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**Source: Qualcomm Incorporated**

**Title: KI#3: Updates to solution 7**

**Document for: Discussion/Approval**

**Agenda Item: 19.10**

**Work Item / Release: FS\_UAS\_Ph3**

*Abstract of the contribution: the P-CR eliminates ENs addressing them as appropriate and describes how the solution options are applicable to LTE.*

# 1. Discussion

## 1.1 Removal of Editor’s Notes

The following ENs have been removed as explained below:

Editor’s Note: the solution is based on a set of assumptions related to the expected behavior of a UAV UE when in the NTZ (i.e. the NTZ area and the restricted frequency bands). Depending on verification of such assumptions, the solution may need to be revised.

Based on discussion in TFES, the LS sent by TFES to 3GPP, and their understanding of NTZ restrictions, the existing text in the description regarding AUEs not being allowed to transmit AT ALL in the NTZ is valid and the corresponding EN is not needed.

Editor’s Note: whether the UE is allowed to receive DL data in an area corresponding to and NTZ is FFS

Based on discussion in TFES, the LS sent by TFES to 3GPP, and their understanding of NTZ restrictions, AUE may be also restricted from receiving DL data. However, the existing text in the solution already caters for this.

Editor’s Note: Additional/what parameters need to be considered to properly describe NTZ and actual restrictions/enforcement aspects and roles of NTZ in the core and radio network are FFS.

The existing text “NTZ information refer to a geospatial description of an NTZ (in two dimensions or three dimensions to consider height restrictions) and the restricted frequencies corresponding to such area” already covers the information required for NTZs.

Regarding the restriction/enforcement roles in CN and RAN, the solution options already cover the various functions.

Editor’s Note: how the solution can address change of NTZ information is FFS

Text has been added to clarify these aspects.

# 2. Text proposal

It is proposed to agree the following changes vs. TS 23.700-59:

>>>>BEGINNING OF CHANGES<<<<

## 6.7 Solution #7: Mobility Enhancements for enforcements of NTZ

### 6.7.1 Key Issue mapping

This solution applies to Key Issue #3.

### 6.7.2 Description

#### 6.7.2.1 Introduction

The solution addresses the following aspects:

- How to ensure an aerial UE respects no-transmit zones. This includes the following scenarios:

- mobile network cells overlapping completely or partially with the NTZ and using the restricted frequency bands of the NTZ.

- support NTZ of any size, depending on regional requirements.

- the provisioning of NTZ-related information to the UAV UE.

- how to allow the enforcement for both aerial UEs in connected mode and aerial UEs in idle mode.

#### 6.7.2.2 Solution Overview

The solution assumes the following:

- compliance with NTZ restrictions is enforced in the UAV UE based on configuration information and assistance information provided by the mobile network, as described below

- NTZ information is provided to the PLMN functions (depending on the solution options described below) via OAM by external parties, with the idea that at national level there will be entities in charge of defining NTZs and providing related information to PLMNs.

NOTE 1: in normative phase solutions that extend NEF services to enable providing dynamic NTZ information to the 5GC may be considered.

- NTZ information refer to a geospatial description of an NTZ (in two dimensions or three dimensions to consider height restrictions) and the restricted frequencies corresponding to such area.

- The solution assumes that an UAV UE located in an NTZ (i.e. in the geospatial area associated with the NTZ and in the frequencies restricted for the NTZ, the UAV UE is not allowed to transmit any signal.

- It is assumed that NTZ description contains a geospatial definition of the NTZ and the frequencies that are restricted in the NTZ.

The solution provides multiple options which cater for different size of NTZs with respect to the size of the cells impacted by NTZs:

- Extension of Service Restrictions to cater for NTZs: this solution is suitable for large NTZs that impact a variety of cells in a specific area.

- use of NTZ policy configuration in the UE

- Per-cell indication of the presence of NTZs: this solution assumes that mechanisms are adopted in RAN to provide information to UAV UEs wrt the overlap of an NTZ with the cell (i.e. the whole cell is not suitable for transmission for a UAV UE) in order to ensure that the UAV UE does not transmit at all in the NTZ area of a cell that overlaps partially or fully with an NTZ. The solution is mostly suitable for scenarios where the NTZ covers the majority or entirety of a cell.

A PLMN may use one or more of these solutions depending on local policies and the size of the NTZs impacting the PLMN to provide assistance information to UAV UEs.

In the solutions below, the following behavior is assumed:

- The UAV UE never transmits any signalling or data in the area of a cell corresponding to an NTZ (i.e. the geospatial area corresponding to the NTZ and the frequency band(s) corresponding to the NTZ)

- the UAV UE is provided by the network with NTZ-related information as described in the solutions below.

- the UAV UE deactivates the AS layer or ceases to transmit any data when entering an area corresponding to the NTZ

NOTE 2: in scenarios in which the UE can receive DL data, the UE cannot perform any actions that require any transmission while in the area corresponding to an NTZ.

NOTE 3: in scenarios in which the UE is not allowed, based on regulations, to receive DL data, the network needs to ensure that no DL data is transmitted to the UAV UE, and the UAV UE may de-activate the AS.

- the UAV UE may perform a registration update before entering the NTZ with an indication that the UAV UE is about to enter an NTZ, so that the network considers the UAV UE unreachable but registered, similarly to the mechanisms adopted in previous releases for high latency communication behavior. The UAV UE does so based on the NTZ information it receives as described below. The UAV UE would then performs re-registration when exiting the NTZ. This enables the network to know the exact status of the UAV UE.

- for connected mode UAV UEs, it is expected that the network is configured to know which cells correspond to an NTZ and the RAN will attempt to avoid handing over a UAV UE to a cell corresponding to an NTZ. However, in some scenarios the only suitable cell for an handover may be a cell impacted by an NTZ (location and frequency bands), and the UE behavior described below must apply. Optimizations in the case of connected mode handover to minimize loss of connectivity and ensure the respect of NTZs need to be discussed further with RAN WGs.

- for IDLE mode mobility, the UAV UE behavior is described below.

Editor’s Note: Coordination with RAN WGs are required to progress the solution to ensure that RAN (eNB/gNB) has inputs required to provide the correct assistance information to UAV UEs.

- if NTZ information is updated by the entities defining NTZs, it is expected that updated information is provided to the MNO network (e.g. via OAM or NEF services). It is also assumed that the updated information is provided to the UAV UE depending on the solution options described below.

#### 6.7.2.3 Extension of Service Restrictions for NTZs

In this solution component, a UAV UE supporting NTZ restrictions provides an indication in 5GMM of support of NTZ Restrictions.

The CN receives the NTZ information (e.g. via OAM from external party) and maps the NTZ information to a Restricted Transmission Area (RTA). If the AMF determines that the supporting UE is an UAV UE, i.e. the UE provided indication of NTZ support, the UE has an aerial subscription, and after successful UUAA procedure when it is performed, then the AMF configures the UE with this Restricted Transmission Area. If a UAV UE does not provide the indication, the AMF may deregister the UE and may provide a cause code (and a backoff timer) to indicate not to re-register for a time for this PLMN.

The Restricted Transmission Areas is similar to a Non-Allowed Area, but it is explicitly identified as being different from a Non-Allowed Area to induce a different behavior in the UAV UE. The concept is that the UE is not allowed transmit at all the RTA in the frequencies corresponding to the NTZ.

Based on the RTA information, the UAV UE behavior differs from a traditional UE which, when entering a non-allowed area, may still act as a regular UE in limited state and transmit for emergency services, and is banned from performing any PLMN reselection. An UAV UE entering an RTA shall not initiate any service request or any signaling, including emergency services. When entering an RTA, the UAV UE shall behave as a UE with no suitable serving cell banned from performing any emergency services. An UAV UE in an RTA shall not respond to any paging from the network. When entering an RTA, the UAV UE is allowed to use this event to trigger PLMN reselection.

In order to provide NTZ information as part of the RTA:

- the AMF may be configured with NTZ information and provide RTA to the UAV UE based on the NTZ information after the AMF determines it is a supporting UAV UE (i.e. the UE provided indication of NTZ support), that the UE is an aerial UE based on aerial subscription, and after successful UUAA procedure when it is performed.

- Alternatively, the AMF may be configured to know that there is at least one NTZ in the area served by the AMF but may not create any RTA information. During the registration, the PCF which is configured with NTZ information, may create an RTA for the UAV UE and return it to the AMF which in turn provides it to the UAV UE.

The UDM and the PCF may update the Service Area Restrictions of a UE at any time. For UE in CM-IDLE state in an RTA marked as NTZ, the AMF shall store the updated service area restriction and update the UE upon next signalling interaction with the UE. For a UE located in an RTA marked as NTZ, the AMF shall not initiate paging for a UE to update Service Area Restrictions with Generic UE Configuration Update procedure.

#### 6.7.2.4 NTZ Restriction Policies

This component of the solution re-uses concepts similar to the PC5 policy configuration that was adopted in previous releases to define geofence where certain frequencies are not allowed. However, in the case of NTZs, a blocklist of frequencies associated to the specific area are provided, whereas in the case of PC5 a allowlist was provided. In the solution, the UE is configured with NTZ Restriction Policies that identify the area corresponding to the NTZ and the banned frequency or frequencies. The UE shall not transmit data or signaling when in the area of the NTZ and is being served by the frequencies identified in the NTZ Restriction Policies. The description of the NTZ may be in the form of a 2D or 3D (to include specific altitudes) geo-area/polygon.

In this solution, a UAV UE supporting NTZ restrictions provides an indication in 5GMM of support of NTZ Restrictions.

The UE may be provided with NTZ Restriction Policies in one of the following alternatives:

- Option 1: From AMF. During the registration procedure, if the AMF determines that the supporting UE is an UAV UE, i.e. the UE provided indication of NTZ support, the UE has an aerial subscription, and after successful UUAA procedure when it is performed, then the AMF provides the NTZ Restriction Policies applicable to the UAV UE and the current registration area. The AMF may retrieve the NTZ Restriction Policies from PCF. It is assumed NTZ Restriction Policies are configured in AMF or PCF by OAM, or may have been configured for UAV UEs via NEF services. This option requires all AMF serving areas impacted by NTZ to be configured with NTZ information.​

- Option 2: From PCF. When the UAV UE is in a TA where there is at least NTZ, or when the registration Area that the AMF assigns to the UAV UE contains at least one NTZ, and if the AMF determines that the supporting UE is an UAV UE, i.e. the UE provided indication of NTZ support, the UE has an aerial subscription, and after successful UUAA procedure when it is performed, then the AMF provides a new indication that an NTZ is present in the registration area. The UAV UE triggers the retrieval of NTZ Restriction Policies from the PCF using existing policy retrieval procedures. Alternatively, the AMF may indicate to the PCF during the registration procedure that NTZ are present in the registration area and the PCF triggers NTZ Restriction Policies delivery to the UAV UE. It is assumed NTZ Restriction Policies are configured in PCF by OAM or may have been configured for UAV UEs via NEF services. This solution reduces the impact on AMFs by requiring only AMFs that serve area impacted by NTZs to be configured to know there is an NTZ in the area served by the AMF, without the need to impact other AMFs and without requiring AMFs to be aware of the complete NTZ information.

- Option 3: from NTZ AF. This option assumes that a third-party service is present outside MNOs to provide NTZ-specific information to UAV UEs. This may be a service provided by regulators or other third parties. As in option B, When the UAV UE is in a TA where there is at least NTZ, or when the registration Area that the AMF assigns to the UAV UE contains at least one NTZ, and if the AMF determines that the supporting UE is an UAV UE, i.e. the UE provided indication of NTZ support, the UE has an aerial subscription, and after successful UUAA procedure when it is performed, then the AMF provides a new indication that an NTZ is present in the registration area, and may provide assistance information (e.g. URL) to instruct the UAV UE how to reach the AF. Upon receiving the indication and the assistance information, the UAV UE ​uses existing a suitable user plane connection or establishes an appropriate user plane connection (e.g. the UAV UE may be configured with a specific DNN/S-NSSAI for such connectivity) to the AF and uses application layer signalling to retrieve the information ​(out of scope of the solution).

If in a PLMN multiple options are supported, this solution assumes that what the UAV UE receives in option 3 takes priority over the information received with other options.

#### 6.7.2.5 Per-cell indication of the presence of NTZs:

For potential solutions where a per-cell indication is provided to UAV UEs on the presence of NTZs (independently of the mechanism adopted to do so by e.g. RAN solutions), three categories of UEs need to be considered:

1. new UEs (i.e. Rel. 19) that support NTZ restriction functionality: in a cell where the NTZ indication applies, the UAV UE shall consider the cell barred

2. pre Rel. 19 non-UAV UEs (i.e. terrestrial Ues): these UE should be allowed to use the cell either by ignoring the indication or not receiving it

3. pre-Rel.19 UAV UEs that do not support NTZ restriction: solutions must enable such UAV UEs to consider the cell barred or not suitable

We assume that the network would need to be aware of which of the three categories a UE belongs to, and we assume that new Rel.19 UAV UEs indicates to the network the ability to support NTZ restrictions (e.g. in 5GMM capabilities). CN and RAN are already aware if this is an aerial UE based on the UE subscription being an aerial subscription, which since Rel. 15 is indicated to the RAN when the UE context is provided to the RAN.

Solutions that provide a per-cell indication of the presence of an NTZ shall be able to support all three categories of UAVs with the expected UE behavior described above. Specifically, if RAN WGs develop such solution, the solution must allow non-UAV UEs to use the cell without restriction and must block all UAV UEs from using this cell. This includes also UAV UEs of release 18, not just UAV UEs of Release 19. Moreover, such solutions would need to consider that RAN needs to be configured with NTZ information in order to provide any per-cell indication.

NOTE: coordination with RAN WG is required to consider such solutions.

The following is illustrative text describing an example of how this can be achieved and be applicable to both Rel. 19 and Rel. 18 UE, and applicable to both LTE and NR UEs, and of course any decisions on the feasibility of the solution would need to be made by RAN WGs. The idea would be to use Aerial-specific NS/Pmax value fields of SIB1 added in Rel. 18 (RRC field name is *nr-NS-PmaxListAerial*). This was adopted both for NR and LTE. A cell that corresponds or overlap to an NTZ broadcasts a reserved value of Aerial-specific NS/Pmax value field in SIB1. Based on existing Rel. 18 behavior, a Rel. 18 Aerial UE would ignore the cell when detecting the reserved value. A Rel. 19 Aerial UE would ignore the indication and may consider additional NTZ information that may be provided by RAN or by upper layer solutions described above in order to operate in the cell outside the boundaries of the NTZ (e.g. in case the cell is larger than the NTZ).

### 6.7.2.3 Solution Architecture

No architectural modifications are assumed by the proposed solution.

### 6.7.3 Procedures

NOTE: it is assumed that the following procedures take place when the UAV UE is outside an area corresponding to an NTZ. A UE that determines it is located in an NTZ and in the restricted frequencies will not attempt to connect to the network.

### 6.7.3.1 Extension of Service Restrictions for NTZs



**Figure 6.7.3.1-1: Delivery of NTZ information via Service Area Restrictions.**

1. The UE registers indicating support for NTZ.

2. If the AMF determines that the supporting UE is an UAV UE, i.e. the UE provided indication of NTZ support, the UE has an aerial subscription, and after successful UUAA procedure when it is performed, then the AMF decides to configure the UE with this Restricted Transmission Area. If a UAV UE does not provide the indication, the AMF may deregister the UE and may provide a cause code (and a backoff timer) to indicate not to re-register for a time for this PLMN. The AMF may be configured with NTZ information and provide RTA to the UAV UE based on the NTZ information

3. Alternatively, the AMF may be configured to know that there is at least one NTZ in the area served by the AMF but may not create any RTA information. During the registration, the PCF which is configured with NTZ information, may create an RTA for the UAV UE and return it to the AMF which in turn provides it to the UAV UE.

4. The AMF confirms the registration and returns the RTA information to the UAV UE. Based on the RTA information, a UAV UE entering an RTA shall not initiate any service request or any signaling, including emergency services. When entering an RTA, the UAV UE shall behave as a UE with no suitable serving cell banned from performing any emergency services. An UAV UE in an RTA shall not respond to any paging from the network. When entering an RTA, the UAV UE is allowed to use this event to trigger PLMN reselection.

### 6.7.3.2 NTZ Restriction Policies



**Figure 6.7.3.2-1: Delivery of NTZ restriction policies to UAV Ues.**

1. The UE registers indicating support for NTZ in 5GMM capabilities.

2. If the AMF determines that the supporting UE is an UAV UE, i.e. the UE provided indication of NTZ support, the UE has an aerial subscription, and after successful UUAA procedure when it is performed, then the AMF determines that NTZ Restriction Policies applicable to the UAV UE and the current registration area need to be provided to the UAV UE

3a. In option 1, the AMF may retrieve the NTZ Restriction Policies from the PCF.

3b. in option 1, the AMF returns the NTZ Restriction Policies to the UAV UE.

4a. In option 2, the AMF provides a new indication that an NTZ is present in the registration area.

4b. In option 2, based on the indication in 4a the UAV UE triggers the retrieval of NTZ Restriction Policies from the PCF using existing procedures. Alternatively, the AMF may indicate to the PCF during the registration procedure that NTZ are present in the registration area and the PCF triggers NTZ Restriction Policies delivery to the UAV UE.

5a. In option 3, the AMF provides a new indication that an NTZ is present in the registration area, and may provide assistance information (e.g. URL) to instruct the UAV UE how to reach the AF

5b. In option 3, upon receiving the indication and the assistance information in step 5a, the UAV UE ​uses existing a suitable user plane connection or establishes an appropriate user plane connection (e.g. the UAV UE may be configured with a specific DNN/S-NSSAI for such connectivity) to the AF.

5c. In option 3, the UAV UE uses application layer signaling to retrieve the information  from the AF.

### 6.7.4 Impacts on services, entities and interfaces

The following entities are impacted:

- UE:

- indication of NTZ support for UAV UEs

- receive and process NTZ information, and modify idle mode mobility and connected mode mobility based on received NTZ information as described in options above

- abstain from transmission in areas corresponding to NTZ

- for per-cell solutions, the UE can receive per-cell indication of NTZ

- AMF:

- configuration by OAM to be aware of presence of NTZ in serving area

- potential configuration of NTZ information or assistance information to support NTZ information retrieval

- restrain from paging a UAV UE that is in an NTZ

- PCF:

- may be configured with NTZ information (area and frequencies) depending on solution options

>>>>END OF CHANGES<<<<