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Unmanned Aerial System (UAS) support in 3GPP
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Contents

Foreword

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

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Introduction

Interest in using cellular connectivity to support Unmanned Aerial Systems (UAS) is strong, and the 3GPP ecosystem offers excellent benefits for UAS operation. Ubiquitous coverage, high reliability and QoS, robust security, and seamless mobility are critical factors to supporting UAS command and control functions. In parallel, regulators are investigating safety and performance standards and Registration and licensing programs to develop a well-functioning private and civil UAS ecosystem which can safely coexist with commercial air traffic, public and private infrastructure, and the general population.

The 3GPP system can provide control plane and user plane communication services for UAS. Examples of services which can be offered to the UAS ecosystem includes data services for command and control (C2), telematics, UAS-generated data, remote identification, and authorisation, enforcement, and regulation of UAS operation.

1 Scope

The present document identifies the requirements for operation of Unmanned Aerial Vehicles (UAVs) via the 3GPP system.

This includes requirements for meeting the business, security, and public safety needs for the remote identification and tracking of UAS linked to a 3GPP subscription.

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] FAA UTM Concept of Operations v1.0, Foundational Principles, Roles and Responsibilities, Use Cases and Operational Threads https://utm.arc.nasa.gov/docs/2018-UTM-ConOps-v1.0.pdf

[3] FAA Remote Identification, https://www.faa.gov/uas/research_development/remote_id/

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP 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 3GPP TR 21.905 [1].

Unmanned Aerial System (UAS): Composed of Unmanned Aerial Vehicle (UAV) and related functionality, including command and control (C2) links between the UAV and the control station, the UAV and the network, and for remote identification. An UAS may comprise of a UAV and a UAV controller.

Unmanned Aerial System Traffic Management (UTM): a set of functions and services for managing a range of autonomous vehicle operations.

UAV controller: The UAV controller of a UAS enables a drone pilot to control an UAV. BVLOS Beyond Visual Line of Sight

3.2 Symbols

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

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

BVLOS	Beyond Visual Line of Sight
C2	Command and Control
Remote ID	Remote Identification [3]
UAS	Unmanned Aerial System
UAV	Unmanned Aerial Vehicle
UTM	Unmanned Aerial System Traffic Management [2]

4 Overview on UAS

4.1 General

An Unmanned Aerial System (UAS) is the combination of an Unmanned Aerial Vehicle (UAV), sometimes called a drone, and a UAV controller. A UAV is an aircraft without a human pilot onboard – instead, in some cases. the UAV can be controlled from an operator via a UAV controller and will have a range of autonomous flight capabilities. The communication system between the UAV and UAV controller is, within the scope of this specification and in some scenarios, provided by the 3GPP system. The UAS model considers also the scenario where the UAV controller communicates with the UAV via mechanisms outside the scope of 3GPP.

UAVs range in size and weight from small, light aircraft often used for recreational purposes to large, heavy aircraft which are often more suited to commercial applications. Regulatory requirements vary across this range and vary on a regional basis.

The communication requirements for UAS cover both the Command and Control (C2) between UAV and UAV controller, but also data uplink and downlink to/from the UAS components towards both the serving 3GPP network and network servers.

Unmanned Aerial System Traffic Management (UTM) is used to provide a number of services to support UAS and their operations including but not limited to UAS identification and tracking, authorisation, enforcement, regulation of UAS operations, and also to store the data required for UAS(s) to operate. It also allows authorised users (e.g., air traffic control, public safety agencies) to query the identity and metadata of a UAV and its UAV controller.

5 Requirements for Remote Identification of UAS

5.1 General

The 3GPP system should enable UTM to associate the UAV and UAV controller, identify them as a UAS.

The 3GPP system shall enable a UAS to send UTM the UAV data which can contain: unique identity (this may be a 3GPP identity), UE capability of the UAV, make & model, serial number, take-off weight, position, owner identity, owner address, owner contact details, owner certification, take-off location, mission type, route data, operating status.

The 3GPP system shall enable a UAS to send UTM the UAV controller data which can contains: unique identity (this may be a 3GPP identity), UE capability of the UAV controller, position, owner identity, owner address, owner contact details, owner certification, UAV operator identity, UAV operator license, UAV operator certification, UAV pilot identity, UAV pilot license, UAV pilot certification and flight plan.

The 3GPP system shall enable a UAS to send different UAS data to UTM based on the different authentication and authorizations level which are applied to the UAS.

NOTE: Subject to the regional regulation, the different authentication and authorization levels can be: the initial network access authentication and authorization, UAS identity authentication, UAV flight plan authorization, additional UMT service authentications, such as flight monitoring, collision avoidance services, so on.

The 3GPP system shall support capability to extend UAS data being sent to UTM with the evolution of UTM and its support applications in future.

Based on regulations and security protection, the 3GPP system shall enable a UAS to send UTM the identifiers which can be: IMEI, MSISDN, or IMSI, or IP address.

The 3GPP system shall enable a UE in a UAS to send the following identifiers to a UTM: IMEI, MSISDN, or IMSI, or IP address

The 3GPP system should enable an MNO to augment the data sent to a UTM with the following: network-based positioning information of UAV and UAV controller.

NOTE: This augmentation may be trust-based (i.e. the MNO informs the UTM that the UAV position information is trusted) or it may be additional location information based on network information.

NOTE: This requirement will not be applied to the case which the UAS and UTM has direct control communication connection without going through MNO.

The 3GPP system shall enable UTM to inform an MNO of the outcome of an authorisation to operate.

The 3GPP system shall enable an MNO to allow a UAS authorisation request only if appropriate subscription information is present.

The 3GPP system shall be able to provide UTM with the identity/identities of a UAS.

The 3GPP system shall enable a UAS to update a UTM with the live location information of a UAV and its UAV controller.

The 3GPP network should be able to provide supplement location information of UAV and its controller to a UTM.

NOTE: This supplement may be trust-based (i.e. the MNO informs the UTM that the UAV position information is trusted) or it may be additional location information based on network information.

The 3GPP network shall support UAVs and the corresponding UAV controller are connecting to different PLMNs at the same time.

The 3GPP system shall provide the capability for network to obtain the UAS information regarding its support of 3GPP communication capabilities designed for UAS operation.

The 3GPP system shall support the UAS identification and subscription data which can differentiate the UAS with UAS-capable UE and the UAS with non-UAS-capable UE.

NOTE: UAS-capable UE refers to the UE which support interaction capability with UTM and certain 3GPP communication features which 3GPP provides for UAS

The 3GPP system shall support detection, identification and reporting of problematic UAV(s) and the UAV controller to a UTM.

5.2 Centralised UAV traffic management

The 3GPP system shall provide a mechanism for a UTM to provide route data, along with flight clearance, to a UAV.

The 3GPP system shall be able to deliver route modification information received from a UTM to a UAS with a latency of less than 500ms.

The 3GPP system shall be able to deliver the notifications received from a UTM to a UAV controller with a latency of less than 500ms.

Based on MNO policies and/or regulatory requirements, the 3GPP system shall enable the UTM to take over the communication used to control the UAV.

5.3 Decentralised UAV traffic management

The 3GPP system shall enable a UAV to broadcast the following data for identifying UAV(s) in a short-range area for collision avoidance: e.g. UAV identities if needed based on different regulation requirements, UAV type, current location and time, flight route information, current speed, operating status.

The 3GPP system shall be able to support a UAV to transmit a message via network connection for identifing itself as an UAV to y the other UAV(s).

The 3GPP system shall enable UAV to preserve the privacy of the owner of the UAV, UAV pilot, and the UAV operator in its broadcast of identity information.

The 3GPP system shall enable a UAV to receive local broadcast communication transport service from other UAV in short range.

A UAV shall be able to use a direct UAV to UAV local broadcast communication transport service in the coverage or out of coverage of a 3GPP network.

A UAV shall be able to use a direct UAV to UAV local broadcast communication transport service when the sending and receiving UAVs are served by the same or different PLMNs.

The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service at relative speeds of up to 320kmph.

The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service with variable message payloads of 50-1500 bytes, not including security-related message component(s).

The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service which can ensure separation between UAVs, in which UAVs are considered as separated if they are at a horizontal distance of at least 50m or vertical distance of [30]m or both.

The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service which supports a range of up to 600m.

The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service which can transmit messages at a frequency of at least 10 messages per second.

The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service which can transmit messages with an end-to-end latency of at most 100ms.

The UAV shall be able to locally broadcast its identity with a rate of at least once per 1s.

The UAV shall be able to locally broadcast its identity up to a range of 500m.

5.4 Security

The 3GPP system shall protect the transport of data between the UAS and UTM.

The 3GPP system shall protect against spoofing attacks of the UAS identities.

The 3GPP system shall allow non-repudiation of data sent between the UAS and UTM at the application layer.

The 3GPP system shall support the capability to provide different levels of integrity and privacy protection for the different connections between UAS and UTM as well as the data being transferred via those connections.

The 3GPP system shall support confidentiality protection of identities related to the UAS and personally identifiable information.

The 3GPP system shall support regulatory requirements (e.g. Lawful Intercept) for UAS traffic.

Annex A (informative): UAS Reference Model

A.1 UAS Reference Model in 3GPP ecosystem

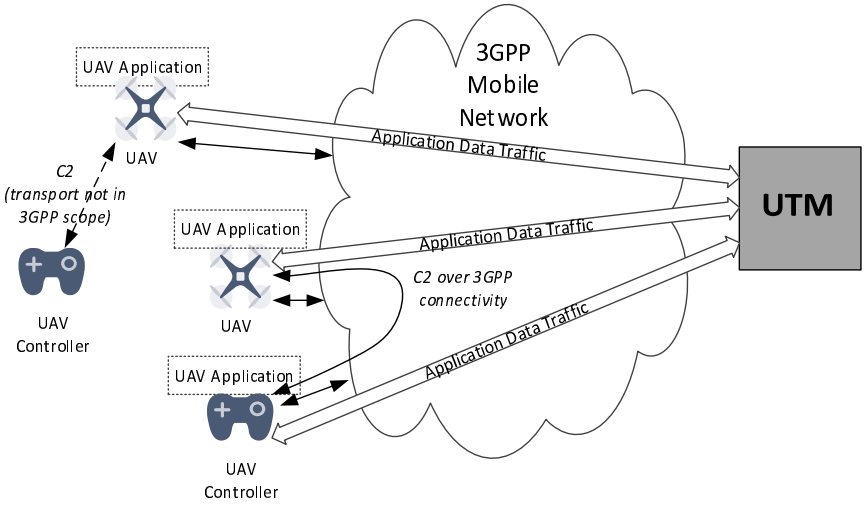

Figure B.1-1: UAS model in 3GPP ecosystem.

In the UAS reference model:

- an UAS is composed by one UAV controller and one or more UAV(s)
- UAVs are connected over cellular connectivity
- a UAV may be controlled by a UAV controller connected via the 3GPP mobile network
- a UAV may be controlled by a UAV controller not connected via the 3GPP mobile network, using a C2 interface not in 3GPP scope
- a UAV controller connected via the 3GPP mobile network may control one or more UAV(s)
- the UAS exchanges application data traffic with a UTM

Annex B (informative): Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
24/08/2018	SA1#83	S1-182766	-	-	-	Skeleton created	0.1.0
16/11/2018	SA1#84	S1-183278	-	-	-	TS22.125 v0.2.0 created to include agreements at this meeting	0.2.0
2018-12	SA#82	SP-181009	-	-	-	Presentation for one-step approval to SA	1.0.0
2018-12	SA#82	SP-181009	-	-	-	Raised to v.16.0.0 following SA#82's one step approval	16.0.0
2019-03	SA#83	SP-190083	0001	2	C	Removal of requirement on enforcement	16.1.0
2019-03	SA#83	SP-190083	0005	1	F	Detect and report the problematic UAV controller to UTM	16.1.0
2019-03	SA#83	SP-190083	0009	1	F	Clarification for identity of UAV controller data	16.1.0
2019-03	SA#83	SP-190083	0008	1	B	Addition for Abbreviations	16.1.0
2019-03	SA#83	SP-190083	0003	3	F	Clarification of Centralized UTM	16.1.0
2019-03	SA#83	SP-190083	0004	3	F	Clarification of Decentralized UTM for Collision Avoidance	16.1.0
2019-03	SA#83	SP-190083	0002	2	F	Clarification of UTM Definition	16.1.0
2019-03	SA#83	SP-190083	0006	3	B	Definition and Clarification for UTM	16.1.0
2019-06	SA#84	SP-190300	0010	3	F	Rewording the enforcement requirement in section 5.2	16.2.0
2019-09	SA#85	SP-190801	0021	2	F	Clarifications on UAS terminology and model	16.3.0

History

Document history		
V16.3.0	November 2020	Publication