3GPP TSG-SA WG2#160-Ad Hoc-e S2-2403273

Electronic Meeting, 22-29 January 2024 (was S2-2402067)

**Source: Qualcomm Incorporated**

**Title: NewSol KI#2: Network-based localized tactical deconfliction**

**Document for: Discussion/Approval**

**Agenda Item: 19.10**

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

*Abstract of the contribution: the P-CR introduces a solution for KI#2.*

# 1. Discussion

## 1.1 Requirements

FS\_UAS\_Ph3 includes the following work task:

**WT#2:** Based on SA1 requirements, study whether and how to enable network-assisted/ground-based mechanism for DAA (Detect And Avoid) that leverages information collected and generated in the 5GS, including whether and what new information is needed.

NOTE 1: The solution shall co-exist with and leverage, to the extent possible, Direct DAA solutions considered in Release 18.

NOTE 2: Sensing related information is out of scope of this study.

The following requirements from TS 22.125 (clause 6.6 “UAV Safety”) apply:

[R-6.6-002] **Based on operator’s policy, the 5G system shall be able to support a method to monitor and provide a 3rd party with information about deviations and violations along a UAV flight path and time.**

NOTE: Deviations can be e.g., in location and/or time with respect to the original flight plan. Violations can be e.g., with respect to exclusion zones provided together with the flight plan or known via other means.

[R-6.6-003] **Based on operator’s policy, the 5G system shall be able to support a method to provide UTM and UAVs with the information collected or generated by the 5G system (e.g., based on sensing results), including e.g., the location or relative distance between 3GPP UAVs and other flying objects (can be drones not using 3GPP connectivity)**.

[R-6.6-005] **Based on MNO policies and/or regulatory requirements, the 5G system shall be able to inform the UTM, when the 5G system detects a specific UAV condition or event, in order to enable UTM control of the UAV communication (e.g., when detecting violation of exclusion zones or maximal distance between UAVs).**

## 1.2 Key Issue

Key issue #2 titled “Key Issue #2: Network-assisted/ground-based mechanism for DAA (Detect And Avoid) with 5GS information” contains the following work description:

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.

# 2. Text proposal

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

>>>>BEGINNING OF CHANGES<<<<

## 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<<<<

## 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

LDS Localized DAA Server

NTZ No-Transmit Zone

NWDAA Network-Based/Assisted DAA

>>>>NEXT CHANGE<<<<

(all new text)

## 6.X Solution #X: Network-supported Tactical Deconfliction

### 6.X.1 Key Issue mapping

This solution applies to Key Issue #2.

### 6.X.2 Description

### 6.X.2.1 Introduction

Sense and Avoid (SAA), Detect and Avoid (DAA), or tactical deconfliction systems are technologies that allow unmanned aerial vehicles (UAVs) and drones to integrate safely into civilian airspace, avoiding collisions with other aircraft, buildings, power lines, birds and other obstacles. These systems observe the environment surrounding the drone, decide whether a collision is imminent, and generate a new flight path to avoid collision.

Traditional UAV sense and avoid systems may combine data from communication interfaces (e.g. A2X), a number of sensors, using sensor fusion algorithms, image recognition and artificial intelligence to provide the best outcome. Data is fed back to the drone on-board computer and/or drone flight controller, which can then decide on the best evasive maneuver or flight path correction to avoid collision. A reliable onboard DAA system is crucial for obtaining a waiver for flight operations in many jurisdictions that typically otherwise require human observers or ground-based observation systems along the entire flight path. DAA systems are thus key to unlocking commercially viable BVLOS (beyond visual line of sight) drone operations that provide services such as inspection and cargo delivery over extremely long distances.

Regulations regarding tactical deconflictions are being developed, and they traditionally refer to solution components that employ a ground component in order to:

- Not having to rely fully on RPS (remote Pilot Station)/UAVC (UAV controller)/GCS (Ground Control Station)/human pilot

- Leverage the high level of automation that is already widely available in aerial vehicles, while at the same time not relying solely on aerial vehicle awareness of surrounding traffic

- Leverage ground networks ability to have higher spatial awareness of traffic

In the scope of this solution, we use the term Network-based DAA (NWDAA) to refer to tactical deconfliction solutions that utilize a network-based or ground-based component to collect, elaborate, and distribute tactical deconfliction information.

### 6.X.2.2 Solution Overview

The solution proposed assumes the deployment of an AIML-based localized USS/UTM function tailored specifically to provide NWDAA services to UAVs and UTM. We identify this function as Localized DAA Server (LDS) for tactical deconfliction. We assume that LDS is a functionality separate from USS/UTM due to the different service it provides, and the fact that LDS may be provided by the MNO.

The solution is based on the following assumptions:

- The LDS provides a subscription-based service, available to all aerial UEs or a subset of the aerial UE (identified by the aerial subscription introduced in Rel. 15)

- LDS nodes elaborate spatial awareness based on information collected on UAVs and potentially other aerial vehicles

- LDS collects spatial awareness information from a set of sources: UAVs, sensors (e.g. radar station, ADS-B receivers, A2X receivers, etc.). The location of such sensors and interfacing with the LDS is dependent on deployment

- LDS may belong to the MNO domain or may be provided by a 3rd party

Editor’s Note: how trust of LDS is assured (including LDS authorization) and how a 3rd party LDS can access NWDAF and NEF services is FFS.

- A UAV may be visible to multiple LDSs. Only one LDS interacts and serves a UAV UE, but multiple LDSs may consider a specific UAV UE presence and information

- LDS could interact with NDWAF and leverage information obtained by NDWAF

NOTE: no new services for NWDAF are proposed in this solution, but if new services related to UAV become available, the LDS is assumed to be able to access those.

- Each LDS serves a specific area

- an LDS implements conflict detection and traffic separation algorithms and collision notification features across one or more mobile network cells

- the LDS service area is configured in the LDS and may be configured in the PLMN. It is assumed that an LDS may communicate the serving area to UTM.

- The LDS obtains situational awareness information about UAVs (e.g. UAV identity, location, flight vectors) and potentially additional situational awareness about the airspace (e.g. obstacle identification, manned aircraft that transmit ADS-B)

- The LDS may leverage NEF/UAS NF services for interaction with UTM/USSs

- LDS may obtain specific UAVs flight plans

- LDS may report potential or actual conflicts to UTM, and receive instructions and configuration information from the UTM

- LDS may provide via NEF exposure Aerial congestion information API and UAV information to USS to support USS in flight authorization

- LDS is assumed to communicate with USS via UAS NF/NEF, and as such LDS is not required to know the serving USS, and the serving USS is not required to know the serving LDS function, i.e. no information about the serving USS is provided to the LDS, and the LDS is not required to discover the serving USS. The UAV communicates with LDS providing the current CAA-Level UAV ID, and the LDS uses the CAA-Level UAV ID to discover the serving UAS NF and provide the information together with the CAA-level UAV ID. The UAS NF can then forward such information to the USS(s) serving the UAV associated to the CAA-Level UAV ID received from the LDS.

- for any asynchronous request from USS to the LDS, it is assumed that the LDS serving a UAV ID registers itself with the serving UAS NF for the UAV ID using the CAA-Level UAV ID to indicate which UAV UE it is serving

- The serving LDS for a UAV may change during the flight path of the UAV, and the UAV context is moved between UAVs using application layer mechanisms.

- Connectivity between the UAV and the LDS is over user plane, and it is assumed that a dedicated PDU session is established to enable such communication (e.g. to leverage edge connectivity).

Editor’s Note: re-use of existing PDU sessions (e.g. for UAV-UTM communications) is FFS.

NOTE: edge relocation mechanisms may be used to relocate the serving LDS for a UAV.

### 6.X.2.3 Solution Architecture

The solution assumes that the LDS is deployed by the MNO at the edge of the network, and communications over the UAV and the LDS are carried out over user plane.

The LDS can interface with NEF/UAS NF using existing or new/extended service exposure functionality.

### 6.X.3 Procedures

### 6.X.3.1 Overall Information Flow

The following logical flow is assumed:



**Figure 6.X.3.1-1: Overall Information Flow for NWDAA Solution.**

NOTE: steps 4 to 7 are exchanged at application layer and are outside the scope of 3GPP. They are described here to provide an overview of how the solution would work as a whole.

1. The UAV registers to the 5G System using existing procedures, with the enhancements described in this solution.

2. The UAV establishes connectivity with the LDS server. This may include authorization and authentication of the UAV to be enabled to access LDS services. This may also include the UAV receiving policy information on LDS availability, and on LDS communication (what information is to be exchanged, and at what frequency, etc.). The LDS server registers itself with the UAS NF of the UAV and provides the CAA-Level UAV ID of the UAV.

3. At any time the LDS may retrieve UAV-related information from USS via NEF, e.g. the UAV flight plan or any other information that supports LDS functionality

Editor’s Note: whether an existing NEF service is used or a new one needs to be defined will be determined during normative phase.

4. The UAV sends information to the LDS according to the policies received in step 2. This includes information about the UAV (e.g. CAA-Level UAV ID, location, flight vector, etc.), and information received by the UAV via A2X and regarding other UAVs visible to the UAV. The LDS may also receive information from other sources, e.g. ADS-B receivers, radar stations, etc.

5. Upon detecting a potential conflict, the UAV may indicate the conflict to the LDS and request deconfliction assistance

6. Based on information received at step 4 or based on conflict detection performed autonomously by the LDS, the LDS may send deconfliction information or warn the UAV of potential conflict. The UAV may exchange such information with the UAVC for deconfliction actions.

7. Based on information received at step 4 or based on an urgent and serious conflict detection performed autonomously by the LDS, the LDS may send emergency directives to one or more UAVs. It is expected that emergency directives are processed locally and autonomously by the UAV, and the UAV may inform the UAVC.

8. At any time the LDS may interact with the USS via NEF to provides aerial congestion/conflict information to support flight planning in USS

9. At any time the USS may subscribe to LDS service notifications regarding a specific UAV.

It is assumed that a UAV UE that is capable of LDS indicates it supports NWDAA in NAS signaling capabilities as described in the following sections.

LDS service may not be available ubiquitously in the whole serving network; therefore an indication of LDS Service Area needs to be provided to the UAV. The network may provide to the UAV UE that has indicated LDS support and is subscribed to LDS whether LDS is available or not and may provide an LDS Service Area (e.g. whole PLMN, current RA, list of TAs, etc.). This may be generated by the AMF based on OAM configuration and provided to the UE directly in MM signaling or passed to the SMF and returned to the UAV UE upon successful establishment of PDU session for UAS services.

### 6.X.3.2 UAV-LDS Connectivity Establishment for LDS@Edge

UAV UE that is capable of LDS provides the LDS indication during a PDU Session Establishment for UAS services as described in TS 23.256 and may be for a PDU session established for C2, for C2 and UTM services, or dedicated for LDS services depending on UAV UE configuration as to which DNN shall be used for LDS services. UUAA-SM may be extended to contain an indication that the UAV is requesting LDS service, to enable UTM to authorize the use of LDS service and to authorize the specific LDS server. The UUAA-SM may return to the SMF information about the LDS server(s).

Upon successful PDU session establishment for LDS services, the UAV is provided by the SMF with information on how to reach the LDS, and the UAV establishes connectivity with the LDS directly using application layer signaling outside the scope of this solution.

NOTE: it is expected that security mechanisms may be required to ensure the UAV is authorized to access the LDS. This may require the LDS to perform an additional UUAA procedure, or an additional security mechanism may be required.



**Figure 6.X.3.2-1: UAV-LDS Connectivity Establishment for LDS@Edge.**

1. The UAV UE registers to the network

2. UAVE UE provide the LDS indication to the SMF in the PDU Session Establishment request. This may be during the establishment of a PDU session for UAS services as described in TS 23.256, for a PDU session established for C2, for C2 and UTM services, or a dedicated PDU session for LDS services depending on UAV UE configuration as to which S-NSSAI/DNN shall be used for LDS services.

3. The SMF verifies the LDS subscription and may perform UUAA-SM, depending on the type of PDU session being used.

4. Upon successful PDU session establishment, the SMF provides indication that LDS is available and authorized, and provides information on how to reach the LDS

5. The UAV UE establishes connectivity with the LDS directly using application layer signaling outside the scope of this solution.

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

The following entities are impacted:

- UE:

- NWDAA capability indication in 5GSM

- ability to receive policies for LDS information transmission

- ability to receive LDS@Edge addressing information transmission

- SMF:

- verify LDS service subscription

- configuration of LDS service availability

- provide UAV UE with LDS information

- receive LDS information and policies from PCF (optional)

- NEF/UAS NF:

- extend existing services or define new services for interaction between LDS and UTM

- UDM: optional indication of NWDAA service subscription

The following impacts on services are identified:

- UUAA-SM extended to carry LDS information (information may be in existing payload or new payload and does not impact NEF/UAF NF)

- Existing NEF services may be extended, or new ones defined, to enable the UTM to subscribe to LDS services (e.g. even reporting for potential or identified traffic conflicts)

- Existing NEF services may be extended, or new ones defined, to enable the UTM to provide UAV flight plan and additional UAV information to LDS

NOTE: the specific impacts on NEF services will be identified during normative phase.

>>>>END OF CHANGES<<<<