the UE). This is based on our reading of the condition: “***Only when no two consecutive slots are indicated as downlink slots by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigDedicated.***” Our understanding is that this condition is satisfied when all slots are indicated as flexible. |
| Intel | The signalling should be per UE. It is correct understanding that ***csi-RS-ForTracking*** from Rel-15 is provided per band. On the other hand, this granularity is mainly for other components. For 1 slot TRS itself, per UE reporting is sufficient. |
| Ericsson | On consequence of not supported, we can state that “no TRS can be configured when when no two consecutive slots are indicated as downlink slots by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigDedicated”  |
| Apple | We believe this only applies to certain TDD band where operator has special alternative D/U slot format deployment. It is only for FR1 since FR2 has no such limitation Therefore, it should be per band and needs xDD/FRx differentiation. We also agree with Qualcomm to clarify the case with flexible slots  |

Following views are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-3.**

* **whether FG14-3 is reported per band or per UE**

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| [8] | Huawei, HiSilicon | In Rel-15, only two-slot TRS is supported for FR1 considering the tracking performance and general use cases. One-slot TRS and two-slot TRS are both supported in FR2 in Rel-15. Although value 2 indicating both one-slot and two-slot for *maxBurstLength* is mandatory in TS38.306, but as detailed described in TS38.214, only two-slot is available for FR1. So, 2-slot is the exact mandatory feature for TRS in Rel-15. Regarding the relationship with *maxBurstLength* for FG2-51, it is up to RAN2 design. One possible way is to revise *maxBurstLength* for FG2-51 as “Value 1 indicate 1-slot TRS, Value 2 indicate 2-slot TRS, where Value 2 is mandatory”. In Rel-16 TEI for one-slot TRS, due to the new deployment for 4.9GHz band, one-slot TRS also may be used, if the following conditions are met:“***Only when no two consecutive slots are indicated as downlink slots by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigDedicated.***” i.e., one-slot TRS only used for the case that there is no way to implement the two-slot periodic TRS. So, as agreed in the TEI, one-slot periodic TRS is an optional feature and only used for the agreed scenarios.One more comment is that, in the draft version, one-slot periodic TRS is per UE reporting. However, the TRS feature is per Band reporting in Rel-15. To align the capability signaling, the one-slot TRS is also need to be per Band configuration. |

# **14-4: SRS Tx switch with allowing downgrading configuration**

In [1], FG14-4 is captured as below.

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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 | 14-4 | 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] | 2-53 (SRS resource)[2-55] | Yes | N/A |  | FFS: [Per band combination 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 RAN2FFS: whether components 2 and 3 are necessary or not | Optional with capability signallingComponent 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} |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | Rel-15 SRS Tx switching capability should (or should have been) per band per band combination. The same xTyR capability doesn’t seem to 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 be per band per band combination (FS). If the section is only between BC and FSPC then it should be FSPC. Agreeing with previous comment by Intel that component 2 and 3 should be 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. |
| Intel | 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 pre-requisite of 14-4. It should be only captured as 2-55 - 2-55 itself has pre-requisite of 2-54 and 2-54 has pre-requisite 2-53 in Rel-15. No need to capture redundant information. Regarding granularity. It is already BC in TS 38.306.  |
| Apple | We are curious why Rel-15 FG2-55 is per BC, since in certain inter-band BC, for example LH BC, the antenna/PA configuration is different. We prefer to have separate FG mimicking FG2-55, but at least per FS. However, we think it is better to have per FSPC since 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.  |
|  |  |

Following views are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-4.**

* **Whether or not FG14-4 includes component 2 and 3**
* **Whether or not component 1 for FG14-4 i.e., signaling of xTyR configuration in Rel-16, only supports downgraded xTyR configurations which are decoupled from highest xTyR reported in Rel-15**
* **The FG14-4 is reported per band combination**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [3] | OPPO | In Rel-15, the configuration of SRS Tx port switching is signaled per band combination. It is natural to follow the same principle to signal Rel-16 configuration.Moreover, in the last RAN2 meeting, a CR for SRS Tx switch with allowing downgrading configuration was agreed as follows [2]

| ***SRS-TxSwitch***Defines whether UE supports SRS for DL CSI acquisition as defined in clause 6.2.1.2 of TS 38.214 [12]. The capability signalling comprises of the following parameters:- *supportedSRS-TxPortSwitch* indicates SRS Tx port switching pattern supported by the UE, which is mandatory with capability signaling. The indicated UE antenna switching capability of ′xTyR′ corresponds to a UE, capable of SRS transmission on ′x′ antenna ports over total of ′y′ antennas, where ′y′ corresponds to all or subset of UE receive antennas, where 2T4R is two pairs of antennas.*supportedSRS-TxPortSwitch-r16*, which is optional to report, indicates downgrading configuration of SRS Tx port switching pattern. If the UE indicates the support of downgrading configuration of SRS Tx port switching pattern using *supportedSRS-TxPortSwitch-r16*, the UE shall report the values for this as below, based on what is reported in *supportedSRS-TxPortSwitch*.

|  |  |  |
| --- | --- | --- |
| ***supportedSRS-TxPortSwitch*** |  | ***supportedSRS-TxPortSwitch-r16*** |
| *t1r2* |  | *t1r1-t1r2* |
| *t1r4* |  | *t1r1-t1r2-t1r4* |
| *t2r4* |  | *t1r1-t1r2-t2r2-t2r4* |
| *t2r2* |  | *t1r1-t2r2* |
| *t4r4* |  | *t1r1-t2r2-t4r4* |
| *t1r4-t2r4* |  | *t1r1-t1r2-t2r2-t1r4-t2r4* |

- *txSwitchImpactToRx* indicates the entry number of the first-listed band with UL in the band combination that affects this DL, which is mandatory with capability signaling; - *txSwitchWithAnotherBand* indicates the entry number of the first-listed band with UL in the band combination that switches together with this UL, which is mandatory with capability signaling. For *txSwitchImpactToRx* and *txSwitchWithAnotherBand*, value 1 means first entry, value 2 means second entry and so on. All DL and UL that switch together indicate the same entry number.The UE is restricted not to include fallback band combinations for the purpose of indicating different SRS antenna switching capabilities. | BC | FD | No | No |

That is to say, RAN2 has decided the corresponding configured is signaled per band combination. Based on the above discussions, we have the following proposal***Proposal 1: In Rel-16, the configuration of SRS Tx switch with allowing downgrading configuration is signaled per band combination (BC).******~***The current version of Component 2 and component 3 are not clear:* For Rel-15 (TS 38.306), there is a capability *txSwitchImpactToRx* indicates the entry number of the first-listed band with UL in the band combination that affects this DL”. If the value of 2nd components is YES, does it mean the new SRS Tx swiching capability follows *txSwitchImpactToRx* of Rel-15, or the new SRS Tx switching capability has impact on all DL of the band combination? If the value of 2nd component is NO, does it mean the new SRS Tx switching capability has no impact on the DL band indicated by *txSwitchImpactToRx* of Rel-15, or the new capability has on impact on any DL within the band combination?
* Rel-16 new capability contains more than one SRS Tx port switching configuration. Take {t1r1, t1r2, t1r4} as example. Is the 2nd component applicable to the whole set {t1r1, t1r2, t1r4}, or only some of them?

There are two possible ways to avoid the above confusion* Alt.1: Configure { *txSwitchImpactToRx, txSwitchWithAnotherBand*} for each SRS switching configuration supported by the UE capability
* Alt.2: Remove component 2 and component 3

Alt.1 can offer the most flexible at the cost of larger signaling overhead. However, the benefit of additional signaling flexibility is not clear so far for practical UE implementation. In contrast, Alt.2 is a simple solution, which seems sufficient at current stage. Thus we have the following proposal***Proposal 2: Remove component 2 and component 3 from “14-4 SRS Tx switch with allowing downgrading configuration”, and UE follows the Rel-15 configuration of { txSwitchImpactToRx, txSwitchWithAnotherBand} .*** |
| [4] | MediaTek Inc. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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] | 2-53 (SRS resource)[2-55] | Yes | N/A |  | Per band combination  | 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 RAN2FFS: whether components 2 and 3 are necessary or not | Optional with capability signallingComponent 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} |

 |
| [5] | Intel Corporation | In Rel-15 UE capability for SRS Tx switching supports signaling of the xTyR as well as indication of the DL and UL bands which are impacted by the corresponding switching. In Rel-16 support of the additional xTyR configurations has been agreed as part of TEI work. The agreed xTyR signaling is a sequence of the all possible xTyR’s including the highest xTyR which should be already indicated using Rel-15 capability signaling for the backward compatibility purpose. Considering that Rel-16 indication includes highest xTyR already indicated in Rel-15 (highlighted in yellow), reporting of the affected DL and UL bands can be reused from Rel-15 capability. On the other hand, it is beneficial to have separate indication of the affected DL and UL for downgraded xTyR configuration (highlighted in green) since in most of the cases (except for t1r1-t1r2-) those configurations doesn’t involve any physical switching of the antennas and can be performed without any interruptions to DL and UL bands.* {t1r1, t1r2}
* {t1r1, t1r2, t1r4}
* {t1r1, t1r2, t2r2, t2r4}
* {t1r1, t2r2}
* {t1r1, t2r2, t4r4}
* {t1r1, t1r2, t2r2, t1r4, t2r4}

Considering the discussion above the following proposal can be made:**Proposal:*** *If signalling of xTyR configurations in Rel-16 supports highest xTyR as in the latest TS 38.306 [2]*
	+ *Affected DL and UL bands are inherited from Rel-15 capability*
* *If signaling of xTyR configuration in Rel-16 only supports downgraded xTyR configurations which are decoupled from highest xTyR reported in Rel-15*
	+ *Affected DL and UL bands are not applicable for downgraded xTyR configuration, except {t1r1, t1r2} entry for which associated Rel-15 capability can be reused*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 14-4 | SRS Tx switch with allowing downgrading configuration | 1) Support SRS Tx port switch | 2-53 (SRS resource)[2-55] | BC | Optional with capability signallingComponent 1: Candidate value set:{o{t1r1 }o{t1r1, t1r2 }o{t1r1, t1r2, t2r2 }o{t1r1}o{t1r1, t1r2, t2r2}}NOTE: Rel-15 capability for the affected DL and UL bands are not applicable for downgraded Rel-16 xTyR capability, except {t1r1, t1r2}. |

 |
| [8] | Huawei, HiSilicon | For SRS antenna switching, it is down-gradation from Rel-15 UE capability. Generally the supporting features in Rel-15 also should be inherited for Rel-16. For the impact between DL and UL Tx switching, the impact reporting on 2-55 is only for the reported specific case, such as 1T4R. However, there are new entries are introduced in Rel-16 UE capability, such as {t1r1, t1r2, t1r4} which is more than 1T4R only, so it is necessary to report the impact between DL and UL antenna switching, i.e., keep Component-2 and 3.One more comment is for reporting granularity, to align with Rel-15, it is better to per Band Combination.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 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] | 2-53 (SRS resource)[2-55] | ~~FFS: [Per band combination or per FSPC]~~Per Band Combination | 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 RAN2FFS: whether components 2 and 3 are necessary or not | Optional with capability signallingComponent 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} |

 |

# **14-5: Half-duplex UE behaviour in TDD CA (at least for same SCS)**

Based on agreements and [1], FG14-5 can be defined as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 14-5 | 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
2. [Support for directional collision handling between reference and other cell(s) for half-duplex operation in CA with different SCS]
 | 6-5, 6-6, simultaneousRxTxInterBandCA not supported | Yes | N/A |  | FFS: [Per band combination 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] |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | FG 14-5 should be per FS |
| Ericsson | In our view this feature should be “per UE” and is related to UE capability of TDD CA. If UE supports CA with different SCS, 14-5 component 2 can be used to indicate if the HD behaviour is supported. |
| Apple | One question to Qualcomm If it is per FS, assume we have Band A + Band BIf UE indicates it supports FG14-5 on Band A in Band A + Band B. Does that mean UE supports both?* CC1 in Band A + CC2 in Band A

CC1 in Band A + CC2 in Band B |
|  |  |

Following views are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-5.**

* **whether FG14-5 is reported per band combination or per UE**
* **For “Need of FDD/TDD differentiation”, it can be clarified that FG14-5 is only for TDD, i.e., “N/A (TDD only)”.**
* **For “Need of FR1/FR2 differentiation”, it can be “N/A” in case that “type” is per band or can be “No” in case that “type” is per UE.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [4] | MediaTek Inc. | FG14-5 should be optional with capability signalling.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 14-5 | Half-duplex UE behaviour in TDD CA with 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 |  | Per band combination  | N/A (TDD only) | 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 |

 |
| [6] | Ericsson | If we consider separating the UE capability for same and different SCS, then each capability shall be a “Per UE” capability. If the capability 14-5 applies to “Per Band Combination”, then there’s no need to add 14-5a. |
| [8] | Huawei, HiSilicon | The UE capability on same SCS or different SCS for CA cases are already reported through 6-5/6 and 6-9. So, it is not necessary to split the feature group “Half-duplex UE behaviour in TDD CA” into two cases with the same SCS and different SCS.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 14-5 | Half-duplex UE behaviour in TDD CA | 1. Support for directional collision handling between reference and other cell(s) for half-duplex operation in CA ~~with same SCS~~

~~[2] Support for directional collision handling between reference and other cell(s) for half-duplex operation in CA with different SCS]~~ | 6-5, 6-6, simultaneousRxTxInterBandCA not supported | FFS: [Per band combination or Per UE] | 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] |

 |

# **[14-5a: Half-duplex UE behaviour in TDD CA with different SCS]**

Based on agreements and [1], FG14-5a can be defined as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | [14-5a] | 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
 | 6-5, 6-6, simultaneousRxTxInterBandCA not supported | Yes | N/A |  | FFS: [Per band combination or Per UE] | [N/A or No] (TDD only) | [N/A or Yes or No] |  | 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] |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | 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.Therefore, we think that FG 14-5a is not needed. |
| Ericsson | 14-5a is not needed. |
| Apple | We are okay with Qualcomm proposal of removing this FG, with the assumption either of the two * UE does not need to support TDD CA with different SCS
* UE does not need to support half-duplexing collision handling for TDD CA with different SCS
 |
|  |  |

Following views are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-5a.**

* **Whether FG14-5a is kept or removed**
* **whether FG14-5a is reported per band combination or per UE**
* **For “Need of FDD/TDD differentiation”, it can be clarified that FG14-5a is only for TDD, i.e., “N/A (TDD only)”.**
* **For “Need of FR1/FR2 differentiation”, it can be “N/A” in case that “type” is per band or can be “No” in case that “type” is per UE.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [4] | MediaTek Inc. | Remove brackets for FG14-5a.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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
 | 6-5, 6-6, simultaneousRxTxInterBandCA not supported | Yes | N/A |  | Per band combination  | N/A (TDD only) | 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 |

 |
| [6] | Ericsson | If we consider separating the UE capability for same and different SCS, then each capability shall be a “Per UE” capability. If the capability 14-5 applies to “Per Band Combination”, then there’s no need to add 14-5a. |
| [8] | Huawei, HiSilicon | The UE capability on same SCS or different SCS for CA cases are already reported through 6-5/6 and 6-9. So, it is not necessary to split the feature group “Half-duplex UE behaviour in TDD CA” into two cases with the same SCS and different SCS. |

# **14-6: New RACH configuration for FR1 TDD**

In [1], FG14-6 is captured as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | 14-6 | 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 | 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 |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | FG 14-6 should be marked in the xDD differentiation column as TDD only and in the FRx differentiation columns as FR1 only. |
| Apple | Agree with Qualcomm which is also suggested by the FG name |
|  |  |
|  |  |

Following view is provided in a contribution for the RAN1#100bis-e meeting.

|  |  |  |
| --- | --- | --- |
| [8] | Huawei, HiSilicon | For the “Need of FR1/FR2 differentiation” column of FG 14-6, there is a mistake that the bracket in “(FR1 only]” should be replaces as “(FR1 only)”, which means only applicable for FR1. |

# **[14-7: New capability for beamSwitchTiming values of 224 and 336]**

Based on agreements and [1], FG14-7 can be defined as below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | [14-7] | New capability for beamSwitchTiming values of 224 and 336 | [48 is used as the beam switching threshold for UEs reporting 224 or 336When 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.] | [2-28] | Yes | N/A |  | FFS: [per UE or per band] | [No or N/A] | [No or N/A (FR2 only)] | N/A | FFS: relationship with beamSwitchTiming for FG2-28Agreements:・48 is used as the beam switching threshold for UEs reporting 224 or 336When 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 |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

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| --- | --- |
| Company | Comment |
| Qualcomm | FG 14-7 should be kept. FG 14-7 should be per band and FR2 only. |
| Intel | Remove brackets in 14-7 and 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 48Agreements:48 is used as the beam switching threshold for UEs reporting 224 or 336When 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. |

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| Apple | We support to have this separate FGSimilar as FG2-28, the new FG is per band and only applies to FR2We do not think proposal from Intel is absolutely necessary. We prefer the report to be completely independent. For example, we can report sym28 as Rel-15But we can report sym224 as Rel-16. The rational is simple, even though Rel-16 completed the AP-CSI-RS *beamSwitchTiming* design, it is not comprehensive and pretty faulty in our view.Without dormant panel switch, if a UE can do 28 symbols, UE can report that as of Rel-15. However, in Rel-16, if a UE prefers to have sym224 simply for Rx beam sweep, unfortunately, due to the design limitation in the current specification, UE has to suffer sym48 as of Rel-16. However, we don’t think we need to finish all the design in this meeting. We either give full flexible UE reporting, or we adopt restricted UE reporting under very careful checking while the latter is not preferred by us  |
|  |  |

Following feedbacks are provided in contributions for the RAN1#100bis-e meeting.

**Based on the feedbacks, at least following points should be discussed for FG14-7.**

* **Whether FG14-7 is kept or removed**
* **What is the component(s) of FG14-7**
* **Whether the FG14-7 is per band or per UE**

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| [2] | vivo | It can be noticed that the UE behavior is undefined when the reported value is one of the values of {224, 336} in RAN1 spec. Overall, it can be understood that for Rel-15 UE reporting of beamSwitchingTiming equal to 224 or 336 symbols is not supported, although it is included in RAN2 spec. Following UE behavior was agreed in Rel-16 TEI for the UEs reporting beamSwithchingTiming of 224 or 336:*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.*In our understanding there are two ways to handle this issue:Option1: define a new UE capability as described in 14-7 Option2: agree in RAN1 that Rel-15 UE shall not report beamSwithchingTiming values of 224 or 336, then Rel-16 UE can reuse those values. In this case the agreement can be captured in section 15 of [1].  |
| [4] | MediaTek Inc. | Remove brackets for FG14-7.

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| 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.
 | [2-28] | Yes | N/A |  | per band | N/A | N/A (FR2 only) |  | FFS: whether this FG is necessary or notFFS: relationship with beamSwitchTiming for FG2-28Agreements:・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 |

 |
| [5] | Intel Corporation | It should be noted that in the UE is not aware which functionality is supported by the gNB. Due to such uncertainty UE is unlikely to report 224 or 336 values using Rel-15 capability to ensure backward compatibility for the “old” gNB potentially not supporting UE behaviour for beam switching timing of 224 and 336. Then, the agreed enhancement for aperiodic CSI-RS based on Rel-15 capability indication becomes useless. In order to solve the problem, it is necessarily to introduce Rel-16 capability for (e.g., beamSwitchTiming-r16) indicating new values of {224, 336} while keep supporting Rel-15 capability for the backward compatibility purpose without any changes. New UE behaviour in TS 38.214 defining threshold of 48 symbols for aperiodic CSI-RS can be enabled depending whether UE includes Rel-16 capability or not. It should be also noted that Rel-16 enhancement with beam switching timing of {224, 336} is supported based on UE capability and without explicit RRC configuration from gNB. Such approach was not recommended by RAN2 in the LS [4]. As the result ambiguity may occur on the actually assumed threshold for aperiodic CSI-RS, if UE in Rel-15 indicates *beamSwitchTiming* value other than 48 and also include new *beamSwitchTiming*-*r16* in Rel-16 implying threshold of 48 according to TS 38.214. To avoid ambiguity on the actually assumed threshold for aperiodic CSI-RS without explicit RRC signalling, UE including Rel-16 capability of {224, 336} should be required to include the value of 48 using Rel-15 *beamSwitchTiming* to avoid possible ambiguity between Rel-15 and Rel-16.

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| --- | --- | --- | --- | --- | --- |
| ~~[~~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’*.* | ~~[~~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 48Agreements:48 is used as the beam switching threshold for UEs reporting 224 or 336When 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. |

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| [6] | Ericsson | * Ericsson is supportive of the new feature.
* The following component should be added

3) Support for scheduling aperiodic CSI-RS for beam management with an offset smaller than the beam switching threshold. |
| [8] | Huawei, HiSilicon | The entry seems a description of large values for the beam switching time, the feature reporting in 2-24 can be reused. In current spec for Rel-16, the agreement on the beam switching is captured in TS 38.306 and TS 38.214, so no new UE feature group need to be introduced. |

# **[14-8: CSI trigger states containing non-active BWP]**

Based on the email discussion [100b-e-NR-UEFeatures-TEIs-01], a new FG14-8 can be defined as below.

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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 | [14-8] | [CSI trigger states containing non-active BWP] | [CSI reporting with CSI trigger states containing non-active BWP] | TBD | [Yes] | N/A |  | Per UE | No | No | N/A |  | [Optional with capability signaling] |

**Companies are encouraged to provide feedbacks focusing on signaling design aspects (e.g., components with candidate values for reporting, Type, Need of xDD/FRx differentiation).**

|  |  |
| --- | --- |
| Company | Comment |
| Qualcomm | FG 14-8 should be kept. In order to the gNB to know whether it can use a trigger codepoint including invalid CSI (while also including some valid CSI), the gNB needs to know whether FG 14-8 is supported by the Rel-16 UE. |
| Intel | 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.  |
| Ericsson | We would like to understand the consequence of introducing/not introducing this FG. Does this mean the non-active BWP also consumes UE CSI processing capacity for Rel-15 UE? Or gNB is not expected to trigger such CSI report for a Rel-16 UE if supporting of this FG is not signaled? |
| Apple | We support this FG |

# **Conclusion**

TBD

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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
2. Maximum number of LTE-CRS non-overlapping rate matching patterns within a NR carrier
 | 5-28 (Rate-matching around LTE CRS) | Yes | N/A |  | Per band | N/A | N/A | 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 signallingComponent 1:{2, 3, 4, 5, 6}[Component 2: {1, 2, 3}] |
| 14. NR TEI | 14-1a | Multiple LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier | 1. Up to two LTE-CRS overlapping rate matching patterns within a part of NR carrier overlapping with a LTE carrier
 | 14-1 (Multiple LTE-CRS rate matching patterns),16-2 (mTRP support) | Yes | N/A |  | Per band | N/A | N/A | 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 | Indicates whether the UE supports PDSCH Type B scheduling of length 9 and 10 OFDM symbols | 5-6a (PDSCH mapping type B) | Yes | N/A |  | FFS: [Per band or Per UE] | [N/A or No] | [N/A or No] | [N/A] | For DSS | FFS: [Mandatory with capability signailng or Optional with capability signaling] |
| 14. NR TEI | 14-3 | One slot periodic TRS configuration for FR1 | 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 UE | 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] | 2-53 (SRS resource)[2-55] | Yes | N/A |  | FFS: [Per band combination 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 RAN2FFS: whether components 2 and 3 are necessary or not | Optional with capability signallingComponent 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
2. [Support for directional collision handling between reference and other cell(s) for half-duplex operation in CA with different SCS]
 | 6-5, 6-6, simultaneousRxTxInterBandCA not supported | Yes | N/A |  | FFS: [Per band combination 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 | 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 |

# **References**

[1] R1-2001484 RAN1 UE features list for Rel-16 NR after RAN1#100-E Moderator (AT&T, NTT DOCOMO, INC.)

[2] R1-2001724 Discussion on UE TEI feature 14-7 vivo

[3] R1-2001741 Discussion on Rel-16 UE features for TEIs OPPO

[4] R1-2001834 Views on Rel-16 UE features for NR TEIs MediaTek Inc.

[5] R1-2002025 UE features for NR TEI Intel Corporation

[6] R1-2002280 UE features for TEIs Ericsson

[7] R1-2002573 Discussion on UE features for TEI Qualcomm Incorporated

[8] R1-2002597 Rel-16 UE features for TEIs Huawei, HiSilicon