**3GPP TSG-RAN WG4 Meeting # 108bis** **R4-2317341**

**Xiamen, China, October 09 - October 13, 2023**

**Title:** WF on RRM requirements for NR ATG

**Agenda Item:** 5.13.8

**Source:** CMCC

**Document for:** Approval

# **The wording inline is for your further check**

**The wording inline is for CR drafting information, will be removed in the final draft/formal version**

# General

**Issue 1-1: ATG UE feature**

**Proposals**

* Option 1: Introduce following ATG UE features:

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| Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| Uplink Time and Frequency pre-compensation and timing relationship enhancements | Support of UE specific TA calculation based on its GNSS-acquired position and the indicated BS location.For TA update in RRC\_CONNECTED state, support of combination of both open (i.e. UE autonomous TA estimation) and closed (i.e., received TA commands) control loopsSupport of pre-compensation of the calculated TA in its uplink transmissionsSupport of frequency pre-compensation to counter shift the Doppler experienced on the service linkSupport of determining timing of the scheduling of PUSCH, PUCCH and PDCCH ordered PRACH, CSI reference resource, transmission of aperiodic SRS activation of TA command, first PUSCH transmission in CG Type 2 with cell-specific K\_offset if indicatedSupport of UE receiving cell-specific K\_offset in system information |  | TBD | BandNR | No | No | An ATG UE is required to at least support UE specific TA and frequency calculation based at least on its GNSS-acquired position and the indicated BS locationNote: This UE feature group is applicable only for ATG operating bands | Optional with capability signallingFor UE supports NR communication via ATG, UE must indicate this FG is supported. |

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| Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| UE reporting of TA information  | Support UE reporting of TA information | TBD[Uplink Time and Frequency pre-compensation and timing relationship enhancements] | TBD | BandNR | No | No | Note: The exact content of UE reporting of information about the TA pre-compensation is up to RAN2Note: This UE feature group is applicable only for ATG operating bands | Optional with capability signalling  |
| UE-specific K\_offset  | Support of reception of UE-specific K\_offset via MAC-CESupport of determining the timing of PUSCH, PUCCH, CSI reference resource, transmission of aperiodic SRS, activation of TA command, first PUSCH transmission in CG Type 2 with UE-specific Koffset | TBD[Uplink Time and Frequency pre-compensation and timing relationship enhancementsAnd UE reporting of information related to TA pre-compensation] | TBD | BandNR | No | No | Note: This UE feature group is applicable only for ATG operating bands | Optional with capability signalling |

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| Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| Increasing the number of HARQ processes | The maximal supported HARQ process number is X for UL and Y for DL |  | TBD | BandNR | No | No | Candidate component values for (X,Y): {(16,32),(32,16),(32,32)}Note: This UE feature group is applicable only for ATG operating bands | Optional with capability signalling |
| K1 range extension | Support of extended K1 value range of (0..31) for unpaired spectrum |  | TBD | BandNR | No | No | Note: This UE feature group is applicable only for ATG operating bands | Optional with capability signalling  |

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| Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| Location based CHO | Indicates whether the UE supports location based CHO | condHandover-r16 is set for ATG bands. | TBD | BandNR | No | No | UE shall set the capability value consistently for all ATG operating bands. | Optional with capability signalling |
| Event A4 based CHO | Indicates whether the UE supports Event A4 based CHO | condHandover-r16 is set for ATG bands. | TBD | BandNR | No | No | UE shall set the capability value consistently for all ATG operating bands. | Optional with capability signalling |
| Location-based measurement report trigger | Indicates whether the UE supports location-based triggered measurement reporting (i.e., event D1) | TBD[Location based CHO] | TBD | MeasAndMobParametersCommon | No | No |  | Optional with capability signalling |

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| Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| SR triggered by a TA report | Indicates whether the UE supports triggering of SR when a TA report is triggered and there are no available UL-SCH resources.  |  | TBD | MAC-ParametersCommon | No | No |  | Optional with capability signalling |
| TA reporting during initial access | It is mandatory to support TA reporting during initial access for UEs supporting uplink-TA-Reporting-r17 as specified in TS 38.321 [10]. |  | n/a | n/a | n/a | n/a |  | Conditional mandatory without capability signalling |

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| Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| RRC\_INACTIVE in ATG | Indicates whether the UE supports RRC\_INACTIVE in ATG |  | TBD | TBD | No | No |  | Conditional mandatory with capability signalling |

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| Feature group | Components | Prerequisite feature groups | Field name in TS 38.331 [2] | Parent IE in TS 38.331 [2] | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Note | Mandatory/Optional |
| Enhanced RRM requirements for measurements in IDLE and INACTIVE modes | If UE does not support the capability, other ATG measurement requirements (as specified in TS 38.133, clause 4.2X.2) are applied. |  | n/a | n/a | No | No |  | Optional without capability signaling |

# Maintenance

**The wording inline is information for CR drafting, will be removed in the final formal version**

**Issue 1-2: Specification documentation**

* For the ATG requirements, revise the current ATG clauses which could directly refer to legacy clauses with additional note (if needed) to clarify that the legacy requirements shall apply only for FR1 and NR SA operation mode without considering CA/DC and inter RAT measurement.

**Issue 2-1: Remove the square brackets**

* Keep the square brackets for UE with antenna array and UE with omnidirectional antennas as it is, further refine the spec in the next meeting, based on the alignment with RF spec.

**Issue 2-4: Requirement applicability for CHO requirement**

* For CHO requirements, it should be applicable even if UE doesn’t have the valid and applicable parameters of BS location information and Koffset for target NR cell.

**Issue 2-2: Tsearch in HO requirements for UE with antenna array**

**Agreement**

* For HO requirements, when network assistance on ATG unknown target cell’s reference BS locations is provided,
	+ the Tsearch should be scaled with scaling factor N= 2
* For HO requirements, when network assistance on ATG unknown target cell’s reference BS locations is not provided,
	+ the Tsearch should be scaled with scaling factor N=4

**Issue 2-5: Tidentify\_intra\_NR in RRC Re-establishment delay requirement for UE with antenna array**

**Agreement**

* Scaling factor is not needed for known cell
* Scaling factor for unknown cell
	+ When network assistance on ATG cells reference location of the target cell is provided to UE, N = 3
	+ Otherwise, N = 4

**Issue 3-1: validity timer for ATG**

**Agreement**

* Keep [] for validity timer and wait for RAN2 conclusion.

**Issue 4-1: Sharing factor for L1 measurements**

**Agreement**

* P value for an L1-RS resource to be measured is defined as
	+ Psharing factor \* Ntotal / Noutside\_MG with Navailable = 0
	+ Ntotal / Navailable with Navailable > 0
		- For a window W of duration max(TL1, MGRPmax), where MGRPmax is the maximum MGRP across all configured per-UE measurement gaps and per-FR1 measurement gaps, and starting at the beginning of any L1-RS resource occasion:
		- Ntotal is the total number of L1-RS resource occasions within the window, including those overlapped with measurement gap occasions or SMTC occasions within the window W, and
		- Noutside\_MG is the number of L1-RS resource occasions that are not overlapped with any measurement gap occasion within the window W
		- Navailable is
			* the number of L1-RS resource occasions that are not overlapped with any measurement gap occasion nor any SMTC occasion within the window W
		- TL1 is periodicity of the target L1-RS
		- Psharing factor = 3.

**Issue 5-1: Phase antenna array impact for L3 measurements**

**Agreement**

* For inter-frequency L3 measurements of ATG UE with antenna array
	+ N = 3 for the case when network assistance on ATG cells reference BS locations is provided
	+ N= 4 otherwise

**Issue 5-2: If any additional UE capability is needed for ATG UEs with [antenna arrays]**

**Proposals**

* Option 1: No capability is needed for ATG UE to support antenna arrays in FR1 4GHz.
* Option 2: Define a UE capability to differentiate UE with [omnidirectional antennas] and UE with [antenna arrays].
* Option 3: For the band n79 capable UE, it works with phase antenna array by default at band n79.
	+ Regarding the antenna assumption, phase antenna array is tied with band n79, and omni-antenna is tied with other ATG bands.
* Other Options are not precluded.

**Issue 5-3: Clear description of behavior for UE with antenna arrays when network assistance on ATG cells reference location is provided**

**Agreement**

* UE shall be able to form a beam based on the reference location

# ATG RRM performance requirement

**Issue 6-1-1: Measurement accuracy**

**Agreement:**

* Reuse the L3 and L1 accuracy requirement of legacy FR1 TN

**Issue 6-2-1: General test configuration**

**Agreement:**

* Configuration 1:15 kHz SSB SCS, 10 MHz bandwidth, FDD duplex mode, only for UE with omnidirectional antennas
* Configuration 2: 30 kHz SSB SCS, 40 MHz bandwidth, TDD duplex mode, for UE with antenna array and UE with omnidirectional antennas.
* FFS on TDD pattern

**Issue 6-2-2: Test scope**

**Agreement**

* RAN4 not to define test cases for SCC
* Only define test case for non-DRX mode in connected mode
* For requirements with scaling factor, consider to select some configurations for RRM test cases.
* Take the test cases in the following table as baseline, other test cases are not precluded.

|  |  |
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| **Test scope****RRC\_IDLE state mobility** | **Test number** |
|
| Cell reselection to intra-frequency neighbour cell | ATG 1-1 |
| Location based cell reselection to intra-frequency neighbour cell | ATG 1-2 |
| Cell reselection to inter-frequency neighbour cell | ATG 1-3 |
| Cell reselection to inter-frequency NR cell for UE configured with [enhanced requirements] | ATG 1-4 |
| Location based cell reselection to inter-frequency neighbour cell | ATG 1-5 |

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| **Test scope****RRC\_CONNECTED state mobility** | **Test number** |
|
| Intra-frequency HO with known target cell | ATG 2-1 |
| Intra-frequency HO with unknown target cell | ATG 2-2 |
| Inter-frequency HO with known target cell | ATG 2-3 |
| Inter-frequency HO with unknown target cell | ATG 2-4 |
| Intra-frequency location based CHO  | ATG 2-5 |
| Inter-frequency location based CHO  | ATG 2-6 |
| Intra-frequency RRC Re-establishment with known target cell | ATG 2-7 |
| Intra-frequency RRC Re-establishment with unknown target cell  | ATG 2-8 |
| Inter-frequency RRC Re-establishment with known target cell | ATG 2-9 |
| Inter-frequency RRC Re-establishment with unknown target cell  | ATG 2-10 |
| Inter-frequency RRC Re-establishment in FR1 without serving cell timing | ATG 2-11 |
| 4-step RA type contention based random access test | ATG 2-12 |
| 4-step RA type Non-Contention based random access test | ATG 2-13 |
| 2-step RA type contention based random access test | ATG 2-14 |
| 2-step RA type Non-Contention based random access test | ATG 2-15 |
| RRC Connection Release with Redirection | ATG 2-16 |

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| **Test scope****Timing** | **Test number** |
|
| UE transmit timing test | ATG 3-1 |
| Timing advance adjustment delay and accuracy | ATG 3-2 |

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| **Test scope****Signalling characteristics** | **Test number** |
|
| Radio Link Monitoring Out-of-sync Test for FR1 PCell configured with SSB-based RLM RS in non-DRX mode | ATG 4-1 |
| Radio Link Monitoring In-sync Test for FR1 PCell configured with SSB-based RLM RS in non-DRX mode | ATG 4-2 |
| Radio Link Monitoring Out-of-sync Test for FR1 PCell configured with CSI-RS-based RLM in non-DRX mode | ATG 4-3 |
| Radio Link Monitoring In-sync Test for FR1 PCell configured with CSI-RS-based RLM in non-DRX mode | ATG 4-4 |
| Beam Failure Detection and Link Recovery Test for FR1 PCell configured with SSB-based BFD and LR in non-DRX mode | ATG 4-5 |
| Beam Failure Detection and Link Recovery Test for FR1 PCell configured with CSI-RS-based BFD and LR in non-DRX mode | ATG 4-6 |
| DCI-based and Timer-based Active BWP Switch | ATG 4-7 |
| RRC-based Active BWP Switch | ATG 4-8 |
| UE specific CBW change | ATG 4-9 |
| Pathloss reference signal switching delay | ATG 4-10 |

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| **Test scope****Measurement procedure** | **Test number** |
|
| Intra-frequency measurements event triggered reporting tests without gap under non-DRX | ATG 5-1 |
| Intra-frequency measurements event triggered reporting tests with per-UE gaps under non-DRX | ATG 5-2 |
| Intra-frequency measurements event triggered reporting tests without gap under non-DRX with SSB index reading | ATG 5-3 |
| Intra-frequency measurements SA event triggered reporting tests with per-UE gaps under non-DRX with SSB index reading | ATG 5-4 |
| Inter-frequency measurements event triggered reporting tests for FR1 without SSB time index detection when DRX is not used | ATG 5-5 |
| Inter-frequency measurements event triggered reporting tests for FR1 with SSB time index detection when DRX is not used | ATG 5-6 |
| Inter-frequency measurements event triggered reporting tests for FR1 without gap when DRX is not used | ATG 5-7 |
| SSB based L1-RSRP measurement when DRX is not used | ATG 5-8 |
| CSI-RS based L1-RSRP measurement when DRX is not used | ATG 5-9 |
| L1-SINR measurement with CSI-RS based CMR and no dedicated IMR configured when DRX is not used | ATG 5-10 |
| L1-SINR measurement with SSB based CMR and dedicated IMR when DRX is not used | ATG 5-11 |
| L1-SINR measurement with CSI-RS based CMR and dedicated IMR configured when DRX is not used | ATG 5-12 |
| SA intra-frequency CGI identification of NR neighbor cell in FR1 | ATG 5-13 |

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| **Test scope****Measurement Performance requirements** | **Test number** |
|
| SS-RSRP intra-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-1 |
| SS-RSRP inter-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-2 |
| SS-RSRQ intra-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-3 |
| SS-RSRQ inter-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-4 |
| SS-SINR intra-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-5 |
| SS-SINR inter-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-6 |
| L1-RSRP measurement SSB based L1-RSRP measurement | ATG 6-7 |
| L1-RSRP measurement CSI-RS based L1-RSRP measurement on resource set with repetition off | ATG 6-8 |
| L1-SINR measurement with CSI-RS based CMR and no dedicated IMR configured and CSI-RS resource set with repetition off | ATG 6-9 |
| L1-SINR measurement with SSB based CMR and dedicated IMR | ATG 6-10 |
| L1-SINR measurement with CSI-RS based CMR and dedicated IMR | ATG 6-11 |
| CSI-RSRP intra-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-12 |
| CSI-RSRP inter-frequency case measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-13 |
| CSI-RSRQ Intra-frequency measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-14 |
| CSI-RSRQ Inter-frequency measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-15 |
| CSI-SINR intra-frequency measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-16 |
| CSI-SINR Inter-frequency measurement accuracy with FR1 serving cell and FR1 target cell | ATG 6-17 |

**Issue 6-2-3: RMC (not discussed in adhoc session)**

**Agreement:**

* As baseline, the legacy NR RMCs defined in section A.3.1 of TS 38.133 are reused for ATG test cases.

**Issue 6-2-4: OCNG (not discussed in adhoc session)**

**Agreement:**

* As baseline, following legacy NR OCNGs are reused for ATG test cases:
	+ Generic OCNG pattern for all unused REs defined in A.3.2.1.1 in TS 38.133.
	+ Generic OCNG pattern for unused REs in the same bandwidth as CORESET defined in A.3.2.1.3 of TS 38.133.
	+ Generic OCNG pattern for all unused REs outside SSB slot(s) defined in A.3.2.1.4 in TS 38.133

**Issue 6-2-5: Test method for UE with antenna array (not discussed in adhoc session)**

**Agreement:**

* On the test method for UE with antenna array, further discuss:
	+ Whether OTA test is feasible.
	+ Whether/how if conducted test is to be used. FFS whether scaling factor needs to be considered in the test requiremetns.

**Issue 6-2-6: whether to define test cases for TCI switching delay requirements**

**Proposals**

* Option 1: RAN4 to discuss the test cases for TCI switching delay requirements for MAC-, DCI and RRC-based TCI state switching delay requirements.

**Issue 6-2-7: GNSS setup**

**Proposals**

* Option 1: GNSS is viable via AT command for all test cases, and GNSS only changed during the test for location-based CHO.
* Other Options are not precluded.

**Issue 6-2-8: UE mobility assumption**

**Proposals**

* Option 1: For the location-based cell re-selection tests, location-based CHO tests and UL transmit timing tests, the UE mobility should be assumed with 1200km/h. For the other tests, UE could be assumed with no mobility.
* Other Options are not precluded.

**Issue 6-2-9: Neighbour cell configuration**

**Proposals**

* Option 1: For the FDD cell re-selection test and intra/inter-frequency measurement test for UE with omnidirectional antenna, configure 1 neighbour cell. For the TDD cell re-selection test and and intra/inter-frequency measurement test for UE with antenna array, choose some test cases to configure 2 neighbour cells.
* Other Options are not precluded

**Issue 6-2-10: Channel model**

**Proposals**

* Option 1: Use the AWGN with residual doppler channel model for RRM test cases.