**3GPP TSG-RAN4 Meeting #112 *R4-2412830***

**Maastricht, Netherlands, 19th – 23th Aug 2024**

**Agenda item:** 8.10.5

**Source:** Moderator (CMCC)

**Title:** Topic summary for [112][128] NR\_ATG\_enh

**Document for:** Information

# Introduction

*RAN#103 meeting approved RP-240839 New WID on Enhancements for Air-to-ground network for NR in Rel-19. This is the first meeting for R19.*

*This thread focuses on UE RF requirement parts for Rel-18 ATG maintenance and Rel-19 ATG enhancement and corresponds to agenda 5.8.1, 8.10.1 and 8.10.2.*

*Previous approved WF are listed as below:*

* *R4-2406594, WF on Rel-19 ATG UE requirements, CMCC, RAN4#110 bis*
* *R4-2410687, WF on Rel-19 ATG UE RF requirements, CMCC, RAN4#111*

# Topic #1: R18 UE RF requirements maintenance

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411412**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411412.zip) | Apple | Reference sensitivity for is clarified for ATG UE with omni-directional antenna and antenna array.  Update antenna port to antenna connectors or TAB connectors |
| [**R4-2412942**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412942.zip) | Huawei, HiSilicon | According to the CR R4-2406592, the general clarificaiton on how to measure Tx requirements for ATG UE was removed. Based on the discussion paper R4-2409320, RAN4 need to clarify how to measure the Tx requirements referring to UL MIMO.  For ATG UE, it’s proposed to clarify how to measure the each of Tx requirements referring to UL MIMO. |
| [**R4-2413158**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413158.zip) | Apple | **Proposal 1: It is proposed that RAN4 adopt the requirement applicability rules as proposed in Table 2-1 for ATG UE.**  Table 2-1 Tx requirement applicability for ATG UE   |  |  | | --- | --- | | **Tx requirements for ATG UE** | **Requirement applicability** | | **6.2J Transmitter power for ATG** |  | | 6.2J.1 UE maximum output power for ATG | **Defined as the sum of all antenna connectors or TAB connectors and terminologies have been introduced in [3]** | | 6.2J.2 Configured transmitted power for ATG | **Defined as the sum of all antenna connectors or TAB connectors and terminologies have been introduced in [3]** | | **6.3J Output power dynamics for ATG** |  | | 6.3J.1 Minimum output power for ATG | **Defined as the sum of all antenna connectors or TAB connectors** | | 6.3J.2 Transmit OFF power for ATG | **Defined as the sum of all antenna connectors or TAB connectors** | | 6.3J.3 Transmit ON/OFF time mask for ATG | **Defined as the sum of all antenna connectors or TAB connectors for ON/OFF power measurement** | | 6.3J.4 Power control for ATG | **Defined as the sum of all antenna connectors or TAB connectors** | | **6.4J Transmit signal quality for ATG** |  | | 6.4J.1 Frequency error for ATG | Defined at each antenna connector or TAB connector | | 6.4J.2 Transmit modulation quality for ATG | Defined at each antenna connector or TAB connector | | **6.5J Output RF spectrum emissions for ATG** |  | | 6.5J.1 Occupied bandwidth for ATG | **Defined as the sum of all antenna connectors or TAB connectors when measuring power.** | | 6.5J.2 Out of band emission for ATG | **Defined as the sum of all antenna connectors or TAB connectors** | | 6.5J.3 Spurious emissions for ATG | **Defined as the sum of all antenna connectors or TAB connectors** | |

## Open issues summary

This corresponds to item 5.8.1.

### Sub-topic 1-1 Tx requirements applicability

It has been agreed in R4-2410739 that the Tx power related requirement will be specified as the sum of all antenna connectors including UE maximum output power and configured transmitted power. While the applicability for other requirements remains open.

**Issue 1-1: Tx requirements applicability for ATG Tx requirements for two types of antenna**

* Proposals

Table 2 Tx requirements definition for two types of ATG UE antenna

|  |  |  |
| --- | --- | --- |
| **Tx requirements for ATG UE** | **The definition for Tx requirements** (Defined as the **sum of all antenna connectors/TAB connectors** or **at each antenna connector/TAB connector)** | |
| **APPLE** | **Huawei** |
| **6.3J Output power dynamics for ATG** |  |  |
| 6.3J.1 Minimum output power for ATG | **Defined as the sum of all antenna connectors/TAB connectors** | **Defined as the sum of all transmit connectors** |
| 6.3J.2 Transmit OFF power for ATG | Defined at each antenna connector/TAB connector | Defined at each antenna connector |
| 6.3J.3 Transmit ON/OFF time mask for ATG | Defined at each antenna connector/TAB connector | Defined at each antenna connector |
| 6.3J.4 Power control for ATG | **Defined as the sum of all antenna connectors/TAB connectors** | **Defined as the sum of all transmit antenna connectors in closed-loop spatial multiplexing scheme** |
| **6.4J Transmit signal quality for ATG** |  |  |
| 6.4J.1 Frequency error for ATG | Defined at each antenna connector/TAB connector | Defined at each antenna connector |
| 6.4J.2 Transmit modulation quality for ATG | TBD | Defined at each antenna connector |
| **6.5J Output RF spectrum emissions for ATG** |  |  |
| 6.5J.1 Occupied bandwidth for ATG | **Defined as the sum of all antenna connectors/TAB connectors** | **Defined as the sum of all antenna connectors** |
| 6.5J.2 Out of band emission for ATG | **Defined as the sum of all antenna connectors/TAB connectors** | **Defined as the sum of all antenna connectors** |
| 6.5J.3 Spurious emissions for ATG | **Defined as the sum of all antenna connectors/TAB connectors** | **Defined as the sum of all antenna connectors** |

Moderator note: the difference between proposals from APPLE and Huawei are highlighted by yellow. Following list the recommended WF from moderator, we can discuss one by one.

1. There is two types of antenna type for R18 ATG UE. For omni-direction antenna, the requirements should be measured at antenna connectors but for antenna array, the requirements should be measured at TAB connectors.
2. Following requirements are defined as the sum of all antenna connectors/TAB connectors

* 6.3J.1 Minimum output power for ATG
* 6.3J.4 Power control for ATG
* 6.5J.1 Occupied bandwidth for ATG
* 6.5J.2 Out of band emission for ATG
* 6.5J.3 Spurious emissions for ATG

1. Following requirements are defined at each antenna connector/TAB connector

* 6.3J.2 Transmit OFF power for ATG
* 6.3J.3 Transmit ON/OFF time mask for ATG
* 6.4J.1 Frequency error for ATG
* EVM requirements

1. FFS for following requirements

* 6.3J.4 Power control for ATG
  + FFS do we need to emphasize “in closed-loop spatial multiplexing scheme”
* Transmit modulation quality for ATG

ZTE: frequency error should be measured per layer instead of per TRP. For occupied bandwidth, it should be specified for each connecter rather than sum of connector.

### Sub-topic 1-2 recommendation for the formal CR provided in this meeting

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** | **recommendation** |
| [**R4-2411412**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411412.zip)  Formal CR | Apple | Updated sub-clause includes: 7.2J; 7.3J | agreed |
| [**R4-2412942**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412942.zip)  Formal CR | Huawei, HiSilicon | Updated sub-clause includes: 6.3J, 6.4J, 6.5J, | Needs to be updated based on conclusion from topic 1-1 |

# Topic #2: R19 UE RF for intra-band contiguous CA

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411728**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411728.zip) | CMCC | **Proposal 1: Use the following BCS for CA\_n79C.**  **Table 1: BCS for CA\_n79C**   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **NR CA configuration / Bandwidth combination set** | | | | | | | | | | **NR CA configuration** | **Uplink CA configurations or single uplink carrier5** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Maximum aggregated  bandwidth (MHz)** | **Bandwidth combination set** | | CA\_n79C | CA\_n79C | 50 | 60, 80, 100 |  |  |  | 200 | 0 | |  |  | 60 | 60, 80, 100 |  |  |  |  |  | |  |  | 80 | 80, 100 |  |  |  |  |  | |  |  | 100 | 100 |  |  |  |  |  | |  |  | See n79 channel bandwidths in Table 5.3.5-1 for each carrier2 | |  |  |  | 200 | 4 and 5 |   **Proposal 2: The ACS principle and requirements in clause 7.5A.1 for intra-band contiguous CA could be reused except for the test parameters case 2, and case 2 could be defined as Table 3.**  **Table 3: Test parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 2**   |  |  |  | | --- | --- | --- | | **Rx Parameter** | **Units** | **NR CA bandwidth class** | |  |  | **C** | | Pw in Transmission Bandwidth Configuration, per CC | dBm | -73.54  -61.55 | | PInterferer | dBm | -424  -305 | | BWInterferer | MHz | BWchannel CA | | FInterferer (offset) | MHz | BWchannel CA  /  -BWchannel CA | | NOTE 1: The transmitter shall be set to 24 dB below PCMAX\_L,f,c at the minimum UL configuration specified in Table 7.3.2-3 with PCMAX\_L,f,c defined in clause 6.2.4.  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with an SCS equal to that of the closest carrier.  NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1.  NOTE 4: Pinterferer shall be set to -42dBm for omni-directional antenna.  NOTE 5: Pinterferer shall be set to -30dBm for antenna array. | | | |
| [**R4-2412701**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412701.zip) | ZTE Corporation, Sanechips | **Proposal 1**: use BCS0 for band combination n79C if there are no practical market demand for 10/20/30/70MHz channel bandwidth.  **Proposal 2**: for RF requirements for inter-band DL CA, refer to the proposals in table 2. |
| [**R4-2412954**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412954.zip) | Huawei, HiSilicon | **Proposal 1: RAN4 can discuss the following solutions based on whether to support CA\_n79C\_BCS4&5 for ATG UE in Rel-19.**  **Option 1: if RAN4 decides not to support CA\_n79C\_BCS4&5 for ATG UE, RAN4 can clarify the applicability of BCS4/5 for ATG UE** **in the existing configuration table. But don’t create a new separate configuration table for ATG UE supporting CA.**  **Option 2: if RAN4 decides to support CA\_n79C\_BCS4&5 for ATG UE, RAN4 can reuse the existing configuration table for ATG UE supporting DL CA\_n79C.** |
| [**R4-2413264**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413264.zip) | Ericsson | [Proposal 1 To fully enable the bandwidth usage, BCS 0, 4, and 5 should be supported for CA\_n79C](#_Toc174131758)  [Proposal 2 ACS case 2 needs to be updated. Particularly Power in transmission bandwidth configuration, per CC needs to be scaled according to the ATG UE maximum input level.](#_Toc174131759) |
| [**R4-2413262**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413262.zip) | Qualcomm Incorporated | **Proposal 1: BCS4 and BCS5 can be applied for ATG UE. Whether to specify BCS4 and BCS5 for DL CA\_n79C is dependent on operator’s request. BCS4/BCS5 shall be requested together, but BCS5 can’t be reported together with BCS4.**  **Proposal 2: New capability is needed for UE antenna type which is per band combination. The signal is optional that means by default the same UE antenna type per band would apply for that band in a band combination.**  **Proposal 3: Not allow n39 UL for CA\_n3A-n39A for ATG UE.**  **Proposal 4: To specify BCS0 for CA\_n3A-n39A.**  **Proposal 5: ULFPTx mode for UL-MIMO is NOT supported for ATG UE.** |

## Open issues summary

This corresponds to agenda 10.8.2.1

### Sub-topic 2-1 system parameters

Last meeting agreements are listed as below

|  |
| --- |
| **Issue 2-1-1: BCS for DL CA\_n79C**  Agreement:   * Reuse the existing BCS table for ATG * Clarify that uplink CA is not supported for ATG UE elsewhere for Rel-19 * FFS on whether BCS#4 and #5 are not supported for ATG UE for Rel-19   **Issue 2-1-2: whether/how to reflect operation band information in spec**  Agreement:   * The information that only DL CA is supported in Rel-19 for ATG can be reflected in the clause of operating band for ATG |

**Issue 2-1: BCS for DL CA\_n79C**

* Proposals
  + Option 1: use BCS0 for band combination n79C if there are no practical market demand for 10/20/30/70MHz channel bandwidth. (ZTE)
  + Option 2: BCS 4 and 5 also needs to be specified besides BCS0. (CMCC, Ericsson, Qualcomm)
    - Whether to specify BCS4 and BCS5 for DL CA\_n79C is dependent on operator’s request. BCS4/BCS5 shall be requested together, but BCS5 can’t be reported together with BCS4. (Qualcomm)

ZTE: we did not see the request for 10/20/30/70MHz. That is the reason for us to request BCS0.

CMCC: We do not preclude them.

Agreement:

* BCS 4 and 5 also needs to be specified besides BCS0.

**Table 1: BCS for CA\_n79C**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NR CA configuration / Bandwidth combination set** | | | | | | | | |
| **NR CA configuration** | **Uplink CA configurations or single uplink carrier5** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Channel bandwidths for carrier (MHz)** | **Maximum aggregated  bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n79C | CA\_n79C | 50 | 60, 80, 100 |  |  |  | 200 | 0 |
|  |  | 60 | 60, 80, 100 |  |  |  |  |  |
|  |  | 80 | 80, 100 |  |  |  |  |  |
|  |  | 100 | 100 |  |  |  |  |  |
|  |  | See n79 channel bandwidths in Table 5.3.5-1 for each carrier2 | |  |  |  | 200 | 4 and 5 |

* + Option 3:RAN4 can discuss the following solutions based on whether to support CA\_n79C\_BCS4&5 for ATG UE in Rel-19. (Huawei)
    - Option 3-1: if RAN4 decides not to support CA\_n79C\_BCS4&5 for ATG UE, RAN4 can clarify the applicability of BCS4/5 for ATG UE in the existing configuration table. But don’t create a new separate configuration table for ATG UE supporting CA.
    - Option 3-2: if RAN4 decides to support CA\_n79C\_BCS4&5 for ATG UE, RAN4 can reuse the existing configuration table for ATG UE supporting DL CA\_n79C.
* Recommended WF

*It’s suggested to first focus on option 1 and option 2 discussion and then discuss option 3 based on conclusion of option 1/option 2.*

### Sub-topic 2-2 ACS testing parameters for case 2

Last meeting agreements are listed as below

|  |
| --- |
| **Issue 2-2: ATG Rx requirements applicability**  Agreement:   * Following requirements needs to be updated for ATG CA compared with TN CA.   + Max input level (approved in last meeting)   + ACS testing case 2 * Following requirements can reuse legacy TN CA requirements   + Blocking including in-band and out of band blocking, narrow-band blocking   + REFSENSE   + Spurious response   + Intermodulation * Following requirement is not applicable for ATG CA   + No CA Rx Spurious emission   + No CA narrow-band blocking * Following single carrier requirement of ATG is enough and no need to define ATG CA specific requirements   + diversity characteristics requirement   **Issue 2-4: ACS testing parameters for case 2**  Agreement:  the principle of TN contiguous CA could be reused |

**Issue 2-2: ACS testing parameters for case 2**

* Proposals
  + Option 1: The ACS principle and requirements in clause 7.5A.1 for intra-band contiguous CA could be reused except for the test parameters case 2, and case 2 could be defined as Table 3. (CMCC)

**Table 3: Test parameters for intra-band contiguous CA with FDL\_low ≥ 3300 MHz and FUL\_low ≥ 3300 MHz, case 2**

|  |  |  |
| --- | --- | --- |
| **Rx Parameter** | **Units** | **NR CA bandwidth class** |
|  |  | **C** |
| Pw in Transmission Bandwidth Configuration, per CC | dBm | -73.54  -61.55 |
| PInterferer | dBm | -424  -305 |
| BWInterferer | MHz | BWchannel CA |
| FInterferer (offset) | MHz | BWchannel CA  /  -BWchannel CA |
| NOTE 1: The transmitter shall be set to 24 dB below PCMAX\_L,f,c at the minimum UL configuration specified in Table 7.3.2-3 with PCMAX\_L,f,c defined in clause 6.2.4.  NOTE 2: The absolute value of the interferer offset Finterferer (offset) shall be further adjusted to MHz with SCS the sub-carrier spacing of the carrier closest to the interferer in MHz. The interferer is an NR signal with an SCS equal to that of the closest carrier.  NOTE 3: The interferer consists of the RMC specified in Annexes A.3.2.2 and A.3.3.2 with one sided dynamic OCNG Pattern OP.1 FDD/TDD for the DL-signal as described in Annex A.5.1.1/A.5.2.1.  NOTE 4: Pinterferer shall be set to -42dBm for omni-directional antenna.  NOTE 5: Pinterferer shall be set to -30dBm for antenna array. | | |

* + Option 2: ACS case 2 needs to be updated. Particularly Power in transmission bandwidth configuration, per CC needs to be scaled according to the ATG UE maximum input level. (Ericsson)
* Recommended WF:
  + Further check option 1.

# Topic #3: R19 UE RF for inter-band CA

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411727**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411727.zip) | CMCC | **Proposal 1: CA\_n3-n39 with DL n39 should not be precluded.**  **Proposal 2: Table 1 as the starting point for BCS of CA\_n3A-n39A.**  **Table 1: BCS for CA\_n3A-n39A**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **NR CA configuration** | **Uplink CA configuration or single uplink carrier** | **NR Band** | **Channel bandwidth (MHz)** | **Bandwidth combination set** | | CA\_n3A-n39A | - | n3 | 5, 10, 15, 20, 25, 30 | 0 | |  |  | n39 | 5, 10, 15, 20, 25, 30, 35, 40 |  |   **Proposal 3: Omni-antenna type could be assumed for both band n3 and n39 in DL CA\_n3-n39.**  **Proposal 4: No need to define new capability for ATG CA.**  **Proposal 5: delta RIB in TS 38.101-1 could be used as the baseline.**  **Proposal 6: RF architecture for CA\_n3-n39 on CPE should be first discussed clearly before discussing MSD value.**  **Proposal 7: OOB blocking requirements could be reused, and there is no need to specify OOB blocking exception for CA\_n3-n39.** |
| [**R4-2412702**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412702.zip) | ZTE Corporation, Sanechips | **Observation 1: assume the antenna type for CA\_n3-n39 as omnidirectional antenna.**  **Proposal 1: antenna type for certain band combinations should be discussed case by case.**  **Proposal 2. The BCS for inter-band DL CA\_n3A-n39A is proposed in table 1.**  Table 1. Supported bandwidths per CA band combination of band n3+n39   |  |  |  |  |  | | --- | --- | --- | --- | --- | | NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set | | CA\_n3A-n39AX | - | n3 | 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 | 0 | |  |  | n39 | 5, 10, 15, 20, 25, 30, 35, 40 |  | | NOTE X: Uplink is only in n3 for CA\_n3-n39 | | | | |   **Proposal 3**: for RF requirements for inter-band DL CA, refer to the proposals in table 2. |
| [**R4-2412955**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412955.zip) | Huawei, HiSilicon | **Observation 1: if WG is targeted to introduce UL configuration in band n39 for DL CA\_n3-n39, the frequency gap between DL band n3 and band n39 should be assumed and considered in the real implementation as the transition guard band for the filter to protect each other.**  **Observation 2: it is possible to enable DL CA\_n3-n39 with UL in either band n3 or n39 by implementing partial frequency range filter from technical perspective with common antenna or separate antenna.**  **Proposal 1: it’s allowed to achieve n39 UL for CA\_n3A-n39A with 5MHz frequency gap in band n39.** |
| [**R4-2413262**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413262.zip) | Qualcomm Incorporated | **Proposal 1: BCS4 and BCS5 can be applied for ATG UE. Whether to specify BCS4 and BCS5 for DL CA\_n79C is dependent on operator’s request. BCS4/BCS5 shall be requested together, but BCS5 can’t be reported together with BCS4.**  **Proposal 2: New capability is needed for UE antenna type which is per band combination. The signal is optional that means by default the same UE antenna type per band would apply for that band in a band combination.**  **Proposal 3: Not allow n39 UL for CA\_n3A-n39A for ATG UE.**  **Proposal 4: To specify BCS0 for CA\_n3A-n39A.**  **Proposal 5: ULFPTx mode for UL-MIMO is NOT supported for ATG UE.** |
| [**R4-2413265**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413265.zip) | Ericsson | [Proposal 1 Omni-directional antenna type can be assumed for band n3 and n39 in DL CA\_n3-n39.](#_Toc174095722)  [Proposal 2 BCS 0, 4, and 5 should be supported for DL CA\_n3-n39](#_Toc174095723)  [Proposal 3 FDD band n3 serves as PCell and TDD band n39 could serve as SCell while n39 is configured as DL to avoid interference with the n3 DL.](#_Toc174095724)  [Proposal 4 No OOB exception for CA\_n3A-n39A](#_Toc174095725) |

## Open issues summary

This corresponds to agenda 8.10.2.2.

### Sub-topic 3-1 antenna type assumption for inter-band DL CA\_n3-n39

Last meeting agreements are listed as below:

|  |
| --- |
| **Issue 3-1: clarify the antenna type for each band for inter-band CA**  Agreement:   * No limitation on antenna types for ATG CA * FFS on whether to assume omni-antenna type can be assumed for both band n3 and n39 in DL CA\_n3-n39 * FFS on whether new capability is needed for ATG CA |

**Issue 3-1-1: clarify the antenna type for DL CA\_n3-n39**

* Proposals
  + Option 1: Omni-antenna type can be assumed for both band n3 and n39 in DL CA\_n3-n39. (CMCC, ZTE, Ericsson)
* Recommended WF
  + Option 1

Qualcomm: Why do we have agreement here? Whether to apply the antenna type per band per BC. If we have such assumption, we do not have any impact on core requirement. We do not need such agreement.

ZTE: tend to agree with Qualcomm. We do not need such agreement.

Agreement: Omni-antenna type can be assumed for both band n3 and n39.

**Issue 3-1-2: whether new capability is needed for ATG CA**

* Proposals
  + Option 1: no need for new capability. (CMCC)
  + Option 2: New capability is needed for UE antenna type which is per band combination. The signal is optional that means by default the same UE antenna type per band would apply for that band in a band combination. (Qualcomm)
* Recommended WF
  + TBA.

**Agreement:**

* no need for new capability for UE antenna type for ATG CA
  + Antenna type per band could be applied to the same band in the band combination.

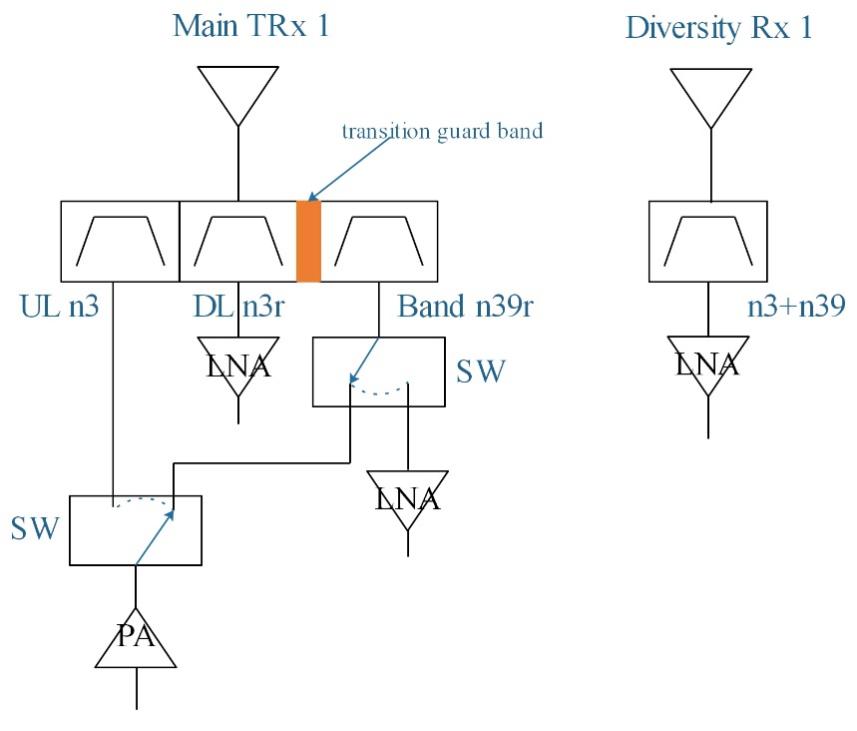
### Sub-topic 3-2 RF implementation for inter-band CA\_n3A-n39A

Last meeting agreements are listed as below:

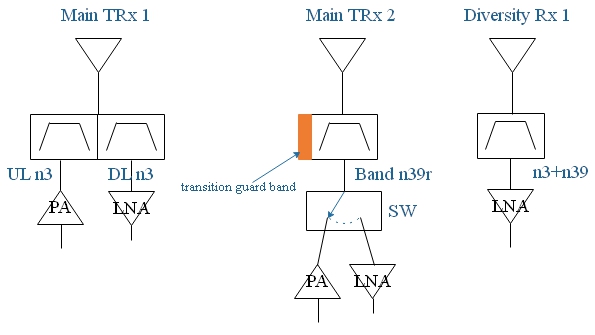
|  |
| --- |
| **Issue 3-2-1: whether to allow n39 UL for CA\_n3A-n39A**  Agreement:   * FFS on whether to allow n39 UL for CA\_n3A-n39A |

**Issue 3-2-1: whether to allow n39 UL for CA\_n3A-n39A**

* Proposals
  + Option 1: not allow n39 UL for CA\_n3-n39 (ZTE, Qualcomm, Ericsson)
    - FDD band n3 serves as PCell and TDD band n39 could serve as SCell while n39 is configured as DL to avoid interference with the n3 DL(Ericsson).
  + Option 2: allow n39 UL for CA\_n3A-n39A (CMCC, Huawei)
    - with 5MHz frequency gap in band n39. (Huawei)
      * Candidate RF architecture with common antenna for DL CA\_n3-n39 with UL in either band n3 or n39. (Huawei)



* + - * Candidate RF architecture with separate antenna for DL CA\_n3-n39 with UL in either band n3 or n39. (Huawei)



* Recommended WF
  + TBA

**Qualcomm: there is similar issue discussed for handheld UE. We prefer not to repeat the discussion and we can use the same conclusion that uplink is not allowed on n39.**

**CMCC: The difference allows to relax the requirement for n39 with gap band.**

**ZTE: Tend to agree with Qualcomm and agree option 1 as baseline.**

**Huawei: We need make the target clear. We have discussed this issue for two meetings. The objective for RAN4 is not to preclude any uplink in the band. For the solutions, we can further discuss them.**

**Ericsson: ATG UE is different type UE with more isolation. We need more study.**

### Sub-topic 3-3 BCS for inter-band CA\_n3A-n39A

**Last meeting agreement is listed as below:**

|  |
| --- |
| **Issue 3-3: BCS for DL CA\_n3\_n39**  Agreement:   * FFS on BCS for DL CA\_n3\_n39 |

**Issue 3-3: BCS for DL CA\_n3\_n39**

* Proposals
  + Option 1: (CMCC, Qualcomm)

**Table 1: BCS for CA\_n3A-n39A**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA configuration** | **Uplink CA configuration or single uplink carrier** | **NR Band** | **Channel bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n3A-n39A | - | n3 | 5, 10, 15, 20, 25, 30 | 0 |
|  |  | n39 | 5, 10, 15, 20, 25, 30, 35, 40 |  |

* + Option 2: (ZTE)

Table 1. Supported bandwidths per CA band combination of band n3+n39

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n3A-n39AX | - | n3 | 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 | 0 |
|  |  | n39 | 5, 10, 15, 20, 25, 30, 35, 40 |  |
| NOTE X: Uplink is only in n3 for CA\_n3-n39 | | | | |

* + Option 3: BCS 0, 4, and 5 should be supported for DL CA\_n3-n39 (Ericsson)

Noted: NR CA\_n3-n39 doesn’t support BCS 4 and 5 in current NR spec.

* Recommended WF
  + Option 1 to be aligned with current NR spec for CA\_n3-n39

Agreement:

**Table 1: BCS for CA\_n3A-n39A**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA configuration** | **Uplink CA configuration or single uplink carrier** | **NR Band** | **Channel bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n3A-n39A | - | n3 | 5, 10, 15, 20, 25, 30 | 0 |
|  |  | n39 | 5, 10, 15, 20, 25, 30, 35, 40 |  |

### Sub-topic 3-4 Rx requirement for inter-band CA\_n3A-n39A

Last meeting agreements are listed as below for information

|  |
| --- |
| **Issue 3-4-1: ATG Rx requirements applicability**  Agreement:   * Following requirements needs further analysis:   + delta RIB,   + MSD,   + Diversity requirements     - FFS whether current ATG single carrier requirement is enough * legacy inter-band CA requirements applies for following requirements while each CC shall meet the ATG UE requirement for single CC   + REFSENSE   + Max input level   + ACS   + in-band blocking   + out of band blocking     - FFS whether no OOB exception for CA\_n3A-n39A   + spurious response   + wide band intermodulation   + spurious emissions * Following requirements are not applicable   + Narrow band blocking |

**Issue 3-4-1: delta RIB for CA\_n3A-n39A**

* Proposals
  + Option 1: delta RIB for NR CA\_n3A-n39A could be used as the baseline (CMCC, ZTE)

Table 3: ΔRIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA combination | ΔRIB,c for NR bands (dB)\* | |
| Component band in order of bands in configuration\*\* | |
| CA\_n3-n39 | - | - |
| NOTE \*: “-” denotes ΔRIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands, such as for CA\_n1-n77 the band order from left to right is n1 and n77. | | |

* Recommended WF
  + Further check option 1

Agreement:

* + delta RIB for NR CA\_n3A-n39A could be used as the baseline

Table 3: ΔRIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA combination | ΔRIB,c for NR bands (dB)\* | |
| Component band in order of bands in configuration\*\* | |
| CA\_n3-n39 | - | - |
| NOTE \*: “-” denotes ΔRIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands, such as for CA\_n1-n77 the band order from left to right is n1 and n77. | | |

**Issue 3-4-2: MSD for CA\_n3A-n39A**

* Proposals
  + Option 1: RF architecture for CA\_n3-n39 on CPE should be first discussed clearly before discussing MSD value. (CMCC)
  + Option 2: The MSD for CA\_n3-n39 captured in TR 38.718-02-01 clause 5.90 could be reused for ATG. (ZTE)
* Recommended WF
  + Separate MSD requirements for supporting n39 UL and not supporting n39 UL.
  + For not supporting n39 UL, further check whether the MSD in TR 38.718-02-01 clause 5.90 could be reused
  + For supporting n39 UL, wait for conclusion of topic 3-2

Qualcomm: the first bullet implies that we will have two sets of requriements and we can further discuss it.

Huawei: the requirement depends on handheld UE. No need MSD for ATG.

**Issue 3-2-1: OOB exception for CA\_n3A-n39A**

* Proposals
  + Option 1: no need to specify OOB blocking exception for CA\_n3-n39 (CMCC, ZTE, Ericsson)
* Recommended WF
  + No need to specify OOB blocking exception for CA\_n3-n39 since the second order intermodulation product of the n3 UL carrier and the CW interfering signal will not overlaps with the n39 DL carrier.

Agreement: No need to specify OOB blocking exception for CA\_n3-n39 since the second order intermodulation product of the n3 UL carrier and the CW interfering signal will not overlaps with the n39 DL carrier.

# Topic #4: R19 UE RF for UL-MIMO

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2413262**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413262.zip) | Qualcomm Incorporated | **Proposal 1: BCS4 and BCS5 can be applied for ATG UE. Whether to specify BCS4 and BCS5 for DL CA\_n79C is dependent on operator’s request. BCS4/BCS5 shall be requested together, but BCS5 can’t be reported together with BCS4.**  **Proposal 2: New capability is needed for UE antenna type which is per band combination. The signal is optional that means by default the same UE antenna type per band would apply for that band in a band combination.**  **Proposal 3: Not allow n39 UL for CA\_n3A-n39A for ATG UE.**  **Proposal 4: To specify BCS0 for CA\_n3A-n39A.**  **Proposal 5: ULFPTx mode for UL-MIMO is NOT supported for ATG UE.** |
| [**R4-2411729**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411729.zip) | CMCC | **Proposal 1: support ULFPTx mode for ATG UL-MIMO.**  **Proposal 2: Use the above Tables to modify the NR UL MIMO requirement with ATG capability antennaArrayType-r18.**  **Proposal 3: apply the coherent UL MIMO requirement for ATG UE.** |
| [**R4-2411876**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411876.zip) | LG Electronics | **Proposal 1: Consider ULFPTx mode for ATG UL-MIMO.** |
| [**R4-2412703**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412703.zip) | ZTE Corporation, Sanechips | **Proposal 1**: ULFPTx Mode is not relevant to this feature.  **Proposal 2** : Configured transmitted power for UL MIMO is per carrier, and it is not needed to define MPR/A-MPR requirements for ATG UE supporting UL MIMO[since there will be power tolerance requirement defined.]  **Proposal 3**: for the minimum output power, reuse the existing requirement in clause 6.3D.1 for two antenna ports for ATG UE with UL MIMO and preclude the single antenna port related requirement.  **Proposal 4**: for transmit OFF power, to reuse the existing requirements in clause 6.3D.2 for two antenna connectors.  **Proposal 5**: for transmit ON/OFF time mask for UL MIMO, to reuse the existing requirements in clause 6.3D.3 for two antenna connectors and preclude the single antenna port related requirement.  **Proposal 6**: for transmit signal quality, the general principle as described in 6.4D.1 could be reused for ATG UE supporting the UL MIMO.  **Proposal 7:**  For ATG UE(s) supporting UL MIMO, the basic measurement interval of modulated carrier frequency is 1 UL slot. The mean value of basic measurements of UE modulated carrier frequency per layer shall be accurate to within ± 0.1 PPM observed over a period of 1 ms of cumulated measurement intervals observed over a period of 1 ms of cumulated measurement intervals compared to ideally pre-compensated reference uplink carrier frequency.  NOTE 1: the ideally pre-compensated reference uplink carrier frequency consists of the UL carrier frequency signalled to the UE by ATG BS and UL precompensated doppler frequency shift.  NOTE 2: UE shall rely on the ATG BS location broadcasted by the [ATG specific SIB] in 38.331.  **Proposal 8**: for transmit modulation quality for UL MIMO, reuse the existing requirements in clause 6.4D.2 for two antenna connectors and preclude the single antenna port related requirement.  **Proposal 9**: for TAE requirement for UL MIMO, reuse the existing requirement in clause 6.4D.3.  **Proposal 10**: don’t apply the coherent UL MIMO requirement for ATG UE.  **Proposal 11**: for OBW, reuse the existing requirement for two antenna ports in clause 6.5D.1 for ATG UE.  **Proposal 12**: for out of band emission, to reuse the existing requirement in 6.5D.2 with the emission requirement referring to subclause 6.5J.2.  **Proposal 13**: for transmitter spurious emission, to reuse the existing requirement in 6.5D.3 for two antenna connectors and preclude the single port related requirements.  **Proposal 14**: for transmitter intermodulation requirements, to reuse the existing requirement in 6.5D.4 for two antenna connectors and preclude the single port related requirements.  **Proposal 15**: for REFSENS requirements, reuse the same REFSENS requirement as specified 7.3J.  **Proposal 16**: for maximum input power, reuse the same maximum input power requirement as specified 7.4J.  **Proposal 17**: for ACS requirement, reuse the same ACS requirement as specified 7.5J.  **Proposal 18**: for blocking requirement, reuse the same blocking requirement as specified 7.6J.  **Proposal 19**:for receiver spurious response requirement, reuse the same spurious response requirement as specified 7.7J.  **Proposal 20**: for receiver intermodulation requirement, reuse the same Intermodulation characteristics requirement as specified 7.8J.  **Proposal 21:** if the legacy requirement for UL MIMO is defined as sum of measurements of all UE transmit antenna connectors, then for ATG UE with capability antennaArrayType-r18, the requirement should be defined as sum of all TAB connector including both polarization. If the legacy requirement for UL MIMO is defined as per antenna port or per layer, then for ATG UE with capability antennaArrayType-r18, the requirement should be defined as sum of all TAB connector per polarization or per layer. |
| [**R4-2412956**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412956.zip) | Huawei, HiSilicon | **Observation 1: Unless WG identify some benefits for ATG UE supporting ULFPTx mode, there is no need to extend ULFPTx mode to ATG UE.**  **Proposal 1: there is no need to apply coherent UL MIMO for ATG UE since only polarization diversity or multiplex is assumed for ATG UL MIMO.**  **Proposal 2: Don’t specify Rx requirements for UL-MIMO for ATG UE.** |
| [**R4-2413159**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413159.zip) | Apple | ***Proposal 1: ULFPTx mode is supported for ATG UE.***  ***Proposal 2: For ATG UE with omini-directional antenna, the requirement is applied at antenna connector or per layer. For ATG UE with antenna array, the requirement is applied at TAB connector or per layer.*** |
| [**R4-2413266**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413266.zip) | Ericsson | [Proposal 1 ULFPTx mode should be supported for ATG UL-MIMO](#_Toc174121580)  [Proposal 2 Reuse the existing NR UL-MIMO requirement for output power dynamic, transmit signal quality, and output RF spectrum emissions, and do not exclude the single antenna port requirement.](#_Toc174121581)  [Proposal 3 Apply the coherent UL MIMO requirement for ATG UE.](#_Toc174121582)  [Proposal 4 Reuse the requirements defined in ATG UE for the following requirements: Reference sensitivity for UL MIMO, Maximum input level for UL MIMO, Adjacent channel selectivity for UL MIMO, Blocking characteristics for UL MIMO, Spurious response for UL MIMO, Intermodulation characteristics for UL MIMO.](#_Toc174121583) |

## Open issues summary

This corresponds to agenda 8.10.2.3.

### Sub-topic 4-1 UL MIMO General requirements

Last meeting agreements are listed as below:

|  |
| --- |
| **Issue 4-1-1: ULFPTx mode for UL-MIMO**  Agreement:   * FFS on whether ULFPTx mode for UL-MIMO is supported for ATG UE |
| In NR, ULFPTx mode is specified for PC2 and PC1.5 as follows.   * Single layer for 2 Tx port & 4 Tx port   + PC2/PC1.5 * 2 layers for 4 Tx port   + PC1.5 |

**Issue 4-1-1: ULFPTx mode for UL-MIMO**

* Proposals
  + Option 1: no need to extend ULFPTx mode to ATG UE (Qualcomm, Huawei)
    - Unless WG identify some benefits for ATG UE supporting ULFPTx mode
  + Option 2: ULFPTx mode still applies for ATG UE to support different implementation (CMCC, LGE, APPLE, Ericsson)
* Recommended WF
  + TBD.

ZTE: we agree with option 1. ATG can transmit the higher power.

Ericsson: we have different understanding. ULFPTx guarantees that 1-layer is scheduled and one connector or combining two connectors are allowed.

CMCC: We have similar view as Ericsson. The capability makes uplink flexible.

Huawei: What is the impact if we go with option 2. For release 16 and 17, full power transmission is based on implementation. ATG may have different implementation. More Tx chains will be used.

Qualcomm: For ATG there is no power class.

**Issue 4-1-2: whether preclude the single antenna port related requirement**

* Proposals
  + Option 1: no
  + Option 2: yes
* Recommended WF
  + TBA

### Sub-topic 4-2 UL MIMO Tx requirements

Last meeting agreements are listed as below:

|  |
| --- |
| **Issue 4-2-1: how to modify the NR UL MIMO requirement with ATG capability antennaArrayType-r18**  Agreement:   * if the legacy requirement for UL MIMO is defined as sum of measurements of all UE transmit antenna connectors, then for ATG UE with capability antennaArrayType-r18, the requirement should be defined as sum of all TAB connector including both polarization. * If the legacy requirement for UL MIMO is defined as per antenna port or per layer, FFS |

**Issue 4-2-1: how to modify the NR UL MIMO requirement with ATG capability antennaArrayType-r18**

* Proposals:
  + Option 1: For ATG UE with omini-directional antenna, the requirement is applied at antenna connector or per layer. For ATG UE with antenna array, the requirement is applied at TAB connector or per layer. (APPLE)
  + Option 2: If the legacy requirement for UL MIMO is defined as per antenna port or per layer, then for ATG UE with capability antennaArrayType-r18, the requirement should be defined as sum of all TAB connector per polarization or per layer. (ZTE)
* Recommended WF
  + If the legacy requirement for UL MIMO is defined **at each antenna connector,**
    - For ATG UE with antenna array, the requirement should be updated at each TAB connector
  + If the legacy requirement for UL MIMO is defined **per layer, FFS**
    - Option 1: for ATG UE with capability antennaArrayType-r18, the requirement should be updated as **sum of all TAB connectors per layer**
    - Option 2: for ATG UE with capability antennaArrayType-r18, the requirement should be updated **per layer without explicitly emphasize the TAB connector**

Agreement:

* + If the legacy requirement for UL MIMO is defined **at each antenna connector,**
    - For ATG UE with antenna array, the requirement should be updated [at each TAB connector]
  + If the legacy requirement for UL MIMO is defined **per layer, FFS**
    - Option 1: for ATG UE with capability antennaArrayType-r18, the requirement should be updated as **sum of all TAB connectors per layer**
    - Option 2: for ATG UE with capability antennaArrayType-r18, the requirement should be updated **per layer without explicitly emphasize the TAB connector**

Following list the summary of requirement applicable reference point/measurement reference point for NR UL MIMO for information.

|  |  |
| --- | --- |
| **Tx requirements for UL MIMO** | **The definition for Tx requirements** (Defined as the **sum of all antenna connectors** or **at each antenna connector)** |
| **6.2D Transmitter power for UL MIMO** |  |
| 6.2D.1 UE maximum output power for UL MIMO | ULFPTx for UL MIMO, **Defined as the sum of all antenna connectors**  single antenna-port transmission **without indicating Tx diversity** with precoding matrix *W*=1, apply for at least one antenna connector  single antenna-port transmission **indicating Tx diversity** with precoding matrix *W*=1, **apply as the sum of all antenna connectors**  single antenna-port transmission with dual Tx indicating the feature *ul-FullPwrMode-r16* or *ul-FullPwrMode2-TPMIGroup-r16* with precoding matrix *W=1*, defined for at least one antenna connector |
| 6.2D.2 UE maximum output power reduction for UL MIMO | **Defined as the sum of all antenna connectors** |
| 6.2D.4 Configured transmitted power for UL MIMO | For UE supporting UL MIMO, the transmitted power is configured per each UE. |
| **6.3D Output power dynamics for UL MIMO** |  |
| 6.3D.1 Minimum output power for UL MIMO | **Defined as the sum of all antenna connectors** for single antenna-port transmission **indicating Tx diversity** with precoding matrix *W*=1 |
| 6.3D.2 Transmit OFF power for UL MIMO | Defined at each antenna connector |
| 6.3D.3 Transmit ON/OFF time mask for UL MIMO | Defined at each antenna connector |
| 6.3D.4 Power control for UL MIMO | **Defined as the sum of all antenna connectors** |
| **6.4D Transmit signal quality for UL MIMO** |  |
| 6.4D.0 General | defined per layer or as the sum of emissions from both antennas to account for the UL MIMO scheme |
| 6.4D.1 Frequency error for UL MIMO | per layer |
| 6.4D.2 Transmit modulation quality for UL MIMO |  |
| 6.4D.2.0 General | For UE supporting UL MIMO, the transmit modulation quality requirements are specified based on measurements made at each transmit antenna connector. |
| 6.4D.2.1 Error Vector Magnitude | per layer |
| 6.4D.2.2 Carrier leakage | per layer |
| 6.4D.2.3 In-band emissions | apply at each transmit antenna connector |
| 6.4D.2.4 EVM equalizer spectrum flatness for UL MIMO | per layer |
| **6.5D Output RF spectrum emissions for UL MIMO** |  |
| 6.5D.1 Occupied bandwidth for UL MIMO | **Defined as the sum of all antenna connectors** |
| 6.5D.2 Out of band emission for UL MIMO | **Defined as the sum of all antenna connectors** |
| 6.5D.3 Spurious emission for UL MIMO | **Defined as the sum of all antenna connectors** |
| 6.5D.4 Transmit intermodulation for UL MIMO | **Defined as the sum of all antenna connectors** |

**Issue 4-2-2: whether to apply coherent UL MIMO requirement for ATG UE**

* Proposals
  + Option 1: yes (CMCC, Ericsson)
    - coherent UL MIMO is an optional feature for the UE, it is generally desirable to allow as much implementation freedom as possible
  + Option 2: no (ZTE, Huawei)
* Recommended WF
  + TBA

### Sub-topic 4-3 UL MIMO Rx requirements

**Issue 4-3: receiver requirements**

* Proposals
  + Option 1: reuse ATG single carrier requirements for following Rx requirements (ZTE, Ericsson)
    - REFSENSE
    - Max input level
    - ACS
    - Blocking
    - Spurious emission
    - Intermodulation
  + Option 2: Don’t specify Rx requirements for UL-MIMO for ATG UE. (Huawei)
    - the Rx requirements have been defined or tested for general ATG UE, there is no need to repeat the same requirements under the UL MIMO scenario.
* Recommended WF
  + - Option 1
    - FFS whether to test the Rx requirements under the UL MIMO scenario since Rx requirements is the same for R18 ATG UE and R19 ATG UE supporting UL-MIMO.

Agreement:

* + reuse ATG single carrier requirements for following Rx requirements (ZTE, Ericsson)
    - REFSENSE
    - Max input level
    - ACS
    - Blocking
    - Spurious emission
    - Intermodulation
    - FFS whether to test the Rx requirements under the UL MIMO scenario since Rx requirements is the same for R18 ATG UE and R19 ATG UE supporting UL-MIMO.