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Contents

Foreword

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Introduction

Interest in using cellular connectivity to support Uncrewed 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 Uncrewed 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/

[4] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1".

[5] IMT 2020(5G): "Application for UAV in 5G White Paper", September 2018

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].

Above ground level (AGL): In the context of a UAV it is the UAV altitude referenced to ground level in the vicinity.

Command and Control (C2) Communication: the user plane link to convey messages with information of command and control for UAV operation between a UAV controller and a UAV.

Uncrewed Aerial System (UAS): Composed of Uncrewed Aerial Vehicle (UAV) and related functionality, including command and control (C2) links between the UAV and the controller, the UAV and the network, and for remote identification. A UAS is comprised of a UAV and a UAV controller.

NOTE: A UAV can be controlled by different UAV controllers, but at any given time, a UAV is under the control of only one UAV controller. The mechanisms to ensure which UAV controller is active and controlling the UAV is out of scope of 3GPP.

Uncrewed 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.

UxNB: radio access node on-board UAV. It is a radio access node providing connectivity to UEs, which is carried in the air by an Uncrewed Aerial Vehicle (UAV).

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	Uncrewed Aerial System
UAV	Uncrewed Aerial Vehicle
UTM	Uncrewed Aerial System Traffic Management [2]

4 Overview on UAS

4.1 General

An Uncrewed Aerial System (UAS) is the combination of an Uncrewed 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), and uplink and downlink data to/from the UAS components towards both the serving 3GPP network and network servers. The applicable C2 communication modes is depicted in clause 4.2.

Uncrewed 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.

4.2 C2 Communication

When using 3GPP network as the transport network for supporting UAS services, the following C2 communication are considered to provision UAS services by guaranteeing QoS for the C2 communication:

Direct C2 communication: the UAV controller and UAV establish a direct C2 link to communicate with each other and both are registered to the 5G network using the radio resource configured and scheduled provided by the 5G network for direct C2 communication.

Network-Assisted C2 communication: the UAV controller and UAV register and establish respective unicast C2 communication links to the 5G network and communicate with each other via 5G network. Also, both the UAV controller and UAV may be registered to the 5G network via different NG-RAN nodes. The 5G network needs to support mechanism to handle the reliable routing of C2 communication.

UTM-Navigated C2 communication: the UAV has been provided a pre-scheduled flight plan, e.g. array of 4D polygons, for autonomous flying, however UTM still maintains a C2 communication link with the UAV in order to regularly monitor the flight status of the UAV, verify the flight status with up-to-date dynamic restrictions, provide route updates, and navigate the UAV whenever necessary.

In general, Direct C2 communication and Network-Assisted C2 communication are used by a human-operator using a UAV controller. UTM-Navigated C2 communication is used by the UTM to provide cleared flying routes and routes updates. In order to ensure the service availability and reliability of the C2 communication for UAS operation, especially when the UAV is flying beyond line of sight (BLOS) of the operator, redundant C2 communication links can be established for any C2 communication links from UAV controller or UTM to a UAV.

For reliability and service availability consideration, it is possible to activate more than one C2 communication with one as a backup link for C2 communication or switch among the applicable links for C2 communication.

- For example, Direct C2 communication can be used at first and then switch to the Network-Assisted C2 communication when the UAV is flying BLOS.

- For example, UTM-navigated C2 communication can be utilized whenever needed, e.g. for air traffic control, the UAV is approaching a No Drone Zone, and detected potential security threats, etc.

There are four control modes considered in the C2 communication for the UAV operation that are with different requirements, e.g. on message intervals, sizes, and end to end latencies, etc., including steer to waypoints, direct stick steering, automatic flight by UTM and approaching autonomous navigation infrastructure.

- Steer to waypoints: the control message contains flight declaration, e.g. waypoints, sent from the UAV controller or UTM to the UAV. The control mode is used in both of direct C2 communication and network-assisted C2 communication.

- Direct stick steering: the control message contains direction instructions sending from the UAV controller to the UAV while optionally video traffic is provided as feedback from the UAV to the UAV controller. The control mode is used in both of direct C2 communication and network-assisted C2 communication.

- Automatic flight by UTM: the control message contains a pre-scheduled flight plan, e.g. array of 4D polygons, sent from the UTM to the UAV, which thereafter flies autonomously with periodic position reporting. The control mode is used in UTM-Navigated C2 communication.

- Approaching autonomous navigation infrastructure: the control message contains direction instructions, e.g. waypoints, altitudes and speeds from the UTM to the UAV. When the UAV is landing/departing, the UTM coordinates more closely with autonomous navigation infrastructure, e.g. vertiport or package distribution center. The control mode is used in UTM-Navigated C2 communication.

5 Requirements for Remote Identification of UAS

5.1 General

[R-5.1-001] The 3GPP system should enable UTM to associate the UAV and UAV controller, and the UTM to identify them as a UAS.

[R-5.1-002] The 3GPP system shall be able to provide UTM with the identity/identities of a UAS.

[R-5.1-003] 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.

[R-5.1-004] The 3GPP system shall enable a UAS to send UTM the UAV controller data which can contain: 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.

[R-5.1-005] 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 0: 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 UTM service authentications, such as flight monitoring, collision avoidance services, so on.

[R-5.1-006] 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.

[R-5.1-007] 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.

[R-5.1-008] 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

[R-5.1-009] 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 1: 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, such as OTDOA, cell coordinates, synchronization source, etc.

NOTE 2: This requirement will not be applied to the case which the UAS and UTM has direct control communication connection without going through MNO, such as OTDOA, cell coordinates, synchronization source, etc.

[R-5.1-010] The 3GPP system shall enable UTM to inform an MNO of the outcome of an authorisation to operate.

[R-5.1-011] The 3GPP system shall enable an MNO to allow a UAS authorisation request only if appropriate subscription information is present.

[R-5.1-012] The 3GPP system shall enable a UAS to update a UTM with the live location information of a UAV and its UAV controller.

[R-5.1-013] The 3GPP network should be able to provide supplement location information of UAV and its controller to a UTM.

NOTE 3: 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.

[R-5.1-014] The 3GPP network shall support UAVs and the corresponding UAV controller are connecting to different PLMNs at the same time.

[R-5.1-014a] The 3GPP system shall support UAVs and the corresponding UAV controller are connecting to different PLMNs at the same time.

[R-5.1-015] 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.

[R-5.1-016] 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 4: UAS-capable UE refers to the UE which support interaction capability with UTM and certain 3GPP communication features which 3GPP provides for UAS.

[R-5.1-017] The 3GPP system shall support the UTM in detection of UAV operating without authorization.

NOTE 5: the scenarios covered by the requirement above are FFS.

5.2 UAS traffic management

5.2.1 General

NOTE: The following requirements are valid for both centralized and decentralized UTM.

[R-5.2.1-001] The 3GPP system shall provide a mechanism for a UTM to provide route data, along with flight clearance, to a UAV.

[R-5.2.1-002] 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.

[R-5.2.1-003] 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.

[R-5.2.1-004] 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.

5.2.2 Decentralized UAS traffic management

[R-5.2.2-001] 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.

[R-5.2.2-002] The 3GPP system shall be able to support a UAV to transmit a message via network connection for identifying itself as an UAV to the other UAV(s).

[R-5.2.2-003] 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.

[R-5.2.2-004] The 3GPP system shall enable a UAV to receive local broadcast communication transport service from other UAV in short range.

[R-5.2.2-005] 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.

[R-5.2.2-006] 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.

[R-5.2.2-007] The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service at relative speeds of up to 320kmph.

[R-5.2.2-008] 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).

[R-5.2.2-009] The 3GPP system shall support a direct UAV to UAV local broadcast communication transport service which supports a range of up to 600m.

[R-5.2.2-010] 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.

[R-5.2.2-011] 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.

5.3 Void

5.4 Security

[R-5.4-001] The 3GPP system shall protect the transport of data between the UAS and UTM.

[R-5.4-002] The 3GPP system shall protect against spoofing attacks of the UAS identities.

[R-5.4-003] The 3GPP system shall allow non-repudiation of data sent between the UAS and UTM at the application layer.

[R-5.4-004] 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.

[R-5.4-005] The 3GPP system shall support confidentiality protection of identities related to the UAS and personally identifiable information.

[R-5.4-006] The 3GPP system shall support regulatory requirements (e.g. Lawful Intercept) for UAS traffic.

6 Requirements for UAV usages

6.1 General

Beyond UAV related requirements, the 3GPP can be used to support for a wide range of applications and scenarios by using low altitude UAVs in various commercial and government sectors. New service level requirements and KPIs for supporting various UAV applications by the 3GPP system have been identified and specified e.g. Service requirements and KPIs related to command and control (C2), payload (e.g. camera) and the operation of radio access nodes on-board UAVs.

6.2 Network exposure for UAV services

[R-6.2-001] The 3GPP system shall provide means to allow a 3rd party to request and obtain real-time monitoring the status information (e.g., location of UAV, communication link status) of a UAV.

[R-6.2-002] Based on operator 's policy, the 3GPP system shall provide means to provide a 3rd party with the information regarding the service status for UAVs in a certain geographical area and/or at a certain time.

NOTE: Service status is about the information of whether the communication service to the UAV can be provided with a certain QoS by the network.

6.3 Service restriction for UEs onboard of UAV

[R-6.3-001] The 3GPP network shall be able to support network-based 3D space positioning (e.g., with altitude 30~300m) of a UE onboard UAV.

[R-6.3-002] The 3GPP system shall be able to notify the authorized third party of potential stopping of connectivity service before the UE onboard of UAV enters an area (e.g., due to altitude) where the connectivity service is not authorized for the UE.

6.4 Requirements for UxNB

[R-6.4-001] The 5G system shall be able to support UxNBs to provide enhanced and more flexible radio coverage.

[R-6.4-002] The 3GPP system shall be able to provide suitable means to control the operation of the UxNBs (e.g. to start operation, stop operation, replace UxNB etc.).

[R-6.4-003] The 3GPP system shall be able to provide means to minimize power consumption of the UxNBs (e.g. optimizing operation parameter, optimized traffic delivery).

[R-6.4-004] The 3GPP system shall be able to minimize interference e.g. caused by UxNBs changing their positions.

6.5 C2 communication

[R-6.5-001] The 3GPP system shall support C2 communication with required QoS for pre-defined C2 communication models (e.g. using direct ProSe Communication between UAV and the UAV controller, UTM-navigated C2 communication based on flight plan between UTM and the UAV).

[R-6.5-002] The 3GPP system shall support C2 communication with required QoS when switching between the C2 communication models.

[R-6.5-003] The 3GPP system shall support a mechanism for the UTM to request monitoring of the C2 communication with required QoS for pre-defined C2 communication models (e.g. using direct ProSe Communication between UAV and the UAV controller, UTM-navigated C2 communication between UTM and the UAV).

7 Performance requirements

7.1 KPIs for services provided to the UAV applications

The 5G system shall be able to provide uncrewed aerial vehicle with the service performance requirements reported in Table 7.1-1.

UAV originated QoS in the table refers to the QoS of Uplink data (e.g. from UAV to the network side). UAV terminated QoS is the QoS of downlink data (e.g. from the network side to UAV).

The data transmitted by the 5G system includes data collected by hardware devices installed on UAV such as cameras, e.g. pictures, videos and files. It is also possible to transmit some software calculation or statistical data, e.g. UAV management data. The service control data transmitted by the 5G system may be based on application triggers, such as switch, rotation, promotion and demotion control of equipment on UAV. Various UAV applications may require different uplink and downlink QoS at the same time. The 5G system may simultaneously provide services to other users on the ground (e.g., the KPIs for rural and urban scenarios as defined in 7.1 of TS 22.261 [4]) in the same area without service degradation.

Table 7.1-1 KPIs for services provided to the UAV applications

Use case	Services	Data rate	End to end Latency	Altitude AGL	service area (note 4)
1	8K video live broadcast	100Mbps UAV originated	200 ms	<100 m	Urban, scenic area
		600Kbps UAV terminated	20 ms	<100 m	
2	Laser mapping/ HD patrol Note 7	120Mbps UAV originated Note 1	200 ms	30-300 m	Urban, rural area, scenic area
		300Kbps UAV terminated	20 ms	30-300 m	
3	4*4K AI surveillance	120Mbps UAV originated	20 ms	<200 m	Urban, rural area
		50Mbps UAV terminated	20 ms	<200 m	
4	Remote UAV controller through HD video	>=25Mbps UAV originated (Note 3)	100 ms	<300 m	Urban, rural area
		300Kbps UAV terminated	20 ms	<300 m	
5	Real-Time Video	0.06 Mbps w/o video UAV originated	100 ms	-	Urban, rural, countryside
6	Video streaming	4 Mbps for 720p video 9 Mbps for 1080p video UAV originated	100 ms	-	Urban, rural, countryside
7	Periodic still photos	1Mbps UAV originated	1s 1S	<0.120m	<120m Urban, rural, countryside - Urban, rural area

NOTE 1: The flight average speed is 60km/h. The KPI is referring to [5].
NOTE 2: The latency is the time of the 5G system provide higher accuracy location information of a UAV to a third party.
NOTE 3: Referring to clause 5.2.2, the absolute flying speed of UAV in this service can be up to 160km/h.
NOTE 4: The density of active UAV is $10/200km^2$. The maximum altitude is 300m. The flight average speed is 60km/h.

7.2 KPIs for UAV command and control

UAVs may use a variety of flight command and control modes. Command and control (C2) communications refers to the two-way communication, which may include video, required to control the operation of the UAV itself. C2 messages may be communicated with the UAV controller, the UTM or both and may or may not be periodic. UAV controller and UTM communications may happen at essentially the same time with different required QoS. Any mission specific communication (e.g. HD video for area surveillance), if required, is additional. Different modes of control and their typical KPIs are listed in this clause below. The 5G system shall support UAV operation at altitudes of at least 120m / 400ft above ground level, e.g. the services should be provided and characterized up to 3000ft AGL.

Table 7.2-1 KPIs for command and control of UAV operation

Control Mode	Function	Typical Message Interval	Max UAV ground speed	Typical message Size (note 1)	End to end Latency	Reliability (note 2)	Positive ACK (note 8)
Steer to waypoints (note 3)	UAV terminated C2 message	>=1 s	300 km/h	100 byte	1 s	99.9%	Required
	UAV originated C2 message (note 4)	1 s		84-140 byte	1 s	99.9%	Not Required
Direct stick steering (note 5)	UAV terminated C2 message	40 ms (note 6)	60km/h	24 byte	40 ms	99.9%	Required
	UAV originated C2 message (note 7)	40 ms		84-140 byte	40 ms	99.9%	Not Required
Automatic flight on UTM (note 10)	UAV terminated C2 message	1 s	300 km/h	<10 kbyte	5 s (note 9)	99.9%	Required
	UAV originated C2 message	1 s (note 9)		1500 byte	5 s (note 9)	99.9%	Required
Approaching Autonomous Navigation Infrastructure	UAV terminated C2 message	500 ms	50 km/h	4 kbyte	10 ms	99%	Required
	UAVoriginated C2 message	500 ms		4 kbyte	140 ms	99.99%	Required

NOTE 1: Message size is at the application layer and excludes any headers and security related load. The numbers shown are typical as message size depends on the commands sent and is implementation specific.
NOTE 2: Message reliability is defined as the probability of successful transmission within the required latency at the application layer while under network coverage.
NOTE 3: Video is neither required nor expected to be used for steering in this mode.
NOTE 4: It may be possible to transmit this message on an event driven basis (e.g. approaching a geo fence). A status message may, but is not required to, be sent as a response to a control message.
NOTE 5: A video feedback is required for this mode. The KPIs for video are defined in table 7.2-2.
NOTE 6: UAVs on-board controllers typically update at either 50Hz (20ms) or 25Hz (40ms).
NOTE 7: A status message may, but is not required to, be sent as a response to a control message A 1Hz slow mode also exists.
NOTE 8: Positive ACK is sent to the originator of the message (i.e. UAV controller and / or the UTM). The 5G system makes no assumption whether an appropriate ACK is sent by the application layer.
NOTE 9: At the application layer, the C2 communication between a UAV and UTM can be allowed to experience much longer traffic interruptions, e.g. timeouts of 30 s on the uplink and 300 s on the downlink.
NOTE 10: This only represents periodic message exchange during a nominal mission in steady state. Itdoes not represent unusual or aperiodic events such as conveying dynamic restrictions or a flight plan to the UAV on the downlink.

Table 7.2-2 KPIs for video used to aid UAV control.

Scenario (note 2)	Data rate	End to end Latency	Reliability (note 1)	Direction	Positive ACK required
VLOS (visual line of sight)	2 Mpbs at 480 p, 30 fps	1 s	99.9%	Sent by UAV	Not Required
Non-VLOS	4 Mbps at 720 p, 30 fps	140 ms	99.99%	Sent by UAV	Not Required

NOTE 1: Message reliability is defined as the probability of successful transmission within the required latency.
NOTE 2: Maximum UAV speed is same as control mode of direct stick steering in 7.2-1

7.3 Positioning performance requirements

Table 7.3-1 below lists typical scenarios and the corresponding positioning requirements for horizontal and vertical accuracy, availability, heading, latency, and UE speed.

NOTE: The column on "Corresponding Positioning Service Level in TS 22.261" maps the scenarios listed in Table 7.3-1 to the service levels defined in TS 22.261 [4].

Table 7.3-1: Positioning performance requirements

Scenario	Accuracy (95 % confidence level)		Availability	Heading	Latency for position estimation of UE	UE Speed	Corresponding Positioning Service Level in TS 22.261
	Horizontal accuracy	Vertical accuracy					
8K video live broadcast	[0.5 m]	[1 m]	99%		1s	[<120 km/h]	5
Laser mapping/ HD patrol	[0.5 m]	[1 m]	99%		1s	[<120 km/h]	5
4*4K AI surveillance	[0.1 m]					[<60 km/h]	
Remote UAV controller through HD video	[0.5 m]	[1 m]	99%		1s	[<120 km/h]	5
Periodic still photos	[0.1 m]	[1 m]				[<60 km/h]	
NOTE: The positioning accuracy in this table is not related to navigation or safety.							

7.4 Other requirements

[R-7.4-001] The 5G system shall support a mechanism to switch between C2 communication modes for UAS operation, e.g. from indirect C2 communication to direct C2 communication, and ensure the disconnect time is below the latency requirements.

[R-7.4-002] The 3GPP system shall enable concurrent communications between the UAV-controller and UAV and between the UTM and the UAV that may require different KPIs.

[R-7.4-003] The 3GPP system shall be capable of switching between the KPIs, as requested by the UAV-controller or the UTM, within [500ms].

Annex A (informative): UAS Reference Model

A.1 UAS Reference Model in 3GPP ecosystem

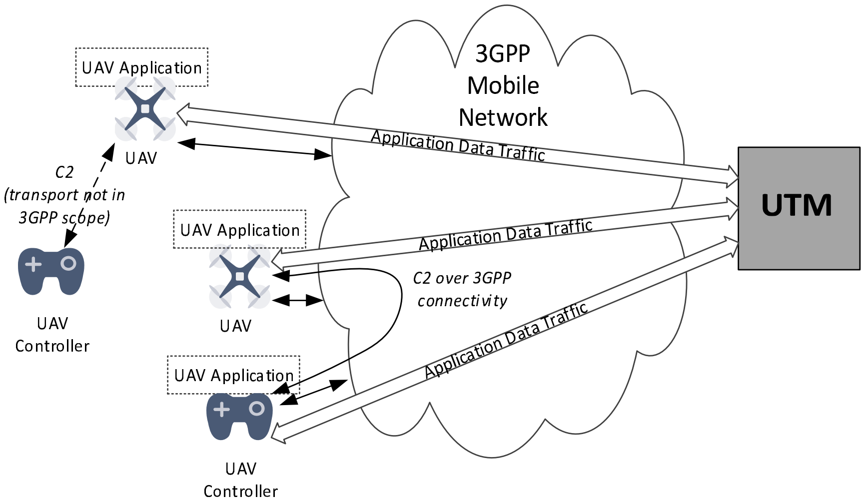

Figure B.1-1: UAS model in 3GPP ecosystem.

In the UAS reference model:

- a UAS is composed of one UAV and one UAV controller in this illustration
- UAVs are connected over cellular connectivity
- a UAV can be controlled by a UAV controller connected via the 3GPP mobile network
- a UAV can 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 can control one or more UAV(s)
- the UAS exchanges application data traffic with a UTM

NOTE: Several types of UAV controllers exist, e.g. hand-held UAV controllers, PCs/WSs and automated or manual functions that are part of the UTM. The mechanisms to ensure which UAV controller is active and controlling the UAV is out of scope of 3GPP.

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
2019-09	SA#85	SP-190809	0017	2	B	Definition and introduction of C2 Communication	17.0.0
2019-09	SA#85	SP-190809	0018	2	B	CR to 22.125 Network exposure requirements for UAV	17.0.0
2019-09	SA#85	SP-190809	0013	2	B	Adding UxNB related requirements	17.0.0
2019-09	SA#85	SP-190809	0020	2	B	Service restriction requirements for UAV	17.0.0
2019-09	SA#85	SP-190801	0024	2	F	Corrections to Requirements	17.0.0
2019-12	SA#86	SP-191024	0026	2	B	KPIs for UAV services	17.1.0
2019-12	SA#86	SP-191024	0027	3	F	Clarification of Control Modes in C2 communication	17.1.0
2020-09	SA#89e	SP-200881	0028	5	F	Clarification of the definition of a UAS	17.2.0
2021-03	SA#91e	SP-210197	0034	1	F	Clarification of problematic UAV	17.3.0
2021-09	SA#93e	SP-211034	0036	1	D	UAS terminology alignment	17.4.0
2021-12	SP-94	SP-211491	0038	1	D	CR Editorial to T22.125 clause 6.4 and clause 7.1	17.5.0
2021-12	SP-94	SP-211491	0039	1	D	CR inclusive language correction to T22.125 clause 1	17.5.0
2021-12	SP-94	SP-211491	0040	1	C	CR to T22.125 for correction and readability improvement clause 4.2 and clause	17.5.0
2021-12	SP-94	SP-211491	0041	2	C	Addition of a note to [R-5.1-017] related to the applicability of the requirement	17.5.0
2022-03	SP#95e	SP-220078	0043	1	D	Editorial corrections to TS 22.125 on UAV	17.6.0

History

Document history		
V17.6.0	April 2022	Publication