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| Technical Report |
| 3rd Generation Partnership Project;Technical Specification Group Services and System Aspects;Study on architecture enhancements of UAS, UAV and UAM; Phase 3(Release 19) |
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# Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# 1 Scope

The present document is to investigate and identify potential architecture and system level enhancements to support additional scenarios and requirements for UAV (Uncrewed Aerial Vehicle) and UAM (Urban Air Mobility) including:

**-** Enhancement of NEF services to support service exposure and interactions between MNOs and UTM functions for i.e. pre-mission flight planning, in-mission flight monitoring, C2 communication reliability, interfacing with UTM (e.g. supporting the scenario of multiple USS serving the geographical areas corresponding to UAV flight path).

- Support of network-assisted/ground-based mechanism for DAA (Detect And Avoid).

- Support of no-transmit zones for UAVs.

# 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".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**No-transmit zones**: geographical area where aerial UE are not allowed to operate in a certain frequency band. The purpose and requirements of NTZ is described in [3].

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

DAA Detect and Avoid

NTZ No-Transmit Zone

NWDAA Network-Based/Assisted DAA

# 4 Architectural Assumptions and Requirements

## 4.1 Architectural Assumptions

The following architectural assumptions apply:

- For solutions to enable network-assisted/ground-based mechanism for DAA (Detect And Avoid),

- co-existence with and leveraging, to the extent possible, Direct DAA solutions specified in TS 23.256 [2] shall be considered.

- sensing related information is out of scope of this study.

- Regarding C2 communication reliability aspects in KI#1, only C2 over the Uu interface is considered in this study, and UAV using multiple-PLMN connectivity to support C2 communication reliability will not be considered in this release.

The following assumptions apply to the support of NTZ:

- NTZ may be defined according to regional/national requirements;

- an NTZ may map to one or more cells or a fraction of a cell, or overlap different cells in a mobile operator network.

NOTE: NTZ scope and mapping to cell(s) need to be coordinated with RAN WGs.

## 4.2 Architectural Requirements

Editor’s note: This clause provides list of architectural requirements, if needed.

- The existing procedures specified in TS 23.256 [2] should be reused as much as possible for solutions.

- Service exposure mechanisms defined in TS 23.256 [2] should be reused as much as possible.

# 5 Key Issues

## 5.1 Key Issue #1: Enhancement of NEF services to support service exposure and interactions between MNOs and UTM functions

### 5.1.1 Description

In this key issue, the following aspects are required to be studied:

- whether and how to enhance NEF services to support service exposure and interactions between MNOs and UTM functions for supporting i.e.,

- pre-mission flight planning and in-mission flight monitoring for UAVs.

- C2 communication reliability.

- the scenario of multiple USS serving different geographical areas corresponding to the UAV flight path.

NOTE: In the scope of this key issue, UTM can represent any authorized aviation AF that may require interaction with the MNO for the functions listed above.

## 5.2 Key Issue #2: Network-assisted/ground-based mechanism for DAA (Detect And Avoid) with 5GS information

### 5.2.1 Description

Network-assisted/ground-based mechanism for DAA (NWDAA) for tactical deconfliction, collision avoidance, and UTM control of UAV flight path, can be considered a complement for existing DAA based on the PC5 reference point specified in Rel-18.

In this key issue, the following aspects are required to be studied:

- Study whether and how to enable network-assisted/ground-based mechanism for DAA (Detect And Avoid);

- Any architectural impacts for the support of NWDAA;

- Whether and what information is needed for NWDAA;

- Study which existing information collected and generated in the 5GS can be utilised to enable NWDAA.

- Study whether any and what type of new information may be collected and/or generated in the 5GS to support NWDAA.

- Whether and how to provide UTM and UAVs with the information collected or generated by the 5G system for the purpose of NWDAA.

## 5.3 Key Issue #3: Support of No Transmit Zones

### 5.3.1 Description

This key issue relates to the introduction by CEPT 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 behavior 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.

# 6 Solutions

6.0 Mapping of Solutions to Key Issues

**Table 6.0-1: Mapping of Solutions to Key Issues**

|  |  |  |
| --- | --- | --- |
| **Solutions** |  |  |
|  | **<Key Issue #x>** | **<Key Issue #y>** |
| **#x** |  |  |
| **#y** |  |  |

6.X Solution #X: <Solution Title>

6.X.1 Key Issue mapping

Editor's Note: This clause lists the key issue(s) addressed by this solution.

6.X.2 Description

Editor's Note: This clause will describe the solution principles and architecture assumptions for corresponding key issue(s). Sub-clause(s) may be added to capture details.

6.X.3 Procedures

Editor's Note: This clause describes high-level procedures and information flows for the solution.

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

Editor's Note: This clause captures impacts on existing and/or new 3GPP nodes and functional elements.

# 7 Overall Evaluation

Editor’s Note: This clause provides evaluations of different solutions, if exists.

# 8 Conclusions

Editor's Note: This clause will list conclusions that have been agreed during the course of the study item activities.

Annex A (informative):
Background Information about No Transmit Zones

# A.1 CEPT Decision 22(07)

This is an extract of the CEPT Decision 22(07) for No Transmit Zones. In November 2022, CEPT made Decision 22(07) on Harmonised technical conditions for the usage of aerial UE for communications based on LTE and 5G NR in several bands harmonized for MFCN. The decision assumes multiple technical conditions and requirements to support aerial UEs in mobile systems (both LTE and NR). Two notable ones are no-transmit zone (NTZ) and out-of-band emission (OOBE) requirements, as shown in the following excerpt from the Decision (further details are in the Appendix):

|  |
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| In addition to the already harmonised technical conditions for MFCN bands and for spectrum compatibility purposes, there is the need to define some spectrum operational restrictions. This can be done using “no-transmit zones”, which should be defined at national level as a geographical area where aerial UE are not allowed to operate in a certain frequency band. Another measure to achieve coexistence is to define additional OOB emission limits specific to aerial UE (to avoid interference to other services in some other bands (e.g. to protect MetSat at 1675-1710 MHz) . The requirement may apply to aerial UE according to their operational frequency band, e.g. aerial UE operating in a specific band or specific channel (see no-fly zone definition set out in ECC Report 309, in this Decision referred to as “no-transmit zone”). In some cases, operation of aerial UE also requires respective cross-border coordination agreements.…**ECC Decision of 18 november 2022 on Harmonised technical conditions for the usage of aerial UE for communications based on LTE and 5g NR in the 703-733 MHz, 832-862 MHz, 880-915 MHz ,1710-1785 MHz, 1920-1980 MHz, 2500-2570 MHz and 2570-2620 MHz MFCN harmonised bands (ECC decision (22)07)**“The European Conference of Postal and Telecommunications Administrations,*Considering**…*1. that a no-transmit zone in this Decision is defined as a geographical area where aerial UE are not allowed to transmit for spectrum compatibility purposes in a given harmonised MFCN band or part of it;
2. that national studies are needed, as appropriate, to define no-transmit zones for spectrum compatibility purposes, for aerial UE operating in the relevant frequency bands;
3. that a mechanism is necessary to ensure that aerial UE respect no-transmit zones;

…*DECIDES**….*that no-transmit zones as described in this Decision should be defined and implemented at national level and where necessary coordinated with neighbouring countries; |

Some further details on no-transmit zones from the ECC Decision 22(07)

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| **A1.2 Operational conditions** The operational conditions to be defined and implemented at national level provide additional measures to the technical conditions in order to protect other services.**703-733 MHz: Protection of DTT receivers and RAS sites**Aerial UE operating in 703-733 MHz should not transmit when less than 30 m above ground level to avoid interference to DTT receivers;Nationally determined no-transmit zones are required around RAS sites operating in 1400-1427 MHz for aerial UE operating in the 703-718 MHz frequency band, as appropriate.**832-837 MHz: Protection of RAS sites**Nationally determined no-transmit zones are required around RAS sites operating in 1660-1670 MHz for aerial UE operating in the 832-837 MHz frequency band, as appropriate.**2500-2570 MHz/2570-2620 MHz: Protection of RAS sites and radars**Nationally determined no-transmit zones are required around RAS sites operating in 2690-2700 MHz for aerial UE operating in the 2500-2570 MHz or 2570-2620 MHz frequency band, as appropriate;Nationally determined no-transmit zones might be required around radars operating in 2700-2900 MHz for aerial UE operating in the 2500-2570 MHz or 2570-2620 MHz frequency band. |

Annex B (informative):
Change history

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| Change history |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| January 2024 | SA2#160e-adhoc |  |  |  |  | First version of the TR skeleton produced | 0.0.0 |
| January 2024 | SA2#160-Ad Hoc-e | S2-2400169, S2-2401814, S2-2401815, S2-2401816, S2-2401817, S2-2401818, S2-2401819 |  |  |  | Approved pCRs implemented |  0.1.0 |