**3GPP TSG-WG SA2 Meeting #161 S2-2403278**

**Athens, Greece, 26 February – 1 March, 2024**

**Source: Ericsson**

**Title: Enabling support of NTZ in aerial UEs, KI#3**

**Document for: Approval**

**Agenda Item: 19.10**

**Work Item / Release: FS\_UAS\_Ph3 / Rel-19**

*Abstract of the contribution: This contribution proposes a solution enabling the support of no-transmit zones for aerial UEs in EPC and 5GC.*

1. Discussion

The key issue on no-transmit zone (NTZ) is documented in TR 23.700-59, see KI#3.

|  |
| --- |
| This key issue relates to the introduction by CEPT ECC Decision 22(07) [3] of No Transmit Zones for aerial UEs. The ECC Decision asserts that a mechanism is necessary to ensure that aerial UEs respect no-transmit zones in order to protect incumbent radio systems from potential interference from aerial UEs.  Since the ECC Decision does not identify any specific RAT, NTZs can be supported by both LTE and NR.  This key issue addresses the following aspects:  - How to ensure an aerial UE respects no-transmit zones, including:  - whether a mobile network cells overlapping completely or partially with the NTZ and using the restricted frequency bands of the NTZ;  - whether mechanisms are needed to differentiate aerial UEs that support functions defined for NTZs in Rel. 19 and aerial UEs that don't;  - what if any, specific aerial UE behaviour when the aerial UE approaches, enters, or exits the NTZ.  - Whether and how to enable configuration of NTZ information in the aerial UE.  - Whether to allow the enforcement of no-transmit zone(s) for both aerial UEs in connected mode and aerial UEs in idle mode and if yes then how.  Editor's note: Interaction with potential other regulatory services is TBD.  NOTE: Any potential solutions developed shall be coordinated with RAN WGs or progressed together with RAN WGs input. |

This solution focuses on aspects related to:

1. Delivering NTZ information from the AF/UTM to RAN nodes (gNB/eNB)
2. Delivering NTZ information from RAN nodes to UEs with the corresponding subscription
3. Delivering NTZ information updates from AF/UTM
4. Ensuring the differentiation of aerial UEs compliant and non-compliant with NTZ requirements
5. Notifying AF/UTM about UEs not complying to NTZ requirements.

2. Text proposal

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

>>>> Start of Changes <<<<

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.256: "Support of Uncrewed Aerial Systems (UAS) connectivity, identification and tracking; Stage 2".

[3] [ECC Decision (22)07 (cept.org)](https://docdb.cept.org/download/4240) <https://docdb.cept.org/download/4240>: "Harmonised technical conditions for the usage of aerial UE for communications based on LTE and 5G NR in the bands 703-733 MHz, 832-862 MHz, 880-915 MHz, 1710- 1785 MHz, 1920-1980 MHz, 2500-2570 MHz and 2570- 2620 MHz harmonised for MFCN".

[4] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[5] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

>>>> Next Change <<<<

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |  |  |
| --- | --- | --- | --- |
| Solutions |  |  |  |
|  | Key Issue #1 | Key Issue #2 | Key Issue #3 |
| #X |  |  | x |
| #y |  |  |  |

>>>> Next Change (all text is new) <<<<

## 6.X Solution #X: Enabling NTZ support for aerial UEs

### 6.X.1 Key Issue mapping

This solution addresses KI#3 aspects.

### 6.X.2 Description

The solution assumes that an aerial UE indicates its capability to respect no-transmit zones (NTZ), and UE’s subscription data has a record about that, as Operators have to enforce the NTZ respect, and the subscription-based approach is one possibility, as described below.

Several options/alternatives are considered when comes to obtaining NTZ information – preconfiguration at the relevant network nodes (e.g., gNodeB (gNB)/eNodeB(eNB), AMF/MME) as well as a network-based configuration of NTZ parameters (e.g. geographical area in form of coordinates (i.e., latitude and longitude), restricted frequency band(s), altitude/elevation etc.).

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.

In order to perform network-based configuration of NTZ parameters, it is assumed that there needs to be operator’s AF with trust relation for this purpose. This AF can be part of UTM (Uncrewed Aerial System Traffic Management) , which is outside operator’s trust domain, and therefore, the AF will invoke a service operation towards an UAS NF / NEF so that the NTZ information can be transferred towards RAN nodes (i.e., gNBs in case of 5GC and eNB in case of EPC), core network (CN) entities and to the affected aerial UEs.

Editor’s Note: Whether UEs in NTZs are allowed to use UL for emergency support is FFS and depends on LS reply.

Current solution assumes that the aerial UEs supporting NTZ will not require emergency services support.

Until otherwise indicated, it is assumed that the NTZ does not allow UEs to send uplink data but allows reception of downlink data from the network. Also, Aerial UEs within NTZ(s) are able to communicate with the network for mobility/registration procedures for the purposes of keeping connectivity to the network.

The main principles/steps for the considered solution options/alternatives.

1. Provisioning RAN (gNB/eNB) with a set of NTZ information (e.g., geographical area in form of coordinates (i.e., latitude and longitude), restricted frequency band(s), altitude/elevation etc.), see Figure 6.X.3-1:

1(a). RAN is provided with NTZ information via a node-level signalling from operator’s AF via UAS NF/NEF, PCF and AMF using the AM Policy Association Establishment/Modification procedures (as described in clauses 4.16.1 and 4.16.2 of TS 23.502 [4]).

1(b). RAN node(s) are configured by OAM with the existing NTZ information that can be requested by the AF/UTM from network’s nodes in the area they serve (e.g., based on RAN node location, Tracking Area(s) identified by a list of tracking area identities (TAI) or a list of cell identities)

1(c): AMF/MME is pre-configured (e.g., local configuration) with NTZ information; and AMF/MME provides the NTZ information to relevant gNB/eNB nodes via non-UE associated signalling (e.g. during NG interface Setup/Reconfiguration procedure), UE-associated signalling (e.g., during Initial Context Setup/Modification procedure or PDU session resource management procedures).

To provide RAN nodes with new/updated NTZ information from the AF/UTM (i.e. triggered by UTM), a node-level signalling from operator’s AF/UTM can be used for Option 1(a), 1(b) and 1(c), whereas reprovisioning via OAM can be done only for Option 1(b).

2. UE’s subscription data include an additional record at UDM, indicating that the UE/UAV is compliant to NTZs requirements. This allows the operator and the network to enforce NTZ respect and to deliver the NTZ information only to UEs with the corresponding subscription. This indication is made available/delivered to RAN nodes (gNB/eNB) so they can enforce the NTZ respect. Additionally, UE’s subscription data at UDM can indicate which set(s) of NTZ are allowed to be disobeyed by high-priority UEs (e.g., first responders).

3. Providing the NTZ information to a UE with the corresponding subscription:

3(a). RAN (gNB/eNB) sends the NTZ information to a UE using the RRC protocol (dedicated signalling).

3(b). The NTZ information is sent to a UE from a core network node (e.g. UAS NF/NEF via an AMF) or from the serving AMF using Non-Access Stratum (NAS) signalling during UE’s registration in a Registration Accept message.

The UE/UAV stores the received NTZ information until the new NTZ information is provided or deleted, e.g. by explicit signalling from the core network (for instance, via AMF NAS signalling) due to request from the AF/UTM.

Editor’s Note: It is FFS if SMF/UPF/PGW-U need to be impacted due to enforcement of no UL data transmission and Aerial UE movement in and out of NTZ(s).

Editor’s Note: Coordination with RAN WGs are required to progress the solution to ensure that RAN (eNB/gNB) has inputs required to enforce UE compliance with NTZ.

### 6.X.3 Procedures

The main procedural steps to provision RAN nodes (gNB/eNB) with the NTZ information is shown in Figure 6.X.3-1.

Editor’s Note: The current procedures assume 5GC signalling. The adaptation for EPC is FFS.

**Option 1: node-level signalling.**

1. An AF (UTM) sends to the UAS NF/NEF an Naf\_Authentication\_Notification request to provide new/updated information about NTZ for the UE/UAV. The AF/UTM includes GPSI, CAA-Level UAV ID, PDU Session IP address if available and the NTZ information in the re-authentication/authentication data update request.

Editor’s Note: Whether to use the existing service operation (e.g., Naf\_Authentication\_Notification) or to design a new for this specific purpose is FFS.

NOTE X1: The similar request can be used by the AF/UTM to send an update about the NTZ information when e.g. the AMF/MME is preconfigured with the set of NTZ information or when the previously delivered information is not valid anymore.

2. The UAS NF/NEF translates the AF-provided NTZ information (e.g., geographical area in form of coordinates (i.e., latitude and longitude), restricted frequency band(s), altitude/elevation etc) into 3GPP identifiers, e.g. a list of Tracking Area Identifiers (TAIs) or a list of cell IDs, RSFP Index.

3A or 3B. The UAS NF/NEF discovers a PCF handling AM Policy for the UE (Option 3A) or a serving AMF (Option 3B); for that the NEF invokes the NRF discovery service and uses UE’s identity.

3C. The UAS NF/NEF uses UDM service (Nudm\_UECM\_Get operation as specified in clause 5.2.3.2.4 of TS 23.502 [4]) to get an NF ID of the AMF serving the UE, i.e. with UE Context. In congestion with that, the UAS NF may invoke another service operation to UDM to retrieve UE’s subscription data and check whether the UE is compliant to NTZs requirements allowing the operator and the network to enforce NTZs.

If the UE’s subscription does not have the NTZ indication, the UAS NF notifies the AF/UTM by sending the response message and include the information about the results inside this message.

NOTE X2: It is up to UTM to decide for which purpose this information can be used; it is outside 3GPP scope.

4A. The UAS NF/NEF sends to the discovered PCF an Npcf\_AMPolicyAuthorization\_Create/Update request containing the translated NTZ information, e.g. a list of TAs/Cell IDs, and the original AF-provided NTZ information (prior the translation by the NEF).

5A. After receiving the NTZ information, the PCF takes policy decision and then may initiate the AM Policy Association Modification procedure for the UE/UAV as described in clause 4.16.2.2 of TS 23.502 [2] to provide the AMF with the NTZ information.

The PCF does not initiate the AM Policy Associations Modification and rejects (i.e., responds with the failure cause) the Npcf\_AMPolicyAuthorization\_Create/Update request in cases when the PCF does not receive information about the UE’s capability to respect NTZ during the AM Policy Association Establishment (see Step 16 in clause 4.2.2.2.2 of TS 23.502[4]). The PCF responds to the Npcf\_AMPolicyAuthorization\_Create/Update request (not shown in Figure 6.X.3-1), and the UAS NF/NEF responds to the AF (using Naf\_Authentication\_Notification response, not shown in Figure 6.X.3-1) to inform the UTM that the UE/UAV does not have capability required.

4B and 4C. If the UE’s subscription data contains the indication that the UE is compliant with NTZ requirements, the UAS NF/NEF sends an Nnef\_Authentication\_Notification request to the AMF/MME, containing the translated NTZ information, e.g. a list of TAs/Cell IDs, the original AF-provided NTZ information to the target AMF. If the UE subscription does not indicate the NTZ compliance, the UAS NF/NEF responds to the AF/UTM to notify that the UE/UAV does not have capability required.

6A and 6B. If the UE subscription check (i.e., compliance to NTZ requirements) has not been performed earlier in the procedure, the AMF/MME checks, based on the subscription data retrieved during the registration, whether the UE is compliant with NTZ requirements.

7. Based on the NTZ information, the AMF determine the relevant RAN node IDs and then sends N2 messages containing the NTZ information and include an indication to enforce (whenever required NTZ respect) to all applicable RAN nodes.

Editor’s Note: What actions and how RAN uses the delivered NTZ information is up to RAN WGs to study, and it is FFS.

NOTE X3: RAN can use the NTZ information to adjust information broadcasting, e.g., prevent UEs from moving from RRC\_IDLE/INACTIVE states to RRC\_CONNECTED state.

**Option 2: OAM configuration.**

1. RAN node(s) are configured by OAM with the existing NTZ information that can be requested by the AF/UTM from network’s nodes in the area they serve (e.g., based on RAN node location, Tracking Area(s) identified by a list of tracking area identities (TAI) or a list of cell identities).

2. AMF sends an N2 message with indication that the RAN needs to enforce NRZ after the Registration Completion.

**Option 3: AMF preconfiguration with NTZ information.**

0. AMF is preconfigured with sets of NTZ information that can be requested by the AF/UTM.

1. To request a specific NTZ requirements, the AF/UTM may use e.g. an index (a number) to a specific set; Steps (some or all), 3B/C, 4B/C, 6A, and 7 as in Option 1 are executed.

2. Delivery of the NTZ information together with the indication to enforce NTZ during NG interface Setup/Reconfiguration procedure, during Initial Context Setup/Modification procedure or PDU session resource management procedures.

Aerial UE

NG-RAN

AMF

PCF

NRF

NEF (UAS NF)

UDM

AF (UTM) NF)

1. Naf\_Authentication\_Notification incl. NTZ information

2. NTZ info translation into 3GPP identifiers (a list of TAs or Cell IDs)

3A/B. Nnrf\_NFDiscovery (discovery of a PCF/AMF )

3C. Discovery of the serving AMF (with UE Context) via UDM

4A. Npcf\_AMPolicyAuthorization\_Create/Update with the NTZ information (incl. translated and the original)

5A. PCF takes a policy decision, considering UE’s capability to respect NTZ, and may initiate the AM Policy Association Modification

4B/C. Nnef\_Authentication\_Notification request with NTZ information (incl. the translated and the original)

4C. Naf\_Authentication\_Notification response

6A/B. AMF performs UE’s subscription compliance check

7. Determination of relevant NG-RAN nodes and delivery of the NTZ information together with the indication to enforce NTZ respect in a N2 message

**NTZ delivery to RAN: Option 1 – via node-level signalling**

1. RAN nodes are configured via OAM to sets of NTZ information

**NTZ delivery to RAN: Option 2 – RAN configured via OAM**

0. AMF is preconfigured with sets of NTZ information

Steps 1, 3B/C, 4B/C, 6A, and 7 as in Option 1

2A. Delivery of the NTZ information together with the indication to enforce NTZ during NG interface Setup/Reconfiguration procedure

2B. Delivery of the NTZ information together with the indication to enforce NTZ during Initial Context Setup/Modification procedure or PDU session resource management procedures

**NTZ delivery to RAN: Option 3 – AMF preconfiguration**

**Figure 6.X.3-1: Procedure to provision RAN nodes (gNB/eNB) with the NTZ information.**

The main procedural steps to provide UEs with the NTZ information is shown in Figure 6.X.3-2.

**Option 1: RAN Mechanism**

1. UE preforms registration procedure as described in clause 4.2.2.2.2 of TS 23.502 [4].

2. AMF retrieves the subscription data from the UDM and checks whether the UE is compliant with NTZ requirements. If so, the AMF/MME sends N2 message with the indication to RAN that it shall enforce the NTZ whenever required.

3. RAN sends the received NTZ information.

**Option 2: Registration Accept**

1. UE to RAN: UEs sends a Registration Request message and include parameters as specified in clause 4.2.2.2.2 of TS 23.502 [4]. Additionally, if the UE has capabilities to respect no-transmit zones, the UE includes the indication about this capability to the network.

2. RAN to AMF: Once RAN selects an AMF, the RAN sends an N2 message containing N2 parameters (specified in Step 3 of clause 4.2.2.2.2 of TS 23.502 [4]) and the received Registration Request message from the RAN (as described in Step 1). The AMF stores information UE’s support for NTZ consideration in the UE Context.

3. If the AMF sees in the registration request information about UEs capability to respect NTZ, the AMF check whether UE subscription data includes indication about UEs compliance with NTZ requirements. If the UE is compliant with NTZs, the AMF may verify the UE’s location before replying with a Registration Accept/Reject message.

4. If the UE is allowed to operate at its present location, the AMF sends to the UE a Registration Accept message and includes inside the message the previously received NTZ information.

If the UE is not allowed to operate at its present location, the AMF may either: (1) send a Registration Reject message with a cause value indicating that the UE is not allowed to operate at the present UE location, or alternatively, (2) send a Registration Accept message in which the AMF includes a UE Radio Capability ID and/or RSFP Index the UE is allowed to operate.

5. If the UE receives a Registration Reject message with cause value indicating the UE/UAV is not allowed to operate in the present location due to NTZ requirements, the UE may attempt to perform an Emergency Registration.

AMF

UDM

PCF

RAN

Aerial UE

1. UE registration as specified in clause 4.2.2.2.2 of TS 23.502

2. N2 message with indication that RAN shall enforce NTZ

3. NTZ information delivery to the UEs with the corresponding subscription using RRC protocol

**NTZ delivery to UE: Option 1 – RRC protocol**

1. Registration Request incl. NTZ capability

2. N2 message to a selected AMF

3. Verification of UE’s location

4. Registration Accept message with the NTZ information or Registration Reject message

5. (If Registration Reject due to NTZ): Emergency Registration

**NTZ delivery to UE: Option 2 – Registration Accept**

**Figure 6.X.3-2: Procedure to providing UEs with the NTZ information.**

The overall NTZ procedure is as shown in Figure 6.X.3-3, and it includes:

1. NTZ information and the indication to enforce NTZ delivery to the relevant RAN nodes as described in Figure 6.X.3-1.

2. NTZ information delivery to UEs with the corresponding subscription, as described in Figure 6.X.3-2.

3. UE location determination. As an option, and depending on UTM requirements, the AMF may use the UE mobility event notifications to get information about UE’s presence in Area(s) of Interest, as specified in clause 5.3.4.4 of TS 23.501 [5].

4. In case of UE’s presence in the AoI: once the AMF detects the UE’s presence in the NTZ, the AMF sends an N2 message with a new value of 'Index to RAT/Frequency Selection Priority' (RFSP Index) to RAN nodes. Based on the received RSFP Index, the NG-RAN nodes decide about redirecting UEs to different frequency layers or RATs (as specified in clause 5.3.4.3.1 of TS 23.501 [5])

Furthermore, when UE transmits in NTZ but not allowed, we need to report to the SMF and UPF so that the UPF can actually block the UL traffic.

5. If there is any change in the provisioned NTZ information, the RAN nodes and UEs need to be re-provisioned with the newest NTZ information.

6. For UEs/UAV in CM\_CONNECT with RRC\_INACTIVE state or in CM\_IDLE, the AMF may initiate, based on the local policy, the Network Triggered Service Request procedure as described in clause 4.2.3.3 of TS 23.502 [4] before executing Step 3-5. If the UE is not updated while it was in IDLE, the AMF updates the UE next time it becomes available gain (e.g. RRC\_CONNECTED).

Aerial UE

NG-RAN

AMF

PCF

NRF

NEF (UAS NF)

UDM

AF (UTM) NF)

1. NTZ information delivery to the relevant RAN nodes, as described in Figure 6.X.3-1

2. NTZ information delivery to UEs with the corresponding subscription, as described in Figure 6.X.3-2

3. UE location or UE’s in the area of interest (i.e., in NTZ) determination

4. Notifying the AF/UTM about UE’s disobeying NTZ requirements (relies on response signaling of Option 1 in Figure 6.X.3-1)

5. Updating UEs and RAN nodes with the newest NTZ information

6. For UEs in CM\_IDLE, the AMF may initiate, based on local policy, the Network Triggered Service Request procedure (clause 4.2.3.3 of TS 23.502 [1])

**Figure 6.X.3-3: Procedure to support UE compliance with the provided NTZ information.**

### 6.X.4 Impacts on services, entities and interfaces

Impact depends on which options/alternatives selected for delivering NTZ information to UEs and RAN nodes and for updating them about any change from the AF/UTM. Overall, the impacts could be the following.

**AF:**

- Invoking a Naf\_Authentication\_Notification or a new service to request NTZ compliance from the network

- Receiving notifications when UEs enter or disobey NTZ requirements

**UAS NF/NEF:**

- Discovering a PCF handling AM policy,

- Discovering AMF serving the UE

- Retrieving information about UE’s subscription and checking whether the UE can comply with NTZ

- Translating the NTZ information to 3GPP identifiers such as TA, NG-RAN node identifiers, cell IDs.

**PCF:**

- Invoking AM Policy Association Modification due to NTZ

- **AMF:**

- Determining UE’s location/presence in the area of interest

- Checking UE’s subscription for NTZ compliance

- Informing PCF about UE’s capability to respect NTZ

- Informing RAN nodes about enforcing NTZ requirements

- Informing PCF about UE’s capability to respect NTZ

- Sending notifications when UE enters the NTZ

**RAN:**

- delivering NTZ information to the relevant UEs

- Enforcing NTZ compliance

**UE/UAV:**

- respecting NTZ requirements

- announces its capability to comply with NTZ requirements.

**UPF:**

- blocking UL data traffic for UEs in NTZ (FFS if/when needed).

>>>> End of Changes <<<<