3GPP Release 17 – Building Blocks for UAV Applications

ATIS-I-0000092
July 2022

Abstract

This report describes how mobile networks supporting the Third Generation Partnership Project (3GPP) Release 17 specifications can enable uncrewed aerial vehicle (UAV) applications. It discusses how 3GPP's work fits with other specifications to address UAV needs and shows how the 3GPP system can be used to enhance the opportunities to safely use UAVs for commercial and leisure applications.

Foreword

As a leading technology and solutions development organization, the Alliance for Telecommunications Industry Solutions (ATIS) brings together the top global ICT companies to advance the industry's most pressing business priorities. ATIS' nearly 200 member companies are currently working to address the all-Internet Protocol (IP) transition, 5G, network functions virtualization, big data analytics, cloud services, device solutions, emergency services, M2M, cyber security, network evolution, quality of service, billing support, operations, and much more. These priorities follow a fast-track development lifecycle — from design and innovation through standards, specifications, requirements, business use cases, software toolkits, open source solutions, and interoperability testing.

ATIS is accredited by the American National Standards Institute (ANSI). The organization is the North American Organizational Partner for the 3rd Generation Partnership Project (3GPP), a founding Partner of the oneM2M global initiative, a member of and major U.S. contributor to the International Telecommunication Union (ITU), as well as a member of the Inter-American Telecommunication Commission (CITEL). For more information, visit www.atis.org.

Notice of Disclaimer and Limitation of Liability

The information provided in this document is directed solely to professionals who have the appropriate degree of experience to understand and interpret its contents in accordance with generally accepted engineering or other professional standards and applicable regulations. No recommendation as to products or vendors is made or should be implied.

NO REPRESENTATION OR WARRANTY IS MADE THAT THE INFORMATION IS TECHNICALLY ACCURATE OR SUFFICIENT OR CONFORMS TO ANY STATUTE, GOVERNMENTAL RULE OR REGULATION, AND FURTHER, NO REPRESENTATION OR WARRANTY IS MADE OFMERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. ATIS SHALL NOT BE LIABLE, BEYOND THE AMOUNT OF ANY SUM RECEIVED IN PAYMENT BY ATIS FOR THIS DOCUMENT, AND IN NO EVENT SHALL ATIS BE LIABLE FOR LOST PROFITS OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES. ATIS EXPRESSLY ADVISES THAT ANY AND ALL USE OF OR RELIANCE UPON THE INFORMATION PROVIDED IN THIS DOCUMENT IS AT THE RISK OF THE USER.

NOTE - The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to whether use of an invention covered by patent rights will be required, and if any such use is required no position is taken regarding the validity of this claim or any patent rights in connection therewith. Please refer to [http://www.atis.org/legal/patentinfo.asp] to determine if any statement has been filed by a patent holder indicating a willingness to grant a license either without compensation or on reasonable and non-discriminatory terms and conditions to applicants desiring to obtain a license.

Copyright Information

Alliance for Telecommunications Industry Solutions
1200 G Street, NW, Suite 500
Washington, DC 20005

Contents

1. Introduction

UAVs are heavily dependent on wireless communications to address multiple requirements including command and control, location finding, cooperative perception and collision avoidance, and remote identification. The widespread availability of mobile cellular networks makes them an obvious candidate for utilization by UAVs. To better serve UAV applications, 3GPP Release 17 specifies mobile cellular capabilities that address UAV use cases.

Because UAV applications interact with several different parts of the 3GPP system, it can be difficult to fully appreciate how 3GPP addresses UAV requirements by direct reference to the specifications. In many cases, the capabilities in 3GPP specifications are intended to be integrated with other standards to build complete solutions. Hence the importance of understanding how 3GPP specifications fit in to the puzzle with other initiatives.

This report aims to help technical decision makers and system architects understand the role of 3GPP specifications for UAVs. It describes how 3GPP Release 17 specifications enable UAV applications and align with other specifications to address UAV needs. This report also shows how the 3GPP system can be used to enhance the opportunities to safely use UAVs for commercial and leisure applications.

2. Status of 3GPP Release 17 and Beyond

3GPP Release 17 was frozen in June 2022. Following normal 3GPP processes, Release 17 is an interoperable specification of a mobile cellular system for both 4G Long Term Evolution (LTE) and 5G New Radio (NR) interfaces from the system architecture point of view. Release 17 evolves previous 3GPP releases and is backward compatible with them. Support for UAV applications has been one component of 3GPP's Release 17 architecture work.

From the 3GPP Radio Access Network (RAN) perspective, 3GPP has addressed UAV requirements with the introduction in Release 15 of User Equipment (UE) Aerial Features. This work in Release 15 covers LTE RAN only. However, 3GPP has agreed to begin work on a Release 18 5G NR work item for the second half of 2022. This work item will align NR solutions with the existing LTE UAV solutions and specify NR-specific enhancements. The four general objectives of this work will include the following:

1. Specify enhancements to measurement reports as follows: UAV-triggered measurement report based on configured height thresholds; reporting of height,

location, and speed in measurement report; flight path reporting; and measurement reporting based on a configured number of cells (e.g., larger than one) fulfilling the triggering criteria simultaneously.

2. Specify the signaling to support subscription-based UAV identification.
3. Study and specify, if needed, enhancements for UAV identification broadcast.
4. Study UE capability signaling to indicate UAV beamforming capabilities and, if necessary, radio resource control (RRC) signaling.

The next section of this report analyzes how the 3GPP Release 17 system architecture specifications address various UAV requirements in terms of different building blocks/architecture.

3. General Concepts

3.1 Flexible and Decoupled System Design

UAVs represent a new and evolving market. Requirements are rapidly changing as technology and use cases evolve. UAV technology requirements are heavily influenced by aviation-related regulations, which can vary in different countries and regions.

In order for the 3GPP global specifications to support UAV requirements without large amounts of customization for national requirements, the Release 17 specification work adopted an approach that allows flexibility in the way aviation features are supported. Aviation aspects have been decoupled from the aspects related to the 3GPP system. 3GPP specifications cover only the necessary features that are intrinsically tightly coupled to the mobile cellular system. Other aspects are left open for definition outside the scope of 3GPP, as Figure 1 illustrates.

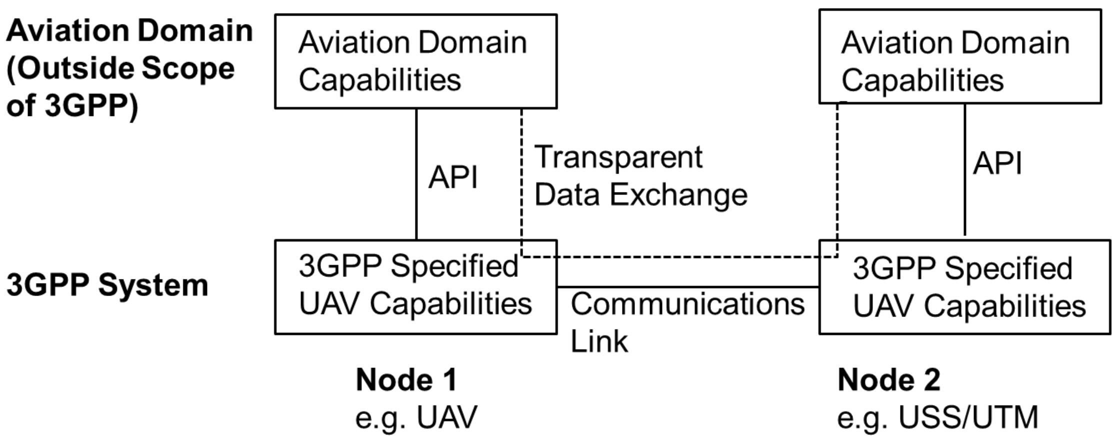

Figure 1: High-level conceptual approach to decoupling 3GPP specifications from aviation aspects

This decoupling has been achieved by several technical means. One main feature is the use of transparent data formats for aviation information that the 3GPP system only transports rather than inspecting or decoding, too. Another feature is the use of application programing interfaces (APIs) that let aviation systems access the 3GPP system without the 3GPP system having to contain feature-specific capabilities.

This flexible and decoupled approach also has the advantage of minimizing the amount of UAV-specific capability needed in the 3GPP system. This design should reduce barriers to deployment in commercial networks.

Although this decoupled approach offers important advantages, it does mean that to deliver complete use cases, the 3GPP specification's capabilities typically need to be augmented with other technical features that are defined outside 3GPP's scope. These features outside 3GPP's scope may be standardized within the aviation community or by regional regulations, or they may be proprietary.

3.2 Different Levels of API to Access UAV Services

In Release 17, 3GPP has specified two different interfaces that may be presented between the 3GPP system and UAV-related applications.

The first interface is described in TS 23.256 [1] and offers direct access to 3GPP network features that support UAV applications via the use of 3GPP's Network Exposure Function (NEF) interface. This interface is suitable for services like UAV Traffic Management (UTM) and UTM Service Suppliers (USS) that have an association with the 3GPP system.

Typically, direct access to this interface would require the external service provider to coordinate with the mobile network operator (MNO) via service-level agreements (SLAs) because the provider platform would act as an application server accessing the NEF APIs. This report refers to this as the "lower-level interface" because of its close connection to 3GPP network functions.

The second interface is described in TS 23.255 [2] and offers a more abstract level of access to 3GPP network features. This interface also includes general capabilities specified in the 3GPP Service Enabler Architecture Layer for Verticals (SEAL) framework, as specified in TS 23.434 [3], such as:

- Location management
- Group management
- Configuration management
- Identity management
- Key management
- Resource management

The second interface is suitable for a more generic application-layer approach with no integration with 3GPP system functions. This report refers to this as the "higher level interface" because it has a higher level of abstraction from 3GPP network functions.

It is up to MNOs to determine which of the interface(s) they provide and the policy and mechanism by which application developers gain access to the interface(s).

The focus of this report is the lower-level interface because this shows the fundamental additions that have been made to the 3GPP system to support UAVs. Unless otherwise stated, the information presented refers to the lower-level interface.

3.3 UAV-Related Entities

3GPP Release 17 defines several UAV-related entities. Entities defined to represent equipment in the hands of users include:

- **The UAV:** The aerial vehicle including 3GPP standardized UE for communication over mobile cellular networks.
- **The UAV Controller (UAV-C):** A controller pilots use to fly the UAV, which in the aviation industry is often referred to as Remote Pilot Station (RPS) or Ground Control Station (GCS).

- **The Uncrewed Aerial System (UAS):** the combination of a UAV and its associated UAV-C (if applicable).

3GPP also defines actors and entities representing infrastructure-based control for UASs. These include:

- **The UAS NF:** A 3GPP UAS network function implemented via the 3GPP NEF for support of aerial functionality related to UAV identification, authentication/authorization and tracking, and to support Remote Identification.
- **The UAS Service Supplier (USS):** An entity that provides services to support the safe and efficient use of airspace by providing services to the UAS operator or pilot. The term USS may refer to both the USS and the USS/UTM.
- **The UAS Traffic Management (UTM):** A system that can safely and efficiently integrate the flying UAV along with other airspace users. It provides a set of functions and services for managing a range of autonomous vehicle operations (e.g., authenticating a UAV, authorizing UAS services, managing UAS policies, and controlling UAV traffic in the airspace).

Figure 2 shows an example configuration of the entities defined above. In particular, the example shows an UAV controller, which is itself a 3GPP mobile UE.

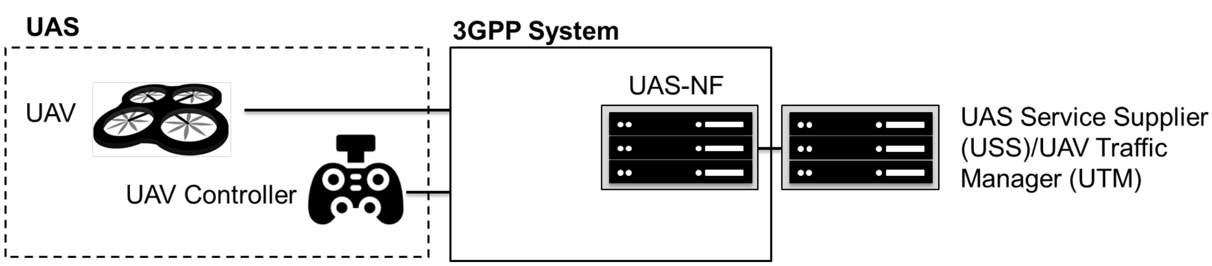

Figure 2: Example configuration of UAV entities in 3GPP Release 17
(Other configurations are possible)

3.4 UAV-Related Identities

With the advent of uncrewed vehicles for different purposes, one of the new requirements will be how to identify those UAVs in the airspace. There are different entities that will want to identify those vehicles:

- The wireless network infrastructure.

- The civilian authorities (e.g., the Federal Aviation Administration (FAA)) that are in charge of the air traffic control over the nation.
- Law enforcement/public safety officials.
- Members of the public may want to know more information about UAVs that they can see or hear flying overhead.

Each of those entities has legitimate reasons for needing to recognize the identities for those aerial vehicles. From the infrastructure perspective, the connection itself for the cellular portion will require an identity for the purposes of registration and validation of the connection. They may also want to have separate identities that are specifically associated with the vertical market of uncrewed vehicles that segregate the different types of UAVs used for, delivery, surveillance, weather monitoring, relays, etc.

3GPP Release 17 supports UAV-related identities that are significant to the 3GPP system, and also identities that the 3GPP system handles transparently.

The **3GPP UAV ID** is an identifier assigned by the 3GPP system. It can be used by functions like the USS or UTM to identify the UAV when providing information to the 3GPP system or requesting services from the 3GPP system via the UAS NF. In Release 17, the 3GPP UAV ID is a 3GPP Generic Public Subscription Identifier (GPSI).

The **CAA (Civil Aviation Administration)-Level UAV Identity** is a UAV identity assigned by USS/UTM. It uniquely identifies a UAV, at least within the scope of a USS. This identity is handled transparently by the 3GPP system.

This form of dual identification allows the 3GPP system to support a variety of ways of identifying UAVs according to varying national and regional requirements.

3.5 UAV-Related Information Payloads

3GPP Release 17 defines UAV-related information payloads that the 3GPP system treats transparently. These include:

- **The command and control (C2) Aviation Payload:** This contains application layer information exchanged between the UAS and the USS containing UAV pairing and/or flight authorization information.
- **USS UAV Authorization/Authentication (UUAA) Authorization Payload**: This contains application layer information that optionally may include UUAA results for UAV consumption provided by the USS to the UAS.

- **UUAA Aviation Payload:** This contains application layer information provided by the UAS to the USS.

The use of transparent payloads allows the 3GPP system to support UAV-related procedures that are standardized outside the scope of 3GPP or to use proprietary capabilities.

4. 3GPP Release 17 Building Blocks for UAVs

This section describes the key building blocks to support UAV services in Release 17. These building blocks may be integrated with other capabilities to support UAV applications.

4.1 Building Block: UAV USS Authentication and Authorization (UUAA)

The UUAA procedure enables the 3GPP MNO to ensure that a UE accessing its network and acting as a UAV has successfully registered with an USS and has therefore been authorized for operations by the USS. An UAV is authenticated and authorized by USS via a UUAA procedure with the support of the 3GPP system before connectivity for UAS services is enabled. The UUAA procedure leverages security mechanisms defined by the aviation community outside the scope of 3GPP.

There are two alternative times that the UUAA procedure may be performed, depending on the requirements of the local environment:

- **UUAA-Mobility Management (UUAA-MM):** The UUAA procedure optionally performed during registration to a 5G system.
- **UUAA-Session Management (UUAA-SM):** The UUAA procedure optionally performed (when UUAA-MM is not performed) during the establishment of a packet data session for UAS services (e.g., connectivity for command and control), and performed during the establishment of a packed data network (PDN) connection or PDU session.

4.2 Building Block: UAV Tracking

3GPP Release 17 provides three modes to support USS tracking of UAVs:

- **UAV location reporting mode**: Obtains the current location of a specific UAV.

- **UAV presence monitoring mode**: Obtains information about a specific UAV going into or out of a particular area.
- **List of UAVs in a geographic area**. Obtains a list of UAVs within a defined geographic constraint.

All three modes are invoked by the USS sending a suitable request to the UAS-NF. The UAS-NF will then interact with other entities in the 3GPP system to provide the requested information to the USS. The modes utilize existing 3GPP system capabilities. As a result:

- When requesting information, UAVs are identified using their 3GPP UAV ID (GPSI).
- The precision and granularity of location data may depend on the capabilities and physical design (e.g., tracking area boundaries) of the mobile network.

Networks may also apply local access policies to ensure that USSs are authorized to obtain location information.

4.2.1. UAV Location Reporting Mode

The USS that wants to receive UAV location reports subscribes to the UAS NF using the target 3GPP UAV ID. The USS may indicate the required location accuracy and whether it's for immediate reporting or deferred reporting (e.g., periodic reporting). The UAS NF reports the UAV's location and the 3GPP UAV ID to the USS.

As Figure 3 shows, the USS requests a location report by sending a subscription request to the UAS-NF (1). The UAS-NF will respond with a notification of the location (2). If the USS has requested periodic reporting, the notification may be repeated (3).

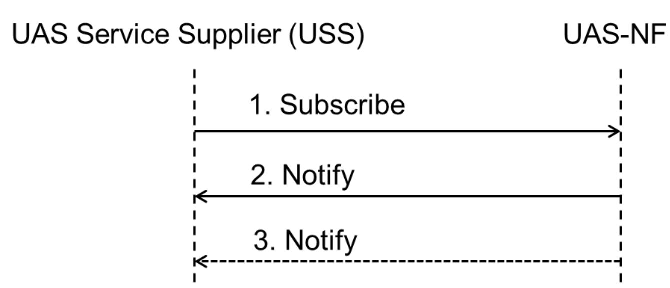

Figure 3: Signaling between USS and USA-NF for UAV location reporting mode

4.2.2. UAV Presence Monitoring Mode

For UAV presence monitoring mode, the USS may subscribe for the event report of a UAV moving in or out of the geographic area (e.g., longitude/latitude, ZIP code, etc.). The request includes the target 3GPP UAV ID and geographic area information. The UAS NF will obtain the information from the 3GPP system and notify the USS of the UAV presence in the geographic area.

The USS may provide policies or rules to the UAS NF based on the received event notification. The UAS NF will interact with the 3GPP system to apply the policies or rules based on the UAV's location. The UAS NF considers those policies as active and ongoing instructions from USS without constant or repeated triggers/requests. The traffic routing policy includes 3GPP UAV ID(s) to identify the UAV(s) and the corresponding network layer actions (e.g., revoke the resources of the related C2 communications).

As Figure 4 illustrates, the USS starts the procedure by sending a tracking request with the UAV identity, geographic area description and any policies to be applied (1). The UAS-NF will report the UAV presence in the geographic area (2) and apply the policies requested.

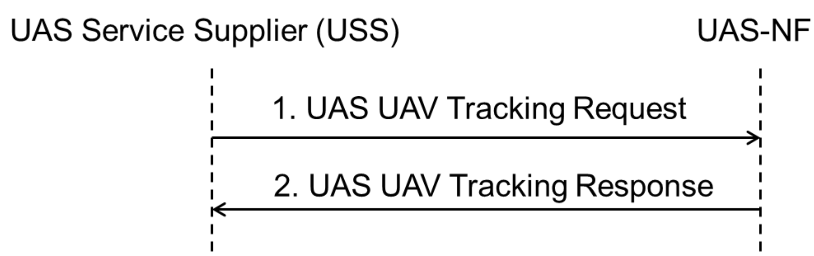

Figure 4: Signaling between USS and USA-NF for UAV presence monitoring mode

4.2.3. List of UAVs a geographic area

To obtain a list of UAVs in a geographic area, the USS sends a subscription request containing a description of the geographical area of interest. The UAS NF will obtain from the 3GPP system all the UAVs in the requested area. Depending on the circumstances, the process of obtaining information about UAVs in the area may involve the UAS NF performing several different types of communication within the 3GPP system.

As Figure 5 shows, the USS requests a location report by sending a subscription request to the UAS-NF (1) containing a description of the area of interest. The UAS-NF will respond with a list of UAVs identified in the area (2). The UAS NF includes the GPSI in the message to USS, as well as the UAV's location information (in the form of geo coordinates). If the USS has requested periodic reporting, the notification may be repeated (3).

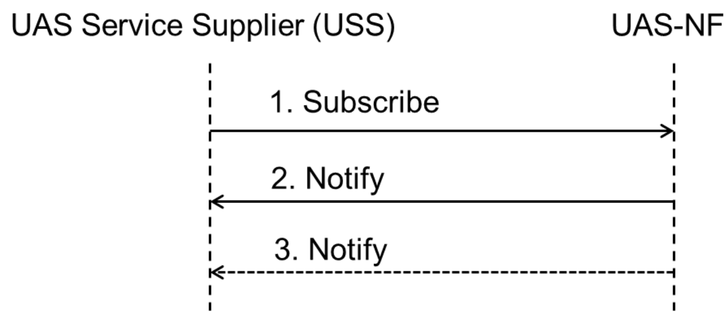

Figure 5: Signaling between USS and USA-NF for UAV for obtaining a list of UAVs in a geographic area

4.3 C2 Authorization

The 3GPP Release 17 C2 authorization procedures allow the USS/UTM to authorize and manage C2 communications for the UAS.

Authorization occurs when a UAV wants to use a 3GPP connection for C2 functions. Authorization for C2 includes the following:

- **UAV to UAV-C pairing authorization**: Authorization for pairing with a networked UAV-C or a UAV-C that connects to the UAV via the internet. One UAV can be paired with only one UAV-C at any time. One UAV-C may be paired with one or more UAVs at the same time.
- **Flight authorization:** Authorization for flight when the UAV also provides flight authorization information.

C2 authorization may be carried out:

- During the UUAA-SM procedure (e.g., at the initial establishment of a PDN connection/PDU session for the transport of C2 traffic).

- During modification of an existing connection to exchange C2 communication related messages (e.g., if at the establishment of the PDN connection/PDU session the pairing between UAV and UAV-C was not yet known).
- During a new connection establishment, if the UAV requires a separate connection for C2 communication with respect to the connection used to exchange traffic with USS/UTM.

During the C2 authorization, the UTM/USS will receive a C2 Aviation Payload from the UAV. It may use this along with other information, such as the Service Level Device Identity/CAA-Level UAV ID and 3GPP UAV ID/GPSI, to determine whether to permit the authorization request.

Following C2 authorization, the UTM/USS may apply network packet routing policies to the C2 connection to ensure that the UAV communicates only with authorized UAV-Controllers.

Additional procedures defined in Release 17 support reconfiguration of previously authorized connections.

5. Example Applications

This section gives examples of UAV applications and how they may make use of the building blocks described in Section 4.

5.1 Application: Remote Identification

Networked Remote Identification and Broadcast Remote Identification

There are two ways of supporting remote identification for UAVs:

- **Networked Remote Identification** uses communication through a network (e.g., the mobile cellular network) to obtain UAV identity information. This leverages a PDN connection/PDU session established for communication with the USS/UTM. 3GPP assumes that the CAA-Level UAV ID is the identity that is sent by the UAV to the Remote Identification USS.
- **Broadcast Remote Identification** does not require a network connection and is based on UAVs providing a local broadcast of their identity. 3GPP assumes that the CAA-Level UAV ID is the identity that is sent in Broadcast Remote Identification.

Different countries are adopting different rules for UAV remote identification. In the U.S., the FAA final rule, effective April 21, 2021, is based on Broadcast Remote Identification only. [4] [5]

In 3GPP Release 17, there are no specific 3GPP features to support Broadcast Remote Identification.

Support for Networked Remote Identification

3GPP Release 17 contains building blocks that can be used to support Networked Remote Identification. However, following the principles of the decoupled architecture described in section 3.1 it does not specify a complete solution for Networked Remote Identification. A fully standardized approach to supporting Networked Remote Identification would require additional work beyond the scope of 3GPP to leverage what 3GPP already has made available.

Figure 6 shows a possible architecture to support Networked Remote Identification based on 3GPP Release 17 and the separation between the 3GPP system and the aviation domain.

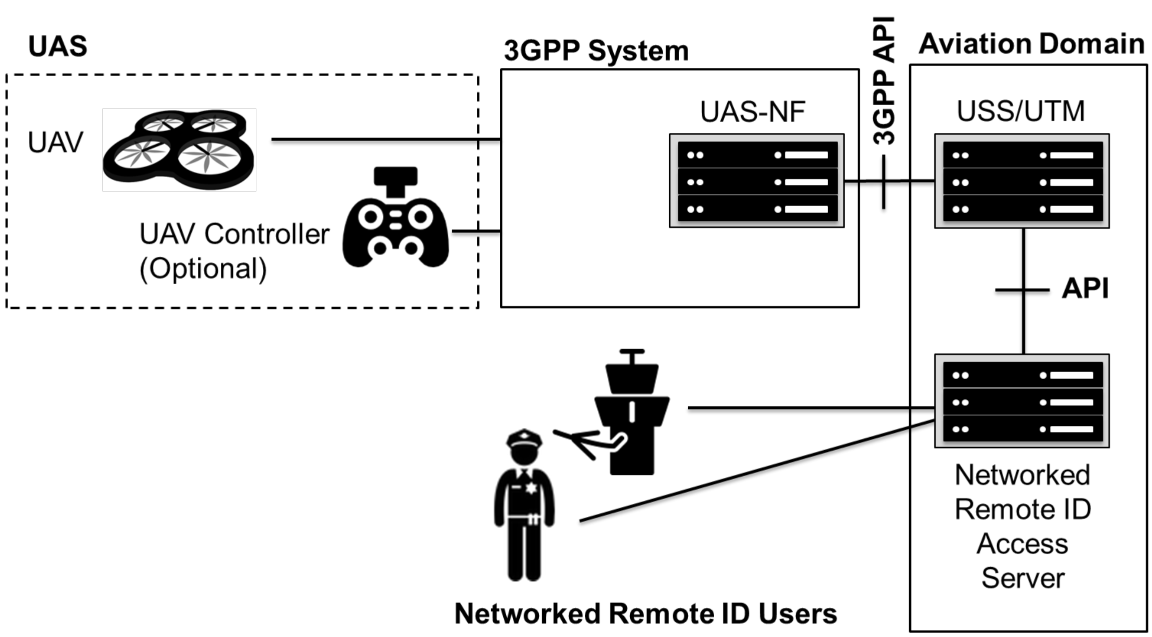

Figure 6: Example architecture to support Networked Remote ID

In this example architecture, information about UAVs (e.g., their identities), their location, and their status is collected by the USS/UTM using building blocks from 3GPP Release 17. This could include use of the following Release 17 features:

- UAV Location Reporting (Section 4.2)
- UUAA (Section 4.1)
- C2 authorization and pairing (Section 5.3).

The USS/UTM presents identity information over an API to the Networked Remote ID Access Server. This server may perform functions such as consolidating identity information from multiple sources and managing user access to identity data. This server will also provide a method for authorized Remote ID Users to receive identity information based on their requests.

In this example, the USS/UTM and the Networked Remote ID Access Server are considered to exist in the aviation domain and therefore outside the scope of 3GPP.

The decoupling of 3GPP-specified features and aviation aspects allows a common set of 3GPP building blocks to support different requirements and regulatory environments for remote identification.

5.2 Application: UTM

The U.S. FAA explains the role of the Uncrewed Aircraft System Traffic Management (UTM) as follows [6]:

Unmanned Aircraft System Traffic Management (UTM) is a "traffic management" ecosystem for uncontrolled operations that is separate from, but complementary to, the FAA's Air Traffic Management (ATM) system. UTM development will ultimately identify services, roles and responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude uncontrolled drone operations.

The FAA’s UTM Concept of Operations Version 2.0 (UTM ConOps v2.0) [7] gives an overview of the UTM concept and its principal technical features and relationship to other systems.

The 3GPP-defined API allows the 3GPP network provide connectivity between the UTM infrastructure and the UASs and the UAS operators. Additionally, the 3GPP API contains building blocks, like those described above, that are relevant to supporting UTM features such as remote identification and authorization for access to controlled airspace.

Figure 7 shows where the 3GPP system may be located in a high-level architecture for a UTM based on the FAA ConOps v2.0 document.

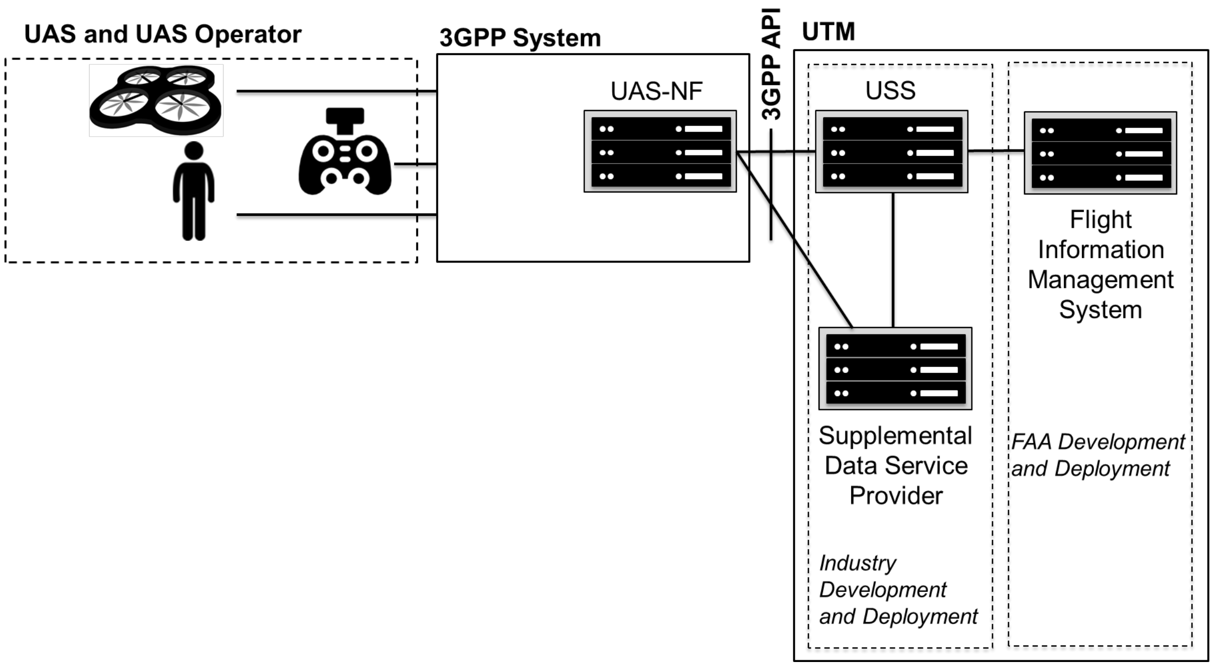

Figure 7: High-level architecture for UTM showing the position of the 3GPP system

In this architecture, the USS is acting as defined in section 3.3. The USS assists UAS operators with meeting UTM operational requirements that enable safe and efficient use of airspace. The Supplemental Data Service Provider offers essential or enhanced services including terrain and obstacle data, specialized weather data, surveillance, and constraint information. The USS and Supplemental Data Service Provider are envisaged to be industry developed and deployed.

The Flight Information Management System (FIMS) is an interface for data exchange between aviation systems like air traffic control and UTM participants. The FIMS enables exchange of airspace constraint data between the FAA and the USS. The FIMS is envisaged to be developed and deployed by the national authorities (e.g., the FAA).

In the UTM model shown in Figure 7, the MNO provides communications and policy functions to the UAS. The UTM function that contains specialized aviation-related functions is separated from the mobile network. This architecture provides a strong domain separation, which will help manage complexity and allow technical experts to focus on their respective areas of expertise.

5.3 Application: Remote Pilot

Remote piloting can utilize a C2 interface between a UAV and a UAV-C. Authorization for C2 includes the following aspects:

- **UAV to UAV-C pairing authorization:** Authorization for pairing with a networked UAV-C or a UAV-C that connects to the UAV via the internet before the UAV and the UAV-C can exchange C2 communication. One UAV can be paired with only one UAV-C at any time. One UAV-C may be paired with one or more UAVs at the same time.
- **Flight authorization:** Authorization for flight when the UAV also provides flight authorization information.

Both these aspects can be controlled by the USS or a Command and Control Connectivity Service Provider (C2CSP) in 3GPP Release 17.

C2 authorization may be carried out:

- During the UUAA procedure (if the UUAA is carried out at a PDU session/PDN connection establishment) when the UAV requests establishment of PDU session/PDN connection for connectivity.
- During PDU session modification/UE-requested bearer resource modification when the UAV requires to use an existing PDU session/PDN connection to exchange C2 communication-related messages.
- During a new PDU session/PDN connection establishment, if the UAV requires to use a separate PDU session/PDN connection for C2 communication.

During the C2 authorization procedure, the C2 Aviation Payload is exchanged between the UAV and the USS to communicate aviation-specific information necessary for the authorization of the C2 communication.

Figure 8 gives a high-level view of an example architecture and information flow between the 3GPP system and the USS for C2 authorization. In the first step of the information flow, the UAV initiates a request for C2 communications. The 3GPP system interacts with the USS to decide whether to authorize this communication. If the communication is authorized, then in the second step the USS will initiate a procedure in the 3GPP system to set a policy for the C2 communication that pairs the UAV with a particular UAV-C.

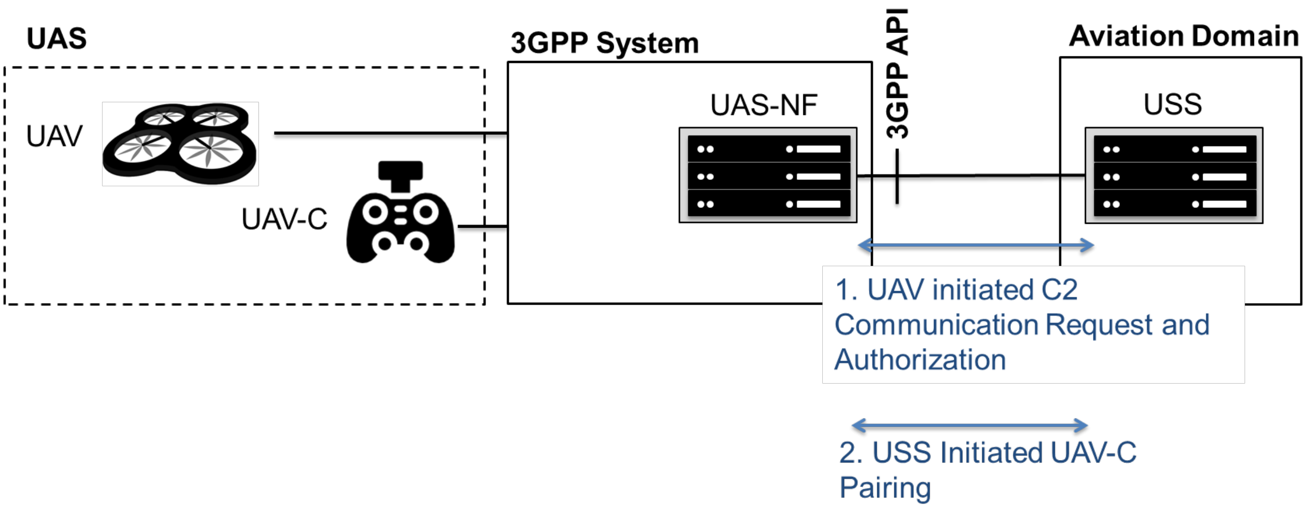

Figure 8: High level view of example information flow for C2 authorization

Once a C2 communication is authorized additional procedures may be used to modify the connection. These include:

- Revocation of the C2 communication by the USS.
- UAV-C replacement or handover by the USS.

In the remote pilot application, the policy features supported in the 3GPP specifications provide capabilities that assist the USS in ensuring that only authorized flights take place and that the 3GPP communications features provide the necessary Quality of Service (QoS) needed for C2.

5.4 Application: Payload Communications

UAVs may carry a range of payload applications that use 3GPP-specified technology for communication. This could include applications such as video backhaul or reporting of environmental data. "Payload communications" refers to the communication needs of these applications, which are separate from the communications used to manage the flight of the UAV (i.e., the "UAS Services" communications between the UAV and the UAV-C, and between the UAS and the USS/UTM). Figure 9 illustrates the UAS service communications and the payload communications.

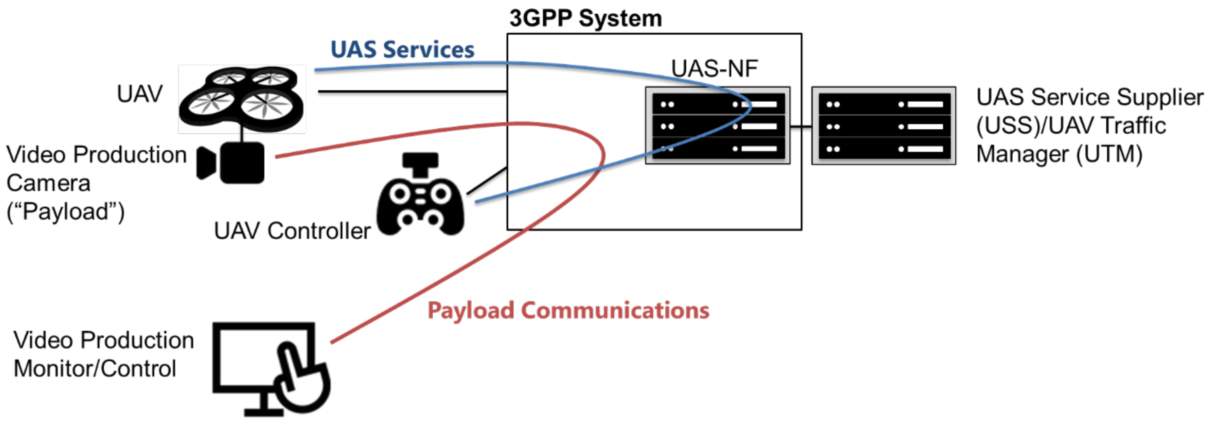

Figure 9: UAS service communications and payload communications

In the example illustrated, the UAV carries a payload in the form of a video camera that is being used for TV production. This camera's video is being monitored on the ground at the video production monitor/control station. The 3GPP-specified network is being used to provide the payload communication between the camera and the monitoring station. In this example, the video stream is not part of the C2 system for the UAV. As a result, the UAS services used to authorize and control the UAV flight are separate from the payload communications.

As this example shows, the payload communications can be treated separately from the UAS services provided that the payload communications are not part of the C2 system. It is a configuration choice for the network whether payload communications are permitted to share the same PDU/PDN connection as the UAS services.

The authorization of UAVs to use 3GPP-specified networks payload communications is managed via the "Aerial UE" subscription option that was introduced in 3GPP Release 15 TS 23.401 [8]. Use of 3GPP networks for payload communications does not require that the network also support the other UAS services described in this document.

The 3GPP-specified network is able to provide a wide range of communication services supporting different bandwidths and latency characteristics to address the needs of a wide range of different UAV payload applications.

,

6. Conclusions

In Release 17, 3GPP specified a range of UAS communication services that can be considered as building blocks to support different UAS applications and requirements. Release 17 includes features to support applications required to fulfil regulatory requirements and air traffic management needs such as remote UAV identification and support of UTM.

3GPP has a focus on specifying a global, interoperable mobile communications system. The work done in Release 17 addresses the generic requirements related to use of the 3GPP system by UASs. 3GPP specifications may be used in combination with aviation domain solutions to create complete solutions for UASs. The aviation domain solutions may be proprietary or may be specified by bodies outside 3GPP. In this model, the 3GPP specifications can support the wide variety of UAS requirements for different jurisdictions and for different UAV classes.

The features specified in 3GPP Release 17 will enable the mobile cellular network to become a core technology in facilitating the safe and efficient use of UASs for commercial and leisure applications. Enabling UAVs to use 3GPP-specified networks will offer advantages of wide-area coverage and remote management of UASs that are not possible with point-to-point local radio technologies.

References

[1] 3GPP, *TS 23.256 Support of Uncrewed Aerial Systems (UAS) connectivity, identification and tracking; Stage 2,* 2022.

[2] 3GPP, *TS 23.255 Application layer support for Uncrewed Aerial System (UAS); Functional architecture and information flows,* 2021.

[3] 3GPP, *3GPP TS 23.434 Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows,* 2019.

[4] Federal Aviation Administration, "Remote Identification of Unmanned Aircraft, RIN 2120–AL31," FAA , 15 January 2021. [Online]. Available: https://www.faa.gov/sites/faa.gov/files/2021-08/RemoteID_Final_Rule.pdf. [Accessed July 2022].

[5] Federal Aviation Administration, "UAS Remote Identification," 13 July 2022. [Online]. Available: https://www.faa.gov/uas/getting_started/remote_id. [Accessed July 2022].

[6] Federal Aviation Administration, "Unmanned Aircraft System Traffic Management (UTM)," 27 May 2022. [Online]. Available: https://www.faa.gov/uas/research_development/traffic_management. [Accessed July 2022].

[7] Federal Aviation Administration, "FAA UAS UTM Concept of Operations (ConOps) v2.0," 2 March 202. [Online]. Available: https://www.faa.gov/uas/research_development/traffic_management/media/UTM_ConOps_v2.pdf. [Accessed July 2022].

[8] 3GPP, *TS 23.401 General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access,* 2015.

Abbreviations

3GPP	Third Generation Partnership Project
API	Application Programing Interface
ATM	Air Traffic Management
C2	Command and Control
CAA	Civil Aviation Administration
FAA	Federal Aviation Authority
FIMS	Flight Information Management System
GPSI	Generic Public Subscription Identifier
ID	Identity
LTE	Long Term Evolution
MNO	Mobile Network Operator
MM	Mobility Management
NEF	Network Exposure Function
NF	Network Function
NR	New Radio
PDN	Packet Data Network
PDU	Protocol Data Unit
QoS	Quality of Service
RAN	Radio Access Network
RRC	Radio Resource Control

SLA	Service-Level Agreement
SEAL	Service Enabler Architecture Layer for Verticals
SM	Session Management
UAS	Uncrewed (or Unmanned) Aerial System
UAV	Uncrewed (or Unmanned) Aerial Vehicle
UAV-C	UAV Controller
UE	User Equipment
USS	UAS Service Supplier
UTM	UAS Traffic Management
UUAA	USS UAV Authorization/Authentication