**3GPP TSG-RAN WG4 Meeting # 104-e** **R4-22xxxxx**

**Electronic Meeting, August 15 – August 26, 2022**

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

**Agenda Item:** 11.12.5

**Source:** CMCC

**Document for:** Approval

# Introduction

This document is to capture all the agreements in email thread [104-e][236] NR\_ATG\_RRM.

# General

**Issue 1-1-1: Scenarios to be considered for ATG RRM**

* FR2 related requirements, CA/DC related requirements and inter-RAT measurement related requirements are not applicable to R18 ATG.
* Both intra-frequency and inter-frequency measurement requirements need to be defined.

**Issue 1-2-1: Impaction on TS38.133 Section 3: Definitions, symbols and abbreviations**

* ATG terminologies need to be introduced.
* FFS on ATG bands table based on input from RF session.

**Issue 1-2-2: TDD impaction**

* Option 1: FFS, RAN4 needs to study impact on TDD band operation due to longer propagation delay between ground gNB and ATG UE.

**Issue 1-2-3: UE assistance information**

* RAN4 further study ATG UE assistance information
  + such as altitude, location, propagation delay difference, flight path, speed, velocity etc., or change in any of these parameters.

# Mobility

# Mobility in RRC\_IDLE/INACTIVE

Consider the following RRM impact for ATG

**Issue 2-1-1: Cell selection requirements**

* No new cell selection requirement (Section 4.1 in TS 38.133) for ATG is need to be developed, legacy requirements can be reused.

**Issue 2-1-2: Cell re-selection requirements**

**Issue 2-1-2-1: Cell re-selection measurement capability**

* Use current UE capability for NR intra-frequency measurement and NR inter-frequency measurement as the starting point.
  + Further study the capability after the scenario is clearer in the RF group.

**Issue 2-1-2-2: Cell re-selection measurement requirements**

* Option 1: Reusing legacy R15 requirements of intra-frequency and inter-frequency measurement as the starting point, further check whether to use HST requirements for ATG until a typically ATG network deployment scenario such as ISD is concluded in RF group.
  + Option 1-1: The A2G UE is allowed to not measure on the neighbour cells based on the coverage information of the serving cell e.g. if serving cell RSRP is above threshold.
    - For cell reselection and handover, the A2G UE should resume the neighbour cell measurement in normal manner without any relaxation if there is any unpredictable change in flight path or sudden drop in aircraft height due to any critical or emergency situation.
    - For cell reselection and handover, UE can determine the sudden change in the flight path autonomously (e.g. internally from flight data) or based on assistance information from the ground base station. Details are FFS

**Issue 2-1-5: Small Data Transmissions (SDT)**

* Option 1: SDT requirements are defined for A2G. Details are FSS (Ericsson)
* Option 2: RAN4 is not going to define ATG specific requirements (HW, CMCC)

# Mobility in RRC\_CONNECTED

Consider the following RRM impact for ATG

**Issue 2-2-1: Handover**

**Issue 2-2-1-1: NR Handover**

* Option 1: Both intra-frequency HO and inter-frequency HO need to be defined.
  + Option 1-1: Reusing legacy intra-frequency HO and inter-frequency HO requirements as the starting point, FFS other details and potential revisions for ATG.
  + Option 1-2: The A2G UE is allowed to not measure on the neighbour cells based on the coverage information of the serving cell e.g. if serving cell RSRP is above threshold.
    - For cell reselection and handover, the A2G UE should resume the neighbour cell measurement in normal manner without any relaxation if there is any unpredictable change in flight path or sudden drop in aircraft height due to any critical or emergency situation.
    - For cell reselection and handover, UE can determine the sudden change in the flight path autonomously (e.g. internally from flight data) or based on assistance information from the ground base station. Details are FFS

**Issue 2-2-1-4: NR Conditional Handover**

* FFS which kind of CHO will be introduced
* FFS whether ATG specific CHO requirements are needed.

**Issue 2-2-2: RRC Connection Mobility Control**

**Issue 2-2-2-1: SA: RRC Re-establishment**

* Reuse the principle from the legacy RRC Re-establishment delay requirements as baseline for ATG
  + Further discuss whether the ATG specific RRC Re-establishment requirement is needed.

**Issue 2-2-2-2: Random access**

* Reuse the principle from the legacy random access requirements as baseline for ATG
  + Further discuss the ATG specific impaction and details
  + Further discuss whether to define requirements for 2-step RA for A2G, and whether ATG specific impaction should be involved.

**Issue 2-2-2-3: SA: RRC Connection Release with Redirection**

* Reuse the principle from the legacy RRC Connection Release with Redirection requirements as baseline for ATG
  + Further discuss whether the ATG specific RRC Connection Release with Redirection requirement is needed

# Timing and frequency adjustment

# General issues

**Issue 3-1-1: Whether ATG UE should be capable of GNSS measurement**

* ATG UE should be capable of GNSS measurement

**Issue 3-1-2: The mechanism of *Koffset* and *Kmac***

* Option 1: The mechanism of Koffset and Kmac for NTN system should be used for ATG network. (CATT, Ericsson (if NTN as base), LGE)
* Option 2: no need to introduce the mechanism of Koffset and Kmac for ATG system (HW, CMCC, ZTE)
* Option 3: FFS (Apple)

**Issue 3-1-3: Frequency offset tracking**

* Option 1: The solution of frequency offset tracking in NTN system can be considered as reference for ATG system when SSB+TRS is not sufficient for some combination of frequency and SCS. (ZTE, Ericsson)
* Option 2: For n78 and n79, it is more likely to operate in 30kHz SCS. Therefore, the current frequency offset tracking method in TN can be the baseline. (CMCC)
* Option 3: FFS (Apple)

**Issue 3-1-4: Maximal cell range and Doppler**

* Option 1: (Ericsson)
  + Clarify maximum Doppler frequency for ATG UE and BS requirements
    - The maximum Doppler frequency for ATG BS is at least 11.6 kHz to cover example bands whilst assuming existing terrestrial 5G access procedures
  + Clarify maximum range in ATG given the capabilities of existing releases up to and including release 17.
    - A long sequence is closer to meet the ATG requirement of up to 300 km cell range but can only reach around 100 km and handle ordinary Doppler corresponding to UE speed of up to 300 km/h or 500 km/h with Restricted Sets. A short sequence can handle the Doppler of ATG but not the range.
  + Clarify the need for and size of GP for ATG TDD.
    - An ATG system needs a full slot or even several slots of GP, however the large ISD and beamforming might mitigate any issues with regards to GP for TDD
* Option 2: (Moderator) Continue the discussion after enough input from RF group is received.

# Timing and frequency pre-compensation by UE

**Issue 3-2-1: Whether to introduce UE based Timing pre-compensation**

* Option 1: The ATG UE should do the compensation of transmit frequency based on relative moving velocity and distance between UE and gNB. (CATT, ZTE, Ericsson, LGE)
* Option 2: Further study whether to introduce the UE based UL timing pre-compensation based on necessity and performance gain. (CMCC, Apple, HW, Ericsson, ZTE)
  + Option 2-1: Use the current timing adjustment procedure as the baseline. (CMCC, HW)

**Issue 3-2-2: Whether to introduce UE based Frequency pre-compensation**

* Option 1: The ATG UE should do the compensation of timing based on relative moving velocity and distance between UE and gNB. (CATT, Ericsson, LGE, CMCC)
* Option 2: Further study whether to introduce the UE based UL frequency pre-compensation based on necessity and performance gain. (CMCC, HW, Ericsson, Apple, ZTE)
  + Option 2-1: Use the current frequency pre-compensation procedure as the baseline. (HW)

# Timing requirements

Consider the following RRM impact for ATG

**Issue 3-3-1: UE transmit timing**

**Issue 3-3-1-1: Initial transmit timing requirements Te**

* Option 1: Need defined RRM requirements for ATG UE. (CATT, Apple, CMCC, HW, Ericsson)
  + FFS if UE specific TA shall be considered in the Te requirement design, like in NTN (Apple, CMCC, HW)
  + Introduce UE specific TA in the Te requirement design. (CATT)

**Issue 3-3-1-2: Gradual timing adjustment**

* Tp and Tq shall be updated for ATG UE
  + FFS if TN or NTN rel-17 is used as baseline
  + FFS how to define the exact value

**Issue 3-3-2: UE timer accuracy**

* No new specific requirement for ATG is need to be developed.

**Issue 3-3-3: Timing advance**

* FFS on the necessity of considering the open loop TA (UE specific TA if needed) and close loop (TAC based adjustment) for the TA adjustment requirement, like in NTN. (CMCC, Apple, Ericsson, LGE, ZTE)

**Issue 3-3-4: Cell phase synchronization accuracy**

* Cell phase synchronization accuracy will be defined for ATG, the legacy TN requirement can be the baseline
  + FFS whether to tighten the requirements or not

**Issue 3-3-5: deriveSSB-IndexFromCell tolerance**

* Option 1: Need defined RRM requirements for ATG UE. (Apple, CMCC, ZTE)
  + Option 1-1: The time misalignment tolerance for ‘deriveSSB-IndexFromCell= true’ shall be revisited due to the extreme large radius of ATG cell. (Apple, LGE)
  + Option 1-2: The legacy TN requirement can be reused (CMCC)
  + Option 1-3: The propagation delay different may impact the tolerance. FFS details. (HW, Ericsson)
* Option 2: Not applicable for R18 ATG (CATT)

**Issue 3-3-6: deriveSSB-IndexFromCell-inter tolerance**

* Option 1: This section was introduced in MG enhancement WI which is not needed for ATG UE (Apple, CATT)
* Option 2: No ATG impact (HW, CMCC)
* Option 3: Need for ATG, NCSG (deriveSSB-IndexFromCell-inter) has benefit for A2G system since the throughput is an important KPI for ATG (Ericsson, CMCC)

# Signalling characteristics

Consider the following RRM impact for ATG

**Issue 4-1-1: Radio Link Monitoring**

* Reuse the principle from the legacy RLM requirements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved.

**Issue 4-1-2: Link Recovery Procedure**

* Reuse the principle from the legacy Link Recovery Procedure requirements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved.

**Issue 4-1-3: Active BWP switching delay**

* Reuse the principle from the legacy Active BWP switching delay requirements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved.

**Issue 4-1-4: Active TCI state switching delay**

* Reuse the principle from the legacy Active TCI state switching delay requirements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved.

**Issue 4-1-5: Active spatial relation switch delay**

* Reuse the principle from the legacy Active spatial relation switch delay requirements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved.

**Issue 4-1-7: Pathloss reference signal switching delay**

* Reuse the principle from the legacy Pathloss reference signal switching delay requirements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved.

**Issue 4-1-8: Active downlink TCI state switching delay for unified TCI**

* Further discuss whether ATG specific impaction is need be involved.

**Issue 4-1-9: Active uplink TCI state switching delay for unified TCI**

* Further discuss whether ATG specific impaction is need be involved.

**Issue 4-1-11: Pre-configured measurement gap activation/deactivation delay**

* Option 1: Need defined RRM requirements for ATG UE (CATT, Ericsson)
* Option 2: GAP enhancement contents are not considered for ATG UE in Rel-18. (Apple, CMCC, HW, LGE, ZTE)

# Measurement

Consider the following RRM impact for ATG

**Issue 5-1-1: General measurement requirement**

* FFS the MG design
  + Option 1: Only FR1 MG is considered in ATG network
* FFS the UE measurement capability/scaling

**Issue 5-1-2: NR intra-frequency measurements**

* Reuse the principle from the legacy R15 NR intra-frequency measurements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved, such as CSSF and so on.

**Issue 5-1-3: NR inter-frequency measurements**

* Reuse the principle from the legacy R15 NR inter-frequency measurements as baseline for ATG
  + Further discuss whether ATG specific impaction should be involved.

**Issue 5-1-4: L1-RSRP and L1-SINR measurements for Reporting**

* No new specific L1-RSRP and L1-SINR measurements for Reporting requirements for ATG are need to be developed.

**Issue 5-1-5: Cross Link Interference measurements**

* Option 1: Need defined RRM requirements for ATG UE (CATT)
* Option 2: This requirement is not necessary for ATG UE (Apple, CMCC, Ericsson, LGE, ZTE)
* Option 3: FFS the RRM impact of CLI (HW, CMCC)

**Issue 5-1-6: CSI-RS based L3 measurements**

* Option 1: Need defined RRM requirements for ATG UE (CATT, CMCC)
* Option 2: FFS Whether to define requirements for CSI-RS based measurement and positioning measurement for ATG. (HW, Ericsson, Apple, LGE, ZTE)

**Issue 5-1-7: L1-RSRP measurements for a cell with different PCI from serving cell**

* Option 1: Need defined RRM requirements for ATG UE (CATT, CMCC)
* Option 2: FFS (HW, Ericsson, Apple, LGE, ZTE)

**Issue 5-1-8: NR measurements with autonomous gaps**

* Option 1: Need defined RRM requirements for ATG UE (CATT, CMCC)
  + Option 1-1: Reusing legacy requirements. (CMCC, HW, Ericsson)
* Option 2: FFS (Apple, ZTE)

# Specification Documentation

**Issue 6-1-1: How to involve ATG RRM core requirements in TS38.133**

* Option 1: The RRM requirements for ATG UE can be defined in new sections of section number with suffix D in specification. (CATT, Apple)
* Option 2: Add ATG related requirements in the current corresponding section, similar as HST. (CMCC, ZTE)