**3GPP SA WG2 Meeting #161** **S2-2402441**

**Athens 26 Feb-1 March, 2024**

**Source: Nokia, Nokia Shanghai Bell**

**Title:** **KI #1: New Sol**:Monitoring & reporting of UAV flight path deviation

**Document for:** **Approval**

**Agenda Item: 19.10**

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

Abstract of the contribution: The contribution proposes a solution to

KI#1: Enhancement of NEF services to support service exposure and interactions between MNOs and UTM functions.

# Introduction

This contribution proposes a solution for monitoring and exposing UAV flight path deviation via NEF.

# Discussion

A UAV starts a flight mission after the flight path authorization is performed by the USS/UTM.

The UAV sends Networked Remote Identification (NRID) information to USS/UTM on a regular interval (depends on regulatory requirements) that also contains the location of the UAV.

USS/UTM, however, does not have any mechanism to confirm whether the UAV is actually following the authorized flight path or deviating from it.

It is critical from USS/UTM functionality (e.g. Flight planning, DAA – Detect and Avoid, etc.) point of view to ensure that the UAV is following the authorized flight path or at least know if/when a UAV is deviating from the authorized flight path, so that it can manage the UAV traffic accordingly and take other appropriate actions.

When the UAV is using cellular connectivity for critical communication like command and control (C2), NRID, telemetry, etc. network determined location information of the aerial UE could be used to validate the location reported by the UAV. However, such information is currently not exposed to the USS/UTM.

The solution introduces a new NWDAF analytics (new analytics Id=FlightPathDeviation). The NWDAF can collect the UE flight path report from NG RAN, collects periodic location reports for the UE from the GMLC or UE MDT reports and compares them with the authorized flight path (information received from the USS/UTM) to determine if the UE is following the authorized flight path or is deviating from it.

The notion of deviation can be defined in terms of threshold crossing considering longitude, latitude, height and time or in terms of a violation considering certain conditions. Such policy may include the flight path coordinates, time schedule, event conditions and absolute distance values or function that is used to derive the limits of the deviation. When a deviation is detected, the NWDAF reports the deviation to the USS/UTM via the NEF.

# Proposal

A solution is proposed for KI#1 for incorporation in the FS\_UAS\_Ph3 TR23.700-59.

\*\*\* Start of changes (all new text) \*\*\*

## 6.X Solution #X: UAV flight path deviation exposure

### 6.X.1 Key Issue mapping

This solution aims to resolve

Key Issue #**1**, "Enhancement of NEF services to support service exposure and interactions between MNOs and UTM functions " and

### 6.X.2 Description

The solution also makes use of UE flight path reporting feature (AAM). It is assumed, in this solution, the UE flight path reporting is also implemented/available in 5G NR. Alternatively, or complementary, this solution can use MDT reports that also bring an insight of the radio conditions and UE location. The solution further proposes enhancements where the reporting can be triggered by an NF/AF (e.g. NEF) via the AMF on the NG RAN and then the NG RAN configures the UE to report its flight path (see steps 2 and 4a in the call flow diagram).

### 6.X.3 Procedures

#### 6.X.3.1 Monitoring & reporting of UAV flight path deviation

The USS/UTM (acting as an external AF) can access 3GPP exposed services using public identifier of the UE (used in the UAV). Below pre-conditions apply:

* When UAV authentication/authorization procedure is used:
	+ UAV is authenticated during PDU session establishment (or optionally at 5GS registration) by USS/UTM.
	+ 3GPP system provides the public identifiers (e.g. 3GPP UAV ID, IP address) of the UE (used in the UAV) to the USS/UTM.
	+ USS/UTM uses the public identifier of the UE to access 3GPP exposed services.
* Or UAV authentication/authorization procedure is not used:
	+ UAS operator provides the serving MNO information and the public identifier (e.g. 3GPP UAV ID) of the UE (used in the UAV) to the USS/UTM.
	+ USS/UTM uses the public identifier of the UE to access 3GPP exposed services.



**Figure 6.X.3.1-1: Monitoring and reporting of UAV flight path deviation using NWDAF analytics.**

1. The USS/UTM sends a request for flight path monitoring of a UE (used in a UAV) to NEF/UAS NF. The request contains at least the following information elements:
	1. UE ID (i.e 3GPP UAV ID) or group of UE Ids)
	2. the authorized flight path in 3D way points along with estimated time,
	3. the acceptable deviation from the authorized flight path expressed in 3D distance deviation and/or time deviation (absolute or relative units).
	4. Conditions, e.g. that may alter or define differently the acceptable 3D deviation including the dimension of time.
2. NEF triggers UE flight path reporting at NG RAN (via AMF). The NG RAN further configures the UE to report its flight path periodically and/or triggered. Alternatively, this can be done by NWDAF at step 4a (i.e. step 2 is skipped), taking advantage of MDT reports.
3. NEF subscribes to new flight path monitoring analytics from NWDAF. The request contains, at least the following information elements:
	1. (a new) Analytics ID=FlightPathDeviation,
	2. the UE ID,
	3. the authorized flight path in 3D way points along with estimated time,
	4. the acceptable deviation or the means (e.g. function) to derive the acceptable deviation considering certain conditions (e.g. weather) from the authorized 3D flight path in the form of:
		1. Acceptable 3D deviation in distance (absolute or relative units).
		2. Acceptable deviation in time (absolute or relative units).
4. Implementation alternatives
5. As an implementation alternative, NWDAF can trigger the UE flight path reporting, instead of NEF doing it in step 2.
6. Or NWDAF subscribes to periodic UE location reporting via GMLC or MDT reports.
7. NWDAF collects UE flight path report from NG RAN (via OAM) and the UE location reporting via GMLC.

NOTE 1: If the UE flight path reporting feature in NR is implemented in a way that for an aerial UE (aerial UE indication provided by AMF to NG RAN during UE registration), NG RAN always enables UE flight path reporting, then steps 2 and 4a can be skipped.

NOTE 2: When the UE is configured by NG RAN to report flight path (either implicitly or with step 2 or step 4a), the UE reports flight path information (waypoints defined as 3D locations as defined in TS 36.355) to the NG RAN node serving the UE. The report is configured to contain time stamps per waypoint.

1. NWDAF analyses/compares the UE location report received through GMLC or MDT reports and the UE flight path report collected from NG RAN with the authorized flight path information received in the request from USS/UTM (forwarded by NEF).
2. NWDAF first verifies if the UE reported flight path information (collected from NG RAN) matches with the corresponding location reports received from GMLC (requested in 4b). If the two reports do not match, then the NWDAF reports it to the USS/UTM (via NEF) in step 6.
3. If the UE reported flight path information matches with the GMLC reported location, the NWDAF then further compares the UE reported flight path with the authorized flight path information received in the request from USS/UTM. The NWDAF also takes into consideration “acceptable deviation” information received as input in the request from USS/UTM.

If a flight path deviation is found, the NWDAF reports it to USS/UTM via the NEF. The report also contains information on detected deviation points (e.g. 3D location) or detected deviation time or both, and confidence of the reported deviation.

NOTE 3: The GMLC based location reporting towards NWDAF described in step 2, 4 & 5 is based on the existing procedure defined in clause 5.3.2 in TS 23.256. The NWDAF may use the same exposure used for location tracking services by the USS. No new RAN location reporting is assumed in this solution.

NOTE 4: The NWDAF can collect location information from 5GC and/or RAN without using NEF and create analytics for acceptable deviation path.

Editor’s Note: No new MDT enhancement is assumed for this solution. It is FFS, whether existing MDT reports are applicable and/or accurate for UAV UEs.

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

AMF

* Impact for supporting new periodic reporting.

NWDAF

* Support for new analytics ID and analytics event.

NEF

* Potential impact to existing exposure API due to new analytics, if any.

UE

* Support for new location reporting if any.

\*\*\* END of changes \*\*\*