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Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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- x the first digit:
 - 1 presented to TSG for information;
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 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

In the present document, modal verbs have the following meanings:

- shall** indicates a mandatory requirement to do something
- shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

- should** indicates a recommendation to do something
- should not** indicates a recommendation not to do something
- may** indicates permission to do something
- need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

- can** indicates that something is possible
- cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

- will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document
- might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

might not indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

is (or any other verb in the indicative mood) indicates a statement of fact

is not (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

1 Scope

The present document specifies the protocols for application layer support for UAS services as specified in 3GPP TS 23.255 [2] for:

- a) UAS application communication between the UE and the UAE server (over the U1-AE interface); and
- b) UAS application communication among UEs (over the U1-AE interface using unicast Uu).

The present specification defines the associated procedures for UAS application communication between the UE and the UAE server and among UEs.

The present specification defines the usage and interactions of the UAE layer with SEAL services.

The present specification also defines the message format, message contents, error handling and system parameters applied by the protocols for the UAE layer.

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] 3GPP TS 23.255: "Application layer support for Unmanned Aerial System (UAS); Functional architecture and information flows".
- [3] 3GPP TS 23.256: "Support of Uncrewed Aerial Systems (UAS) connectivity, identification, and tracking; Stage 2".
- [4] 3GPP TS 23.434: "Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows".
- [5] IETF RFC 7231: "Hypertext Transfer Protocol -- HTTP/1.1: Semantics and Content".
- [6] 3GPP TS 24.544: "Group Management - Service Enabler Architecture Layer for Verticals (SEAL); Protocol specification".
- [7] 3GPP TS 24.545: "Location Management - Service Enabler Architecture Layer for Verticals (SEAL); Protocol specification".
- [8] 3GPP TS 24.546: "Configuration Management - Service Enabler Architecture Layer for Verticals (SEAL); Protocol specification".
- [9] 3GPP TS 24.547: "Identity Management - Service Enabler Architecture Layer for Verticals (SEAL); Protocol specification".
- [10] 3GPP TS 24.548: "Network Resource Management - Service Enabler Architecture Layer for Verticals (SEAL); Protocol specification".
- [xx] 3GPP TS 23.032: "Universal Geographical Area Description (GAD)".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms 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].

UAV identifier (UAV ID): An unique identifier of a UAV. The UAV ID is in the form of a 3GPP UE ID (e.g. GPSI, External Identifier) or CAA level UAV ID as assigned by civil aviation authorities (e.g. FAA) via USS/UTM.

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.255 [2] apply:

UAV
UAS Service Supplier (USS)

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.256 [3] apply:

Command and Control (C2) Communication
Uncrewed Aerial System (UAS)
UAS Traffic Management (UTM)
UAS Services

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.434 [4] apply:

SEAL service

3.2 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].

C2	Command and Control
GPSI	Generic Public Subscription Identifier
SCM-S	SEAL Configuration Management Server
SEAL	Service Enabler Architecture Layer for Verticals
SLM-S	SEAL Location Management Server
UAE	UAS Application Enabler
UAS	Uncrewed Aerial System
UAV	Uncrewed Aerial Vehicle
UAV-C	Unmanned Aerial Vehicle-Controller
USS	UAS Service Supplier
UTM	UAS Traffic Management

4 General description

The UE can contain a UAE client (UAE-C). The UAE-C and the UAE server (UAE-S) are located in the UAE layer. The UAE layer can offer the UAE capabilities to the UAS application specific layer. The UAE layer can utilize SEAL services provided by SEAL, which may include location management, group management, configuration management, identity management, key management and network resource management (see 3GPP TS 23.434 [4]).

The UAE-C communicates with the UAE-S over the U1-AE interface (see 3GPP TS 23.255 [2]). Furthermore, the UAE-C of a UE can communicate with the UAE-C of another UE over the U2-AE interface or over unicast Uu interface (including LTE-Uu or NG-RAN-Uu) (see 3GPP TS 23.255 [2]). Both the UAE-C and the UAE-S can act as an HTTP client or an HTTP server (see IETF RFC 7231 [5]). The HTTP protocol interactions are described in detail in clause 6.

By means of using the U1-AE interface:

- a) Communications between UAVs within a geographical area using unicast Uu can be provided as defined by clause 6.2;
- b) C2 communication mode selection and switching can be provided as defined by clause 6.3;
- c) UAS UE registration can be provided as defined by clause 6.4;
- d) UAS UE de-registration can be provided as defined by clause 6.5; and
- e) UAS UE registration update can be provided as defined by clause 6.6.

5 SEAL services

The UAE layer can utilize following SEAL services to support UAS services:

- a) group management as specified in 3GPP TS 24.544 [6];
- b) location management as specified in 3GPP TS 24.545 [7];
- c) configuration management as specified in 3GPP TS 24.546 [8];
- d) identity management as specified in 3GPP TS 24.547 [9]; and
- e) network resource management as specified in 3GPP TS 24.548 [10].

Interactions between the UAE layer and the SEAL services are described in detail in clause 6.

6 UAE procedures

6.1 General

6.2 Communications between UAVs within a geographical area using unicast Uu

6.2.1 Client procedure

6.2.1.1 Sending of a UAV application message

In order to send a UAV application message, the UAE-C shall generate an HTTP POST request message according to procedures specified in IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-C:

- a) shall set the Request-URI to the URI received in the UAE client UE configuration document via the SCM-S;
- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <UAV-application-message-info> element in the <UAE-info> root element:
 - 1) shall include a <UAV-id> element set to the identity of the UAV which requests the sending of the UAV application message;
 - 2) shall include an <application-defined-proximity-range-info> element to indicate the range information over which the UAV application message is to be sent; and
 - 3) shall include an <application-payload> element set to the application payload that is to be delivered to the other UAVs; and

NOTE: The application payload is provided by the UAS application specific client and its contents are out of scope of 3GPP.

d) shall send the HTTP POST request message towards the UAE-S.

6.2.1.2 Reception of a UAV application message

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <UAV-application-message-info> element in the <UAE-info> root element;

the UAE-C:

- a) shall store the received <application-payload> information included in the <UAV-application-message-info> element; and
- b) shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5] and send the HTTP 200 (OK) response towards the UAE-S.

6.2.2 Server procedure

6.2.2.1 Reception of a UAV application message

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <UAV-application-message-info> element in the <UAE-info> root element;

the UAE-S:

- a) shall obtain the other UAV(s) information in the location of the UAV based on the range information indicated in the <application-defined-proximity-range-info> element from the SLM-S as specified in 3GPP TS 24.545 [7];
- b) shall send the received <application-payload> information to each of the UAV obtained from step a) via unicast Uu channel as specified in clause 6.2.2.2;
- c) shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5] and in the HTTP 200 (OK) response:
 - 1) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
 - 2) may include an application/vnd.3gpp.uae-info+xml MIME body with a <UAV-application-message-info> with an <acknowledgement> child element in the <UAE-info> root element to indicate the acknowledgement of communications between UAVs within a geographical area; and

NOTE: The geographical area is from the perspective of the UAV initiating the communication with other UAVs.

d) shall send the HTTP 200 (OK) response towards the UAE-C.

6.2.2.2 Sending of a UAV application message

In order to send a UAV application message received from a UAV as specified in clause 6.2.2.1 to each of the UAV within a geographical area of the UAV initiating the communication with other UAVs, the UAE-S shall generate an HTTP POST request message according to procedures specified in IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-S:

- a) shall set the Request-URI to the URI corresponding to the identity of the UAE-C of UAV obtained in clause 6.2.2.1;

- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <UAV-application-message-info> element in the <UAE-info> root element:
 - 1) shall include a <UAV-id> element set to the identity of the UAV which requests the sending of the UAV application message; and
 - 2) shall include an <application-payload> element set to the application payload that needs to be delivered to the other UAVs; and
- d) shall send the HTTP POST request message towards the UAE-C.

6.3 C2 Communication mode selection and switching

6.3.1 Client procedure

6.3.1.1 C2 communication modes configuration procedure

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <c2-modes-switching-configuration-info> element,

the UAE-C:

- a) shall store the received configuration information;
- b) shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5]. In the HTTP 200 (OK) response message, the UAE-C:
 - 1) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
 - 2) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <UAE-info> root element:
 - i) shall include a <c2-modes-switching-configuration-info> element with a <result> child element set to the value "positive" or "negative" indicating positive or negative result of reception and storing of the communication mode configuration parameters; and
- c) shall send the HTTP 200 (OK) response towards the UAE-S.

6.3.1.2 C2 communication mode selection by UAE Client procedure

UAE Clients (UAV and UAV-C) select a primary and secondary C2 communication mode based on C2 communication mode configuration, then the UAE-C shall generate an HTTP POST request according to IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-C:

- a) shall set the Request-URI to the URI received in the UAE client UE configuration document via the SCM-S;
- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body with a <C2-communication-mode-notification-info> element in the <UAE-info> root element which:
 - 1) shall include a <UAS-id> element set to the identifier of the UAS;
 - 2) shall include a <selected-primary-C2-communication-mode> element indicating the selected primary C2 communication mode; and
 - 3) may include a <selected-secondary-C2-communication-mode> element indicating the selected secondary C2 communication mode; and
- d) shall send the HTTP POST request towards the UAE-S.

6.3.1.3 UAE-layer assisted dynamic C2 mode switching procedure

Upon detecting a condition for switching C2 communication mode based on local conditions (e.g. using the C2 communication mode switching policy) or based on a command from the UAS application specific server, the UAE-C shall generate an HTTP POST request according to IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-C:

- a) shall set the Request-URI to the URI corresponding to the identity of the UAE-S;
- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body with a <C2-related-trigger-event-report> element in the <UAE-info> root element which shall include:
 - 1) a <UAE-client-id> element set to the identifier of the UAE client which indicates the QoS downgrade; and
 - 2) an <application-QoS-related-event> element including the expected or actual application QoS/QoE parameters which were changed (i.e. latency, throughput, reliability, jitter); and
- d) shall send the HTTP POST request towards the UAE-S.

Upon receiving an HTTP 200 (OK) message containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <C2-operation-mode-switching> element,

the UAE-C may start C2 communication using the indicated C2 communication mode included in the <C2-operation-mode-switching-requirement> child element and generate an HTTP POST request according to IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-C:

- a) shall set the Request-URI to the URI corresponding to the identity of the UAE-S;
- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body with a <C2-operation-mode-switching-performed> element in the <UAE-info> root element which shall include a <result> child element set to the value "positive" or "negative" indicating positive or negative result of the reception; and
- d) shall send the HTTP POST request towards the UAE-S.

6.3.2 Server procedure

6.3.2.1 C2 communication modes configuration procedure

Upon receiving an application request from UAS application specific server (which can be the USS/UTM) to manage the C2 operation modes (direct, network-assisted) of C2 communication for a UAS, the UAE-S shall generate an HTTP POST request message according to IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-S:

- a) shall include a Request-URI set to the URI corresponding to the identity of the UAE-C;
- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body with a <c2-modes-switching-configuration-info> element in the <UAE-info> root element which:
 - 1) shall include a <UAS-id> element set to the identification of the UAS for which the C2 QoS management request applies;
 - 2) shall include a <C2-operation mode-management-requirement> element set to the identification of the type of the C2 mode switching to be supported by the UAE server;
 - 3) shall include an <allowed-C2-communication-modes> element indicating the type of the C2 mode switching;

- 4) shall include a <primary-C2-communication-mode> element indicating the primary type of the C2 mode switching;
 - 5) may include a <secondary-C2-communication-mode> element indicating the secondary type of the C2 mode switching; and
 - 6) shall include a <policy-of-C2-switching> element set to the parameters for C2 switching; and
- d) shall send the HTTP POST request message towards the UAE-C.

6.3.2.2 C2 communication mode selection by UAE Client

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <C2-communication-mode-notification-info> element,

the UAE-S shall store the C2 communication modes and links information received in the <C2-communication-mode-notification-info> element and then forward the C2 communication modes and links information to the UAS application specific server and upon receiving a C2 communication mode notification acknowledgement from the UAS application specific server, the UAE-S shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5]. In the HTTP 200 (OK) response message, the UAE-S:

- a) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <UAE-info> root element:
 - 1) shall include a <C2-communication-mode-notification-info> element with an <acknowledgement> child element indicating the acknowledgement of selected C2 communication mode(s); and
- c) shall send the HTTP 200 (OK) message towards the UAE-C.

6.3.2.3 UAE-layer assisted dynamic C2 mode switching

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <C2-related-trigger-event-report> element,

the UAE-S:

- a) shall obtain a location report for the UAE-C by the SLM-S;
- b) shall determine the switching of the C2 mode from direct to network assisted or vice versa or to USS/UTM navigated;
- c) if the switching of the C2 mode is from direct to network assisted or vice versa, may send a C2 mode switching confirmation request to the UAS application specific server;
- d) if the switching of the C2 mode is from direct to USS/UTM navigated, shall send a C2 mode switching confirmation request to the UAS application specific server; and
- e) the UAE-S shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5]. In the HTTP 200 (OK) response message, the UAE-S:

NOTE: If the UAE-S has sent a C2 mode switching confirmation request to the UAS application specific server, the UAE-S shall wait and receive from the UAS application specific server a C2 mode switching confirmation response and then generate the HTTP 200 (OK) response message.

- 1) shall include a Request-URI set to the URI corresponding to the identity of the UAE-C;
- 2) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";

- 3) shall include an application/vnd.3gpp.uae-info+xml MIME body with a <C2-operation-mode-switching> element in the <UAE-info> root element which:
 - i) shall include a <UAE-server-id> element set to the identifier of the UAE server which instructs the UAS to apply the C2 mode switching;
 - ii) shall include a <C2-operation-mode-switching-requirement> element indicating the type of the C2 mode switching to be applied;
 - iii) may include a <time-validity> element set to the time validity for the C2 switching requirement; and
 - iv) may include a <geographical-area> element indicating the area for which the C2 switching applies; and
- 4) shall send the HTTP 200 (OK) message towards the UAE-C.

6.4 UAS UE registration

6.4.1 Client procedure

Upon receiving a request from a UAV application to register for receiving UAV application messages from the UAS application specific server, the UAE-C shall generate an HTTP POST request message according to procedures specified in IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-C:

- a) shall set the Request-URI to the URI received in the UAE client UE configuration document via the SCM-S;

NOTE 1: The provision of the UAE-S information in the UAE client UE configuration document via the SCM-S is out of scope of 3GPP.

- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <registration-info> element in the <UAE-info> root element:
 - 1) shall include a <UAV-id> element set to the identity of the UAV which initiates the UAS UE registration procedure;
 - 2) may include a <UAS-UE-information> element set to the related information (e.g. UAS UE IP address) the UAS UE needs to provide to the UAE-S; and
 - 3) may include a <proposed-registration-lifetime> element set to the time during which the UAS UE wants to stay registered to the UAE-S for receiving UAV application messages from the UAS application specific server; and

NOTE 2: If the <proposed-registration-lifetime> element is not included in the <registration-info> element, the registration lifetime is valid until the explicit UAS UE deregistration is performed as specified in clause 6.5.

- d) shall send the HTTP POST request message towards the UAE-S.

6.4.2 Server procedure

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <registration-info> element in the <UAE-info> root element;

the UAE-S:

- a) shall store the received registration information for the UAE-C;
- b) shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5] and in the HTTP 200 (OK) response:

- 1) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- 2) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <registration-info> element in the <UAE-info> root element:
 - i) shall include a <result> element set to the value "success" or "failure" indicating success or failure of the UAS UE registration; and
 - ii) may include a <registration-lifetime> element set to the time during which the UAS UE can stay registered to the UAE-S for receiving UAV application messages from the UAS application specific server; and
- c) shall send the HTTP 200 (OK) response towards the UAE-C.

6.5 UAS UE de-registration

6.5.1 Client procedure

Upon receiving a request from a UAV application to de-register for receiving UAV application messages from the UAS application specific server, the UAE-C shall generate an HTTP POST request message according to procedures specified in IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-C:

- a) shall set the Request-URI to the URI of the UAE-S for which the UAS UE has successfully registered (see clause 6.4);
- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <de-registration-info> element in the <UAE-info> root element:
 - 1) shall include a <UAV-id> element set to the identity of the UAV which initiates the UAS UE de-registration procedure; and
- d) shall send the HTTP POST request message towards the UAE-S.

6.5.2 Server procedure

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <de-registration-info> element in the <UAE-info> root element;

the UAE-S:

- a) shall remove the stored UAS UE information for the UAE-C;
- b) shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5] and in the HTTP 200 (OK) response:
 - 1) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
 - 2) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <de-registration-info> element in the <UAE-info> root element:
 - i) shall include a <result> element set to the value "success" or "failure" indicating success or failure of the UAS UE de-registration; and
- c) shall send the HTTP 200 (OK) response towards the UAE-C.

6.6 UAS UE registration update

6.6.1 Client procedure

Upon receiving a request from a UAV application, if the UAE-C needs to update the registration for receiving UAV application messages from the UAS application specific server, the UAE-C shall generate an HTTP POST request message according to procedures specified in IETF RFC 7231 [5]. In the HTTP POST request message, the UAE-C:

- a) shall set the Request-URI to the URI of the UAE-S for which the UAS UE has successfully registered (see clause 6.4);
- b) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml";
- c) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <registration-info> element in the <UAE-info> root element:
 - 1) shall include a <UAV-id> element set to the identity of the UAV which initiates the UAS UE registration update procedure;
 - 2) shall include a <UAS-UE-information> element set to the related information (e.g. UAS UE IP address) the UAS UE needs to update; and
 - 3) may include a <proposed-registration-lifetime> element set to the time during which the UAS UE wants to stay registered to the UAE-S for receiving UAV application messages from the UAS application specific server; and

NOTE: If the <proposed-registration-lifetime> element is not included in the <registration-info> element, the registration lifetime is not updated.

- d) shall send the HTTP POST request message towards the UAE-S.

6.6.2 Server procedure

Upon receiving an HTTP POST request containing:

- a) a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
- b) an application/vnd.3gpp.uae-info+xml MIME body with a <registration-info> element in the <UAE-info> root element;

the UAE-S:

- a) shall update the stored registration information with the received registration information for the UAE-C;
- b) shall generate an HTTP 200 (OK) response according to IETF RFC 7231 [5] and in the HTTP 200 (OK) response:
 - 1) shall include a Content-Type header field set to "application/vnd.3gpp.uae-info+xml"; and
 - 2) shall include an application/vnd.3gpp.uae-info+xml MIME body and in the <registration-info> element in the <UAE-info> root element:
 - i) shall include a <result> element set to the value "success" or "failure" indicating success or failure of the UAS UE registration update; and
 - ii) may include a <registration-lifetime> element set to the time during which the UAS UE can stay registered to the UAE-S for receiving UAV application messages from the UAS application specific server; and
- c) shall send the HTTP 200 (OK) response towards the UAE-C.

7 Coding

7.1 General

This clause specifies the coding to enable an UAE-C and an UAE-S to communicate.

7.2 Structure

The UAE document shall conform to the XML schema described in clause 8.4.

The <UAE-info> element shall be the root element of the UAE document.

The <UAE-info> element shall include at least one of the followings:

- a) a <c2-modes-switching-configuration-info> element;
- b) a <C2-communication-mode-notification-info> element;
- c) a <C2-related-trigger-event-report> element;
- d) a <C2-operation-mode-switching> element;
- e) a <UAV-application-message-info> element;
- f) a <C2-operation-mode-switching-performed> element; or
- g) a <registration-info> element;
- h) a <de-registration-info> element.

The <c2-modes-switching-configuration-info> element shall include the followings:

- a) a <UAS-id> element;
- b) a <C2-operation mode-management-requirement> element;
- c) an <allowed-C2-communication-modes> element;
- d) a <primary-C2-communication-mode> element;
- e) a <secondary-C2-communication-mode> element;
- f) a <policy-of -C2-switching> element; and
- g) a <result> element.

The <C2-communication-mode-notification-info> element shall include the followings:

- a) a <UAS-id> element;
- b) a <selected-primary-C2-communication-mode> element;
- c) a <selected-secondary-C2-communication-mode> element; and
- d) an <acknowledgement> element.

The <C2-related-trigger-event-report> element shall include the followings:

- a) a <UAE-client-id> element; and
- b) an <application-QoS-related-event> element.

The <C2-operation-mode-switching> element shall include the followings:

- a) a <UAE-server-id> element;

- b) a <C2-operation-mode-switching-requirement> element;
- c) a <time-validity> element; and
- d) a <geographical-area> element.

The <UAV-application-message-info> element shall include the followings:

- a) a <UAV-id> element;
- b) a <application-defined-proximity-range-info> element;
- c) a <application-payload> element; and
- d) a <acknowledgement> element.

The <C2-operation-mode-switching-performed> element shall include the followings:

- a) a <result> element.

The <registration-info> element shall include the followings:

- a) a <UAV-id> element;
- b) a <UAS-UE-information> element;
- c) a <proposed-registration-lifetime> element.
- d) a <registration-lifetime> element; and
- e) a <result> element.

The <de-registration-info> element shall include the followings:

- a) a <UAV-id> element; and
- b) a <result> element.

7.3 XML schema

7.3.1 General

This clause defines the XML schema for application/vnd.3gpp.uae-info+xml.

7.3.2 XML schema

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="urn:3gpp:ns:uaeInfo:1.0"
xmlns:uaeinfo="urn:3gpp:ns:uaeInfo:1.0"
elementFormDefault="qualified"
attributeFormDefault="unqualified"
xmlns:xenc="http://www.w3.org/2001/04/xmenc#">
  <!-- root XML element -->
  <xs:element name="uae-info" type="uaeinfo:uaeinfo-Type" id="uae"/>
  <xs:complexType name="uaeinfo-Type">
    <xs:sequence>
      <xs:element name="c2-modes-switching-configuration-info"
type="uaeinfo:tC2ModesSwitchingConfigurationType" minOccurs="0"/>
      <xs:element name="c2-communication-mode-notification-info"
type="uaeinfo:tC2CommunicationModeNotificationType" minOccurs="0"/>
      <xs:element name="c2-related-trigger-event-report"
type="uaeinfo:tC2RelatedTriggerEventReportType" minOccurs="0"/>
      <xs:element name="c2-operation-mode-switching" type="uaeinfo:tC2OperationModeSwitchingType"
minOccurs="0"/>
      <xs:element name="UAV-application-message-info" type="uaeinfo:tUAVApplicationMessageInfoType"
minOccurs="0"/>
    
```

```

    <xs:element name="c2-operation-mode-switching-performed"
type="uaeinfo:tC2OperationModesSwitchingPerformedType" minOccurs="0"/>
    <xs:element name="registration-info" type="uaeinfo:tRegistrationInfoType" minOccurs="0"/>
    <xs:element name="de-registration-info" type="uaeinfo:tDe-registrationInfoType"
minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax"/> minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tC2ModeSwitchingConfigurationType">
  <xs:sequence>
    <xs:element name="UAS-id" type="uaeinfo:contentType" minOccurs="0" maxOccurs="1"/>
    <xs:element name="c2-operation-mode-management-requirement" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="allowed-C2-communication-modes" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="secondary-C2-communication-mode" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="policy-of -C2-switching" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="result" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tC2CommunicationModeNotificationType">
  <xs:sequence>
    <xs:element name="UAS-id" type="uaeinfo:contentType" minOccurs="0" maxOccurs="1"/>
    <xs:element name="selected-primary-C2-communication-mode" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="selected-secondary-C2-communication-mode" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="acknowledgement" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tC2RelatedTriggerEventReportType">
  <xs:sequence>
    <xs:element name="UAE-client-id" type="uaeinfo:contentType" minOccurs="0" maxOccurs="1"/>
    <xs:element name="application-QoS-related-event" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tC2OperationModeSwitchingType">
  <xs:sequence>
    <xs:element name="UAE-server-id" type="uaeinfo:contentType" minOccurs="0" maxOccurs="1"/>
    <xs:element name="C2-operation-mode-switching-requirement" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="time-validity" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="geographical-area-change" type="uaeinfo:tGeographicalAreaChange"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tUAVApplicationMessageInfoType">
  <xs:sequence>
    <xs:element name="UAV-id" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="application-defined-proximity-range-info" type="xs:string" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="application-payload" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="acknowledgement" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tC2OperationModesSwitchingPerformedType">
  <xs:sequence>
    <xs:element name="result" type="xs:string" minOccurs="1" maxOccurs="1"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tRegistrationInfoType">
  <xs:sequence>
    <xs:element name="UAV-id" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="UAS-UE-information" type="xs:string" minOccurs="0" maxOccurs="1"/>

```

```

    <xs:element name="proposed-registration-lifetime" type="xs:integer" minOccurs="0"
maxOccurs="1"/>
    <xs:element name="registration-lifetime" type="xs:integer" minOccurs="0" maxOccurs="1"/>
    <xs:element name="result" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tDe-registrationInfoType">
  <xs:sequence>
    <xs:element name="UAV-id" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:element name="result" type="xs:string" minOccurs="0" maxOccurs="1"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="contentType">
  <xs:choice>
    <xs:element name="uaeURI" type="xs:anyURI"/>
    <xs:element name="uaeString" type="xs:string"/>
    <xs:element name="uaeBoolean" type="xs:boolean"/>
    <xs:any namespace="##other" processContents="lax"/>
  </xs:choice>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tGeographicalAreaChange">
  <xs:sequence>
    <xs:element name="any-area-change" type="vaeinfo:tEmptyTypeAttribute" minOccurs="0"/>
    <xs:element name="enter-specific-area" type="vaeinfo:tSpecificAreaType" minOccurs="0"/>
    <xs:element name="exit-specific-area-type" type="vaeinfo:tSpecificAreaType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="vaeinfo:anyExtType" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tEmptyTypeAttribute">
  <xs:complexContent>
    <xs:extension base="vaeinfo:tEmptyType">
      <xs:attribute name="trigger-id" type="xs:string" use="required"/>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
<xs:complexType name="tSpecificAreaType">
  <xs:sequence>
    <xs:element name="geographical-area" type="vaeinfo:tGeographicalAreaDef"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="vaeinfo:anyExtType" minOccurs="0"/>
  </xs:sequence>
  <xs:attribute name="trigger-id" type="xs:string" use="required"/>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tGeographicalAreaDef">
  <xs:sequence>
    <xs:element name="polygon-area" type="vaeinfo:tPolygonAreaType" minOccurs="0"/>
    <xs:element name="ellipsoid-arc-area" type="vaeinfo:tEllipsoidArcType" minOccurs="0"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="vaeinfo:anyExtType" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tPolygonAreaType">
  <xs:sequence>
    <xs:element name="corner" type="vaeinfo:tPointCoordinate" minOccurs="3" maxOccurs="15"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="vaeinfo:anyExtType" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
<xs:complexType name="tEllipsoidArcType">
  <xs:sequence>
    <xs:element name="center" type="vaeinfo:tPointCoordinate"/>
    <xs:element name="radius" type="xs:nonNegativeInteger"/>
    <xs:element name="offset-angle" type="xs:unsignedByte"/>
    <xs:element name="included-angle" type="xs:unsignedByte"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="vaeinfo:anyExtType" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>

```

```

<xs:complexType name="tPointCoordinate">
  <xs:sequence>
    <xs:element name="longitude" type="vaeinfo:tCoordinateType"/>
    <xs:element name="latitude" type="vaeinfo:tCoordinateType"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="anyExt" type="vaeinfo:anyExtType" minOccurs="0"/>
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax"/>
</xs:complexType>
</xs:schema>

```

7.4 Data semantics

The <UAE-info> element is the root element of the XML document. The <UAE-info> element contains the <c2-modes-switching-configuration-info>, <C2-communication-mode-notification-info>, <C2-related-trigger-event-report>, <C2-operation-mode-switching>, <UAV-application-message-info>, <C2-operation-mode-switching-performed>, <registration-info> and <de-registration-info> sub-elements.

<c2-modes-switching-configuration-info> element contains the following elements:

- a) <UAS-id>, an element contains identification of the UAS, which could be in form of identifier for the UAS, e.g. group ID, or collection of individual identifiers for the UAV and UAV-C, e.g. CAA ID, GPSI, IP address;
- b) <C2-operation mode-management-requirement>, an element contains the identification of the type of the C2 mode switching to be supported by the UAE server, which could be either from direct to network-assisted C2, or from network-assisted to direct C2 or to UTM navigated;
- c) <allowed-C2-communication-modes>, an element contains a string set to "direct", "network assisted", or "USS/UTM navigated";
- d) <primary-C2-communication-mode>, an element contains a string set to "direct", or "network assisted" used to indicate the primary C2 communication mode;
- e) <secondary-C2-communication-mode>, an element contains a string set to "direct", or "network assisted" used to indicate the secondary C2 communication mode;
- f) <policy-of -C2-switching>, an element contains a string set to the parameters for C2 switching, which are the QoS thresholds on active and target link, and
- g) <result>, an element contains a string set to either "positive" or "negative" used to indicate the positive or negative result of the C2 mode switching configuration response.

<C2-communication-mode-notification-info> element contains the following elements:

- a) <UAS-id>, an element contains identification of the UAS, which could be in form of identifier for the UAS, e.g. group ID, or individual identifiers for the UAV and UAV-C, e.g. CAA ID, GPSI, IP address;
- b) <selected-primary-C2-communication-mode>, an element contains a string set to "direct", or "network assisted" used to indicate the selected primary C2 communication mode;
- c) <selected-secondary-C2-communication-mode>, an element contains a string set to "direct", or "network assisted" used to indicate the selected secondary C2 communication mode; and
- d) <acknowledgement>, an element contains a string set to either "yes" or "not" used to indicate the acknowledgement of selected C2 communication mode(s).

<C2-related-trigger-event-report> element contains the following elements:

- a) <UAE-client-id>, an element contains a string set to the identifier of the UAE client which indicates the QoS downgrade; and
- b) <application-QoS-related-event>, an element contains a string indicating the expected or actual application QoS/QoE parameters which were changed (i.e. latency, throughput, reliability, jitter).

<C2-operation-mode-switching> element contains the following elements:

- a) <UAE-server-id>, an element contains a string set to the identifier of the UAE server which instructs the UAS to apply the C2 mode switching;
- b) <C2-operation-mode-switching-requirement>, an element contains a string set to either "direct to network-assisted" or "network-assisted to direct" used to indicate the type of the C2 mode switching to be applied;
- c) <time-validity>, an element contains a string set to the time validity for the C2 switching requirement; and
- d) <geographical-area>, an element specifying a geographical area for which the C2 switching applies and has the following sub-elements:
 - 1) <polygon-area>, an optional element specifying the area as a polygon specified in clause 5.4 of 3GPP TS 23.032 [xx]; and
 - 2) <ellipsoid-arc-area>, an optional element specifying the area as an ellipsoid arc specified in clause 5.7 of 3GPP TS 23.032 [xx].

<UAV-application-message-info> element contains the following elements:

- a) <UAV-id>, an element contains the unique identifier of a UAV which requests the sending of the UAV application message. The UAV-id is in the form of a 3GPP UE ID (e.g. GPSI, External Identifier) or CAA level UAV ID as assigned by civil aviation authorities (e.g. FAA) via USS/UTM;
- b) <application-defined-proximity-range-info>, an element contains the range information over which the UAV application message is to be sent;
- c) <application-payload>, an element contains the application payload that is to be delivered to the other UAVs; and
- d) <acknowledgement>, an element contains a string set to either "yes" or "not" used to indicate the acknowledgement of communications between UAVs within a geographical area.

<C2-operation-mode-switching-performed> element contains the following elements:

- a) <result>, an element contains a string set to either "positive" or "negative" used to indicate the positive or negative result of the reception.

<registration-info> element contains the following elements:

- a) <UAV-id>, an element contains the unique identifier of a UAV which initiates the UAS UE registration procedure;
- b) <UAS-UE-information>, an element contains the information (e.g. UAS UE IP address) the UAS UE needs to provide to the UAE-S;
- c) <proposed-registration-lifetime>, an element contains the time during which the UAS UE wants to stay registered to the UAE-S for receiving UAV application messages from the UAS application specific server;
- d) <registration-lifetime>, an element contains the time during which the UAS UE can stay registered to the UAE-S for receiving UAV application messages from the UAS application specific server; and
- e) <result>, an element contains a string set to either "success" or "failure" indicating success or failure of the UAS UE registration.

<de-registration-info> element contains the following elements:

- a) <UAV-id>, an element contains the unique identifier of a UAV which initiates the UAS UE de-registration procedure; and
- b) <result>, an element contains a string set to either "success" or "failure" indicating success or failure of the UAS UE de-registration.

7.5 MIME types

The MIME type for the UAE document shall be "application/vnd.3gpp.uae-info+xml MIME body".

7.6 IANA registration template

Editor's note: The registration should be made after approval of the specification.

Annex A (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2021-05	CT1#130-e	C1-213381				Draft skeleton provided by the rapporteur.	0.0.0
2021-06	CT1#130-e CT#92e	C1-213382 CP-211330				Implementing the following p-CR agreed by CT1: C1-213382 Addition of the TS number assigned in CT#92e.	0.1.0
2021-09	CT1#131-e	C1-214712 C1-214713 C1-214714 C1-214984 C1-214985 C1-214986 C1-214987 C1-214988 C1-214989 C1-214990 C1-214991 C1-214992 C1-215166 C1-215167				Implementing the following p-CRs agreed by CT1: C1-214712, C1-214713, C1-214714, C1-214984, C1-214985, C1-214986, C1-214987, C1-214988, C1-214989, C1-214990, C1-214991, C1-214992, C1-215166, C1-215167	0.2.0
2021-10	CT1#132-e	C1-215764 C1-215765 C1-215766 C1-215767 C1-215768 C1-215769 C1-215770 C1-215771 C1-215772 C1-215880 C1-215881 C1-215882 C1-215883 C1-215884 C1-215885 C1-215886 C1-215887				Implementing the following p-CRs agreed by CT1: C1-215764, C1-215765, C1-215766, C1-215767, C1-215768, C1-215769, C1-215770, C1-215771, C1-215772, C1-215880, C1-215881, C1-215882, C1-215883, C1-215884, C1-215885, C1-215886, C1-215887	0.3.0
2021-11	CT1#133-e	C1-216575 C1-216576 C1-216577 C1-216578 C1-216579 C1-216580 C1-216581 C1-216733 C1-216734 C1-216735 C1-216736				Implementing the following p-CRs agreed by CT1: C1-216575, C1-216576, C1-216577, C1-216578, C1-216579, C1-216580, C1-216581, C1-216733, C1-216734, C1-216735, C1-216736	0.4.0
2021-12	CT-94e	CP-213067				Presentation to TSG CT for information	1.0.0
2022-01	CT1#133 bis-e	C1-220313 C1-220314 C1-220315 C1-220317 C1-220318 C1-220837				Implementing the following p-CRs agreed by CT1: C1-220313, C1-220314, C1-220315, C1-220317, C1-220318, C1-220837	1.1.0
2022-02	CT1#134-e	C1-221635 C1-221636 C1-221638 C1-222015				Implementing the following p-CRs agreed by CT1: C1-221635, C1-221636, C1-221638, C1-222015	1.2.0
2022-03	CT#95e	CP-220314				TS presented for approval	2.0.0
2022-03	CT#95e					TS created after CT#95 by MCC	17.0.0

History

Document history		
V17.0.0	May 2022	Publication