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

e-Meeting, April 20th – 30th, 2020

Source: NTT DOCOMO, INC.

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

Agenda Item: 7.2.12

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

# **Introduction**

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

[100b-e-NR-TEIs-02]: Email discussion/approval of TPs on remaining issues for half-duplex operation in CA

* Whether/how to capture the agreement which is not correctly reflected in TS38.213
	+ TPs in [R1-2002074](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002074.zip) and [R1-2002229](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002229.zip) are starting points for the discussion
* Whether/how to cover mixed numerology case
	+ TP in [R1-2002229](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002229.zip) is a starting point for the discussion

till 4/23 (DCM, Hiroki)

# **Remaining issue for half duplex operation in CA**

In [4], the following remaining issues regarding half duplex operation in CA are identified.

* The agreement that half-duplex CA UE determines reference cell per symbol as a cell with the lowest ID among multiple serving cells in a band or band combination having direction determined by RRC D/U or semi SFI D/U is not correctly reflected and the meaning of reference cell has changed.
* Only one “and” exists in the “if” conditions, and the last condition should be satisfied for all the multiple serving cells.
* When transmission directions of multiple other cells are not aligned, UE cannot determine to follow the transmission direction of which cell.
* The agreements for inter-band CA case are not correctly captured in the specification.

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| According to the agreement, half-duplex CA UE determines reference cell per symbol as a cell with the lowest ID among multiple serving cells in a band or band combination having direction determined by RRC D/U or semi SFI D/U. However, this is not correctly reflected in the CR for TEI, the reference cell is defined as a cell with the smallest cell index among the multiple serving cells in the CR and the meaning of reference cell has changed compared with the agreement above. According to the email discussion after RAN1#99, to avoid the need of resolving the conflict among other cells, the reference cell should always have a direction determined by RRC D/U or semi SFI D/U. In addition, the four conditions for reference cell determination should be satisfied at the same time but only one ‘and’ exists in the if conditions. Meanwhile, the last condition for reference cell determination should be satisfied for all the multiple serving cells. The same issue also exist in other if conditions for half-duplex operation in CA.Hence, a text proposal is provided for 38.213 section 11.1 as below.***Proposal 1: Adopt the following corrections for reference cell determination to the*** ***half-duplex operation in CA.***-------------------------------------------------- Start of text proposal ------------------------------------------------------**11.1 Slot configuration****\*\*\* Unchanged text is omitted \*\*\***If a UE - is configured with multiple serving cells and is provided *half-duplex-behavior-r16* = 'enable', and- is not capable of simultaneous transmission and reception on any of the multiple serving cells, and- indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2\_0 on any of the multiple serving cells,for a set of symbols of a slot that are indicated to the UE for reception of SS/PBCH blocks in any of multiple serving cells by *ssb-PositionsInBurst* in *SystemInformationBlockType1* or by *ssb-PositionsInBurst* in *ServingCellConfigCommon*, when provided to the UE, the UE does not transmit PUSCH, PUCCH, or PRACH in the slot if a transmission would overlap with any symbol from the set of symbols, and the UE does not transmit SRS in the set of symbols of the slot in any of multiple serving cells.**\*\*\* Unchanged text is omitted \*\*\***If a UE- is configured with multiple serving cells and is provided *half-duplex-behavior-r16* = 'enable', and- is not capable of simultaneous transmission and reception on any of the multiple serving cells, and- indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2-0 on any of the multiple serving cells, the UE determines per symbol a reference cell as a cell with the smallest cell index among the multiple serving cells having direction determined to be- downlink, or uplink as indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*- uplink, if the symbol is flexible and the UE is configured to transmit SRS, PUCCH, PUSCH, or PRACH on the symbol- downlink, if the symbol is flexible and the UE is configured to receive PDCCH, PDSCH or CSI-RS on the symbol If a UE - is configured with multiple serving cells in a frequency band and is provided *half-duplex-behavior-r16* = 'enable', and- is not capable of simultaneous transmission and reception on any of the multiple serving cells, and- indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2\_0 on any of the multiple serving cells, the UE does not expect- a symbol to be indicated as downlink or uplink on the reference cell and as uplink or downlink on another cell, respectively, by *tdd-UL-DL-ConfigurationCommon* or by *tdd-UL-DL-ConfigurationDedicated*,- *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigDedicated* to indicate a symbol as downlink on the reference cell and to detect a DCI format scheduling a transmission on the symbol on another cell, and- to be configured by higher layers to receive PDCCH, PDSCH, or CSI-RS on a flexible symbol on the reference cell and to detect a DCI format scheduling a transmission on the symbol on another cell. If the reference cell and another cell for a UE operate in different frequency bands and if the UE - is configured with multiple serving cells and is provided *half-duplex-behavior-r16* = 'enable', and- is not capable of simultaneous transmission and reception on any of the multiple serving cells, and- indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2-0 on any of the multiple serving cells, the UE - UE assumes symbol as flexible, is not required to receive higher layer configured PDCCH, PDSCH, or CSI-RS and not expected to transmit higher layers configured SRS, PUCCH, PUSCH, or PRACH, when *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* indicates symbol as downlink or uplink on the other cell and as uplink or downlink for the reference cell, respectively, - transmits a signal/channel scheduled by a DCI format on a symbol of the other cell when the symbol is indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigDedicated* for the reference cell,- is not required to receive a higher layer configured PDCCH, PDSCH, or CSI-RS on flexible symbols on the reference cell in a set of symbols, if the UE detects a DCI format scheduling a transmission on one or more symbols in the set of symbols on the other cell. If a UE - is configured with multiple serving cells and is provided *half-duplex-behavior-r16* = 'enable', and- is not capable of simultaneous transmission and reception on any cell from the multiple serving cells, and- indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2-0 on any of the multiple serving cells, the UE - does not expect *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* for the reference cell to indicate a symbol as uplink and to detect a DCI format scheduling a reception on the symbol on another cell- does not expect to be configured by higher layers to transmit SRS, PUCCH, PUSCH, or PRACH on a flexible symbol on the reference cell and to detect a DCI format scheduling a reception on the symbol on another cell- does not transmit a PUCCH, PUSCH or PRACH that is configured by higher layers on a set of symbols on another cell if at least one symbol from the set of symbols is indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* or is a symbol corresponding to a PDCCH, PDSCH, or CSI-RS reception that is configured by higher layers on the reference cell - does not transmit a SRS that is configured by higher layers on a set of symbols on another cell if the set of symbols is indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* or corresponds to a PDCCH, PDSCH or CSI-RS reception that is configured by higher layers on the reference cell - does not receive a PDCCH, PDSCH or CSI-RS that is configured by higher layers on a set of symbols on another cell if at least one symbol from the set of symbols is indicated as uplink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* or is a symbol corresponding to a SRS, PUCCH, PUSCH, or PRACH transmission that is configured by higher layers on the reference cell- assumes a symbol indicated as downlink or uplink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* on another cell to be flexible, if the UE is respectively configured by higher layers to transmit SRS, PUCCH, PUSCH, or PRACH or to receive PDCCH, PDSCH, or CSI-RS on the reference cell- does not expect to detect a first DCI format scheduling a transmission or reception on a symbol on a first cell and a second DCI format scheduling a reception or transmission on the symbol on a second cell, respectively----------------------------------------------------- End of text proposal ------------------------------------------------------According to the agreement for half-duplex UE operation, UE does not always follow reference cell transmission direction. For example, in case 3 and case 16 as shown in Table 1, UE will drop the transmission on reference cell for inter-band CA, the issue is when transmission directions of multiple other cells are not aligned, UE cannot determine to follow the transmission direction of which cell. Table 1 Half-duplex UE behavior in different cases

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| --- | --- | --- | --- | --- |
| **No** | **Ref cell** | **Other cell** | **UE behavior** | **Note** |
| 3 | Semi SFI D | Dynamic U | Alt 1: Allowed to drop D for inter-bandError case in intra-band | Overriding semi SFI D to F on reference cell for the UE |
| 16 | RRC D | Dynamic U | Alt 1: Allowed to drop D for inter-bandError case in intra-band |  |

As an example shown in Table 2, if UE is configured with three cells, Pcell is configured with semi SFI D or RRC D, a dynamic U is scheduled on Scell 1 and RRC D is configured on Scell2. Then, according to the agreement, Pcell is the reference cell, UE should drop D on reference cell and transmit dynamic U on Scell1, but there is no conflict between Pcell and Scell2, it is not clear whether a half-duplex UE should drop dynamic U on Scell 1 or drop RRC D on Scell 2. From our perspective, UE should prioritize dynamic U on Scell1 in this case according to the principle of case 3 and case 16.Table 2 Conflict direction on Scells

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| **Pcell (Reference cell)** | **Scell1** | **Scell2** | **UE behavior** |
| Semi SFI D | Dynamic U | RRC D | drop D or drop U? |
| RRC D | Dynamic U | RRC D | drop D or drop U? |

***Proposal 2: For a half-duplex CA UE, if reference cell is semi SFI D or RRC D, UE should drop high layer configured D on other cells if there is dynamic U on one of the other cells.***In addition, the agreements for inter-band CA case are not correctly captured in the specification. Hence, a text proposal is provided below for half-duplex operation in CA in 38.213 section 11.1.-------------------------------------------------- Start of text proposal ------------------------------------------------------If the reference cell and another cell for a UE operate in different frequency bands and if the UE - is configured with multiple serving cells and is provided *half-duplex-behavior-r16* = 'enable', - is not capable of simultaneous transmission and reception on any of the multiple serving cells, - indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2-0, the UE - UE assumes symbol on the other cell as flexible, is not required to receive higher layer configured PDCCH, PDSCH, or CSI-RS and not expected to transmit higher layers configured SRS, PUCCH, PUSCH, or PRACH, when *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* indicates symbol as downlink or uplink on the other cell and as uplink or downlink for the reference cell, respectively, - transmits a signal/channel on a symbol of the other cell and is not required to receive a higher layer configured PDCCH, PDSCH, or CSI-RS on the symbol on the reference cell and any of the other cells when the symbol is indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigDedicated* for the reference cell and if the UE detects a DCI format scheduling the transmission on the symbol on the other cell,- transmits a signal/channel on a symbol of the other cell and is not required to receive a higher layer configured PDCCH, PDSCH, or CSI-RS on the symbol on the reference cell and any of the other cells, if the symbol on the reference cell is flexible and the UE is configured by higher layers to receive PDCCH, PDSCH, or CSI-RS on the symbol on the reference cell and the UE detects a DCI format scheduling the transmission on the symbol on the other cell. ----------------------------------------------------- End of text proposal ------------------------------------------------------ |

In [5], the following remaining issues regarding half duplex operation in CA are identified.

* The agreement that half-duplex CA UE determines reference cell per symbol as a cell with the lowest ID among multiple serving cells in a band or band combination having direction determined by RRC D/U or semi SFI D/U is not correctly implemented.
* If the above agreement is correctly implemented, then mixed numerology case (which remained open after RAN1#100e) can be handled by defining the reference cell as cell with lowest SCS among cells for which the symbols (configured as RRC D/U or semi SFI D/U) are overlapping

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| In RAN1#100e TP for this feature has been approved. Firstly, it seemed that the following agreement (highlighted in yellow) on determination of reference cell has not been correctly implemented in the TP**Agreement:** * *Half-duplex CA UE determines reference cell per symbol as a cell with the lowest cell ID among multiple serving cells in a band or band combination having direction determined by RRC D/U or semi SFI D/U*
* *Note: this overrides earlier agreement ”Reference (Ref) cell is the cell with the lowest cell ID among cells: (i) within the band or band combination and (ii) with conflicting directions, and “Other cell” is any cell within the band or band combination other than the Ref cell. “*
* *Note: Agreed cases 12, 14, 17 and 18 are not needed anymore*
* *Note: Agreed cases 9 and 10 should apply to collisions between two cells irrespective of a cell being reference or other*

The cell configured with flexible symbol by semi SFI F should not be considered as reference cell, based on the above agreement. Otherwise, it would be necessecary to re-introduce following cases

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| **No** | **Ref cell** | **Other cell** | **UE behavior** | **Note** |
| 12 | Dynamic U | Semi SFI D | Allowed to drop D | Dropping on other cell |
| 14 | Dynamic D | Semi SFI U | Allowed to drop U | Dropping on other cell |
| 17 | Dynamic U | RRC D | Allowed to drop D | Dropping on other cell |
| 18 | Dynamic D | RRC U | Allowed to drop U | Dropping on other cell |

**Proposal 2:** *Adopt the following TP for half-duplex feature to align specification with agreement.*

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| 11.1 Slot configuration<unchanged text omitted >If a UE- is configured with multiple serving cells and is provided *half-duplex-behavior-r16* = ‘enable’, - is not capable of simultaneous transmission and reception on any of the multiple serving cells,- indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2-0, ~~the UE determines per symbol a reference cell as a cell with the smallest cell index among the multiple serving cells and determines a symbol on the reference cell to be~~~~- downlink, uplink, or flexible as indicated by~~ *~~tdd-UL-DL-ConfigurationCommon~~* ~~or~~ *~~tdd-UL-DL-ConfigurationDedicated~~*~~- flexible if~~ *~~tdd-UL-DL-ConfigurationCommon~~* ~~is not provided~~~~- uplink, if the symbol is flexible and the UE is configured to transmit SRS, PUCCH, PUSCH, or PRACH on the symbol~~~~- downlink, if the symbol is flexible and the UE is configured to receive PDCCH, PDSCH or CSI-RS on the symbol~~ the UE determines a reference cell for a symbol, among serving cells where the symbol is configured as - downlink, uplink as indicated by *tdd-UL-DL-ConfigurationCommon,* *tdd-UL-DL-ConfigurationDedicated,* or *tdd-UL-DL-ConfigDedicated-IAB-MT* - uplink, if the symbol is flexible and the UE is configured to transmit SRS, PUCCH, PUSCH, or PRACH on the symbol, or- downlink, if the symbol is flexible and the UE is configured to receive PDCCH, PDSCH or CSI-RS on the symbol, as a cell with the smallest cell index. |

If the above TP is accepted, then mixed numerology case (which remained open after RAN1#100e) can be handled by defining the reference cell as cell with lowest SCS among cells for which the symbols (configured as RRC D/U or semi SFI D/U) are overlapping.**Proposal 3:** *To support mixed numerology scenario for half-duplex feature, adopt the following TP (in magenta)*

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| 11.1 Slot configuration<unchanged text omitted >If a UE- is configured with multiple serving cells and is provided *half-duplex-behavior-r16* = ‘enable’, - is not capable of simultaneous transmission and reception on any of the multiple serving cells,- indicates support of capability for half-duplex operation in CA with unpaired spectrum, and - is not configured to monitor PDCCH for detection of DCI format 2-0, ~~the UE determines per symbol a reference cell as a cell with the smallest cell index among the multiple serving cells and determines a symbol on the reference cell to be~~~~- downlink, uplink, or flexible as indicated by~~ *~~tdd-UL-DL-ConfigurationCommon~~* ~~or~~ *~~tdd-UL-DL-ConfigurationDedicated~~*~~- flexible if~~ *~~tdd-UL-DL-ConfigurationCommon~~* ~~is not provided~~~~- uplink, if the symbol is flexible and the UE is configured to transmit SRS, PUCCH, PUSCH, or PRACH on the symbol~~~~- downlink, if the symbol is flexible and the UE is configured to receive PDCCH, PDSCH or CSI-RS on the symbol~~ the UE determines a reference cell for a symbol of the lowest sub-carrier spacing among multiple serving cells, where the symbol or at least one of overlapping symbols is configured as - downlink, uplink as indicated by *tdd-UL-DL-ConfigurationCommon,* *tdd-UL-DL-ConfigurationDedicated,* or *tdd-UL-DL-ConfigDedicated-IAB-MT* - uplink, if the symbol is flexible and the UE is configured to transmit SRS, PUCCH, PUSCH, or PRACH on the symbol, or- downlink, if the symbol is flexible and the UE is configured to receive PDCCH, PDSCH or CSI-RS on the symbol, as a cell with the smallest sub-carrier spacing first and the smallest cell index second.  |

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Based on above, following remaining issues for half-duplex operation in CA should be discussed in RAN1#100bis-e meeting.

* Whether/how to capture the agreement which is not correctly reflected in TS38.213
* Whether/how to cover mixed numerology case

## 2.1 Discussion 1

**Companies are encouraged to provide views if there is a concern or comment on the following proposals.**

**Proposal: Capture the agreement which is not correctly reflected in TS38.213**

**Alt.1: TP in [4]**

**Alt.2: TP in [5]**

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| Company | Comment |
| ZTE | Regarding the definition of reference cell, both [4] and [5] have similar updates. We are open to the two updates.Regarding the second issue pointed out in [4], i.e., the case where more than two cells are configured, there could be some conflictions and the current spec is not clear about this confliction. More discussion is needed for this issue. |
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## 2.2 Discussion 2

**Companies are encouraged to provide views if there is a concern or comment on the following proposals.**

**Proposal: Cover mixed numerology case.**

**Alt.1: TP in [5]**

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| Company | Comment |
| ZTE | The current TP is not clear how to handle the case of BWP switching, i.e., whether the SCS of the previous BWP or the SCS of the target BWP should be for the determination of reference cell. Some further discussion may be beneficial. |
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# **References**

[1] R1-2001589 Discussion on CLI and TBS ambiguity ZTE

[2] R1-2001957 Remaining details of CLI measurement and reporting at a UE LG Electronics

[3] R1-2002027 Maintenance of aperiodic CSI-RS triggering with beam switching timing of 224 and 336 Intel Corporation

[4] R1-2002074 Remaining issues of half-duplex operation in CA CATT

[5] R1-2002170 On TRS muting for NR coexistence with a narrow band system MediaTek Inc.

[6] R1-2002229 On remaining NR TEI issues Nokia, Nokia Shanghai Bell

[7] R1-2002282 Remaining issues for Rel-16 maintenance and TEI Ericsson

[8] R1-2002355 Considerations on HARQ/CSI enhancements Apple

[9] R1-2002679 Discussion on conditions of rate matching pattern overlapping with PDSCH DMRS symbols Huawei, HiSilicon

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

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

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

[13] R1-2002280 UE features for TEIs Ericsson

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