**3GPP TSG RAN Meeting #90e RP-20xxxx**

**Electronic Meeting, Dec, 2020**

**Agenda item: x**

**Source: CMCC**

**Title:** **Email discussion for RAN4 R17 proposal on ATG**

**Document for: Discussion and Decision**

# 0. Introduction

This is an email discussion for RAN4 R17 non-spectrum proposal on ATG.

1. Rel-17 WI on ATG for NR

Related contributions in RAN#88e and RAN#89e:

RP-200764 Motivation for new WI on air-to-ground network for NR

RP-200765 New WID on air-to-ground network for NR

RP-201053 Discussion on ATG network

RP-201629 Motivation for new WI on air-to-ground network for NR

RP-201630 New WID on air-to-ground network for NR

Here are some key issues which are proposed for Rel-17 in above contributions in RAN#88e and RAN#89e.

## 2.1 Issue 2-1: ATG scenarios and RF requirements

**Scenarios:**

Air-to-ground (ATG) network refers to in-flight connectivity technique, using ground-based cell towers that send signals up to an aircraft’s antenna(s) of onboard ATG terminal. As a plane travels into different sections of airspace, the onboard ATG terminal automatically connects to the cell with strongest received signal power, just as a mobile phone does on the ground.

In RAN#86 meeting, the new WID (RP-193234) solutions for NR to support non-terrestrial networks (NTN) was approved. The NTN work item aims to specify the enhancements identified for NR NTN (non-terrestrial networks) especially LEO and GEO with implicit compatibility to support HAPS (high altitude platform station) and ATG (air to ground) scenarios according to the following principles:

* FDD is assumed for core specification work for NR-NTN.
  + NOTE: This does not imply that TDD cannot be used for relevant scenarios e.g. HAPS, ATG
* Earth fixed Tracking area is assumed with Earth fixed and moving cells
* UEs with GNSS capabilities are assumed.

Although the RAN1/2/3 aspects of standardization work are generally common for satellite, HAPS and ATG, the RAN4 aspects differ very significantly. The node definitions, spectrum considerations and co-existence considerations all differ. In the case of ATG, both base station and UE will be unique types. ATG will operate within existing bands and does not need new bands and band properties to be identified.

The NTN WI includes development of generic requirements for RAN4, however in practice the work will be separate and different for Satellite, HAPS and ATG. To avoid confusion and overloading of the NTN WI and the low dependency between RAN1-3 work and RAN4 work for ATG, it is proposed that the ATG RAN4 work is performed within the context of this WI. The proposal to split off RAN4 work is exceptional for the NTN work due to the large and complex scope of covering quite different types of system and low dependency on RAN1-3.

Form the trials and commercial operation [<https://inflight.telekom.net/ean/>] of proprietary ATG solutions, some characteristics could to be considered for ATG network deployment scenarios:

* ***Extreme large inter-site distance (ISD) and large coverage range:*** In order to control the network deployment cost and considering the limited number of flights, large ISD is preferred, e.g., about 100km to 200km. At the same time, when the plane is above the sea, the distance between the plane and the nearest base station could be more than 200km and even up to 300km. Therefore, ATG network should be able to provide up to 300km cell coverage range.
* ***Utilizing non-disjoint operators’ proprietary frequency for deploying both ATG and terrestrial networks:*** Operators are interested to adopt the same frequency for deploying both ATG and terrestrial networks to save frequency resource cost, while interference between ATG and terrestrial networks becomes nonnegligible and should be addressed. Especially, from China Mobile’s point of view, 4.8GHz is an interesting frequency for deploying both ATG and terrestrial NR network.
* ***Much powerful on-board ATG terminal capacity:*** On-board ATG terminal can be much powerful than normal terrestrial UE, e.g., with higher EIRP via much larger transmission power and/or much larger on-board antenna gain.

Considering the particularity of ATG network deployment, the following aspects should be addressed in a new ATG work item.

* Extreme large cell coverage range (e.g., up to 300 kilometres) and flight speed (e.g., up to 1200km/h).
* Coexistence requirements between ATG and terrestrial network.
* ATG BS/UE core and performance requirements

**Objectives:**

Specify features to core specifications of RF requirements for coexistence between ATG and IMT terrestrial network [RAN4]

* Identify key characteristics where it is absolutely necessary to differentiate ATG BS and UEs from ground based BS and UEs
  + Aim to reuse existing requirements for BS and UE where possible.
* Study and specify the framework how ATG core requirements are defined.
  + This includes identifying whether the requirements are captured within the existing specifications or new specifications are created.
  + Determine whether conducted, OTA or both types of requirement are required for both the BS and UE
* Identify the FR1 potential band(s) to be used as example for ATG
* Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS)
* Specify new UE/BS type(s) for ATG network if necessary
  + Taking into account identified differences between ATG and ground based systems
* Specify RF requirements for ATG UE/BS
  + Considering the results of co-existence simulations in terms of impact on emissions and RX requirements, cell sizes and link budgets, technology capabilities, likely BS and UE architectures and other relevant aspects.
* Specify test procedures for ATG BS conformance testing
  + Determine at an early phase whether conducted, OTA or both types of testing are needed

Q1: Companies are invited to share views on objectives

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| Company | Comments |
| OPPO | Support this WI and interested in the new ATG NR using scenario which will benefit the 5G industry.  Regarding the objectives, maybe a study phase is needed to make all the studies clear like UE types, working conditions, co-existence scenario, requirement types, after that in the WI phase simulation results can be collected and requirements can be defined. |
| ZTE | We support this WID and objectives as there are strong interests from many operators to provide service on aircraft. This onboard service has existed for a couple of years, we think NR based ATG network is quite important feature to enable this kind of service at current phase.  In addition, as mentioned in last RANP meeting, the basic RAN1/2/3 feature of ATG is still defined in NTN WID, however from RAN4 perspective, different coexistence scenarios and different network layout could be foreseen between satellite network and ATG network, thus if only one RAN4 WID is created for accommodating both networks, this RAN4 WID will be very broad and complicated, and the work progress and completion corresponding to ATG and satellite works are unnecessarily coupled with each other. Therefore, we support to have the works split into separate WIDs for ATG and satellite respectively. |
| China Telecom | Support this WI and the objectives proposed by the moderator.  It is important to conduct the co-existence evaluation in 3GPP within Rel-17, so that other organizations such as CCSA can reuse the evaluation outcome from 3GPP.  Our interested frequency bands are n1 and n78, and we are ok to decide the exact bands during the WI. |
| Xiaomi | We support this dedicated WID for ATG since it is quite different from NTN and can be predicted that most of work in RAN4 especially for RF related requirements is independent and not affected by the progress of NTN in RAN1-3. And we are also ok with the objectives proposed by the moderator to start the work in RAN4. |
| CBN | CBN supports this WID and the objectives proposed by moderator. n28 and n79 are our interested bands. |
| vivo | We already supported this WI and would like also prefer a dedicated WI in RAN4.  Though the scope of this WI is quite broad, including co-existence simulation etc, by re-using existing framework and requirements, it is possible for the workload to be controlled. |
| CATT | As discussed during last RAN plenary, CATT supports this WID since there is clear demand from operator. We agree with the new update to limit the scope to FR1 only which is more realistic. |
| CMCC | In china, more than 600,000 base stations have been built and opened for 5G, and the number of 5G UEs connections exceeded 150 million. The application of 5G is not only in the field of traditional ground communication, but also in the integration of space and sky. China Mobile and other operators have clear commercial demand for ATG. ATG standard realization is also an important breakthrough in 5G application extension. Operators such as China Mobile have a strong demand, and there are already some ATG deployment plans. We have obtained the cooperation and support from operators, BS/UE vendors and the aviation industry. We think it is necessary to carry out this ATG WI approval in REL-17 to meet the current urgent needs of operators. |
| China Unicom | We support this WI and the listed objectives.  Our interested bands are n1, n3, and n78. Other potential commercial spectrum could be provided later. |
| Ericsson | As discussed previously, in this circumstance where there is a clear goal and need, and the RAN4 work is substantially different to Satellites etc, we understand and support separating out the work in RAN4. Objectives look OK. |
| Huawei | Thanks for leading the discussion.  We would like to suggest providing the details for the co-existence evaluation as below:  Perform FR1 co-existence evaluation for ATG network:   * + - Study Link budget to derive the reasonable ISD     - Adjacent channel co-existence with adjacent channel terrestrial network for the example band(s).     - Co-channel co-existence for the example band(s), if needed. |
| Intel | * For the co-existence studies between ATG and IMT terrestrial network, we are interested to know if co-channel or adjacent channel scenarios are proposed to be in the scope. Co-channel co-existence studies outcome may have impact on other WGs and should be minimized. We recommend to clearly list the scenarios in the WID and potentially the prioritization, * Also, for co-existence analysis we suggest adding sub-objective to identify the relevant deployment/system parameters (e.g. ISD, aircraft height, antenna characteristics) * For UE test methods, it is expected that RF/BB modules can be tested independently using conducted test methods. So, we do not see enough motivation to apply OTA testing which will make the scope quite wide. Conducted testing can be used as a starting point and OTA can be considered at a later stage. * The ATG use case does not introduce new node types and, therefore, the existing specification should be reused. We prefer to avoid unnecessary discussion on the dedicated specifications. |
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## 2.2 Issue 2-2: RRM/Demod requirements

* The typical speed for civil aircraft are ranging from 900km/h to 1200km/h, and ISD of ATG BS are ranging from 100km to 300km which is also much larger than that of terrestrial NR network, which may have impact on RRM requirements. So RRM core requirements for ATG UE should be discussed.
* Channel model for ATG UE and BS could be different from legacy NR UE and BS. Doppler frequency shift and Tx/Rx antenna configuration between ATG UE and BS could also be different compared with legacy NR. ATG UE and BS demodulation requirements should also be discussed.
* The progress and outcome of Rel-17 NTN work item can be taken into account for ATG RRM and Demodulation requirements.

**Objectives:**

Indentify and specify RRM/Demod requirements for ATG, starting once the Rel-17 NTN WI has progressed sufficiently and taking into account the decisions/outcome of Rel-17 NTN work item.

* RRM core requirements for ATG UE. [RAN4]
  + Considering the different nature of ATG UEs and their view of the network, increased cell sizes and other relevant aspects.
* RRM performance requirements and test cases for ATG UE type. [RAN4]
* Demodulation performance requirements and test cases for ATG UE/BS. [RAN4]
  + Taking into account different cell sizes

Q2: Companies are invited to share views on objectives

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| Company | Comments |
| OPPO | Ok with the objectives, and suggest to align with NTN in requirement definition conditions when it is possible. |
| ZTE | We support the proposed RRM objectives, these general RRM/Demod requirements for ATG UE are based on the practical deployment which is quite essential to define the requirements appropriately. |
| China Telecom | Ok with the objectives. |
| Xiaomi | We are OK with the objectives including the new modification here. |
| CBN | OK with the objectives. |
| vivo | OK with the objectives, similar comments to previous issue. |
| CATT | OK with the objective. |
| China Unicom | We are OK with the modified objectives. |
| Ericsson | Objectives are OK |
| Huawei | OK with objectives. |
| Intel | * The RAN4 work on demodulation can start after the RAN1 design is finalized (or at least substantial progress is made) * The impact on RRM requirements is quite orthogonal to RAN1 discussion and the work can be arranged in parallel with RAN1. * For Demodulation requirements whether separate requirements for different cell sizes are needed is questionable. We prefer to discuss the exact set of test cases up to WI stage and remove proposal “Taking into account different cell sizes”. |

## 2.3 Issue 2-3: others

Other issues or objectives to be identified in Rel-17 (if needed).

Q3: Companies are invited to share views on this use case and objectives

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| Company | Comments |
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## 2.4 Summary for sub work area #2