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| Technical Report | |
| 3rd Generation Partnership Project;  Technical Specification Group Services and System Aspects;  Charging management;  Study on charging aspects of uncrewed aerial systems;  (Release 19) | |
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# Foreword

This Technical Report 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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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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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 studies the charging aspects for the support of uncrewed aerial systems based on the TS 22.125 [2], TS 23.256 [3], TS 23.501 [4], TS 23.502 [5] and TS 23.503 [6].

The following is studied:

- Identify charging scenarios and requirements for supporting uncrewed aerial systems.

- Evaluate the potential solutions to support the above charging scenarios and charging requirements.

# 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 22.125: "Unmanned Aerial System (UAS) support in 3GPP".

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

[4] 3GPP TS 23.501: "System architecture for the 5G System (5GS)".

[5] 3GPP TS 23.502: "Procedures for the 5G System (5GS)".

[6] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[7] 3GPP TS 32.290: "Charging management; 5G system; Services, operations and procedures of charging using Service Based Interface (SBI)".

[8] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[9] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services; Stage 2".

[10] 3GPP TS 32.255: "Charging management; 5G data connectivity domain charging; Stage 2".

[11] 3GPP TS 32.279: "Charging management; 5G Multicast-broadcast Services charging".

[12] 3GPP TS 32.256: "5G connection and mobility domain charging".

[13] 3GPP TS 32.254: "Exposure function northbound Application Program Interfaces (APIs) charging".

[14] 3GPP TS 29.503: "5G System; Unified Data Management Services; Stage 3".

[15] 3GPP TS 23.316: "Wireless and wireline convergence access support for the 5G System (5GS)".

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

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

**3GPP UAV ID:** Identifier assigned by the 3GPP system and used by external AF (e.g. USS) to identify the UAV. GPSI is used as the 3GPP UAV ID.

**CAA (Civil Aviation Administration)-Level UAV Identity:** a UAV identity assigned by USS/UTM, and uniquely identifies a UAV at least within the scope of a USS.

**Command and Control (C2) Communication:** the user plane link to deliver messages with information of command and control for UAV operation from a UAV controller or a UTM to a UAV or to report telemetry data from a UAV to its UAV controller or a UTM. C2 communication may be over Uu reference point or PC5 reference point.

**UAS NF:** a 3GPP UAS Network Function for support of aerial functionality related to UAV identification, authentication/authorization and tracking, and to support Remote Identification.

**UAS Service Supplier (USS):** An entity that provides services to support the safe and efficient use of airspace by providing services to the operator / pilot of a UAS in meeting UTM operational requirements. A USS can provide any subset of functionality to meet the provider's business objectives (e.g. UTM, Remote Identification). In the scope of the present document, the term USS refers to both USS and USS/UTM.

**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 UAV, authorizing UAS services, managing UAS policies, and controlling UAV traffics in the airspace).

**UAV controller:** The UAV controller of a UAS enables a drone pilot to control an 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.

## 3.2 Symbols

Void

## 3.3 Abbreviations

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

A2X Aircraft-to-Everything

C2 Command and Control

TPAE Third Party Authorized Entity

UAS Uncrewed Aerial System

UAV Uncrewed Aerial Vehicle

UAV-C/UAVC Uncrewed Aerial Vehicle Controller

USS UAS Service Supplier

UTM Uncrewed Aerial System Traffic Management

UUAA USS UAV Authorization/Authentication

# 4 Background

## 4.1 General

As defined in TS 22.125 [2], an Uncrewed Aerial System (UAS) is the combination of an Uncrewed Aerial Vehicle (UAV) and a UAV controller. The communication requirements 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.

In SA1, the requirements for UAS support in 3GPP are documented in TS 22.125 [2]. In SA2, there are two study items and two work items which are related to UAS in Release 17 and Release 18. The corresponding normative work is documented in TS 23.256 [3], TS 23.501 [4], TS 23.502 [5], TS 23.503 [6]. This study item will focus on charging solutions to support UAS based on the progress of SA1 and SA2 in Release 17 and Release 18.

## 4.2 Architecture for Support of Uncrewed Aerial Systems

The architecture for support of UAS connectivity, identification and tracking is defined in TS 23.256 [3]. The logical 5GS and EPS architecture for UAV is shown in Figure 4.2-1, and the 5G System non-roaming architecture for UAVs and for A2X communication over PC5 and Uu reference points is shown in Figure 4.2-2.



Figure 4.2-1: Logical 5GS and EPS architecture for UAV

The UAV is a 3GPP UE supporting the UE functionality and is configured for UAS services depicted in clause 4.3.3 of TS 23.256 [3]. UAV functionality can be provided by 5GC connected to NG-RAN and EPC connected to LTE. For EPC, the PDN connections used by UAV are always served by SMF+PGW-C.

The UAS Network Function is supported by the NEF or SCEF+NEF and used for external exposure of services to the UAS Service Supplier (USS), which makes use of existing NEF/SCEF exposure services.



Figure 4.2-2: 5G System non-roaming architecture for UAVs and for A2X communication

Roaming 5G System architecture for UAVs and for A2X communication over PC5 and Uu reference points is defined in clause 4.2.4 of TS 23.256 [3]. It is assumed that access to USS is in the VPLMN, thus packet data connectivity for UAV-USS communication is in local breakout, and the UAS NF function is located in the VPLMN, regardless of whether the roaming architecture is home routed or local breakout.

## 4.3 Business roles

Uncrewed Aerial System involves the services or capabilities may be provided by multiple service providers in the form of following business roles:

- UAS Mobile Network Operator (UAS-MNO): a 3GPP network operator who can provide UAS services for UAS service customer, i.e. MNO.

- UAS Service Provider (UAS-SP): a service provider who can provide UAS services for UAS service customer via the 3GPP system, e.g. USS, UTM.

- UAS Service Customer (UAS-SC): a service customer who is able to consume UAS services, i.e. UAV.

# 5 Charging scenarios and key issues

## 5.1 Topic 1：Converged charging with UAV Information

### 5.1.1 Use cases

#### 5.1.1.1 Use case #1a: Converged charging with UAV Information

As defined in TS 23.256 [3], the UAV is associated with the following identifiers in the 3GPP system:

- CAA-level UAV Identity: A UAV is assigned a CAA-level UAV Identity by functions in the aviation domain (e.g. USS). The UAV provides the CAA-level UAV Identity to the 3GPP system during UUAA procedures.

- 3GPP UAV ID: A 3GPP UAV ID is associated to the UAV by the 3GPP system in the subscription information and is used by the 3GPP system to identify the UAV. GPSI in the format of External Identifier is used as the 3GPP UAV ID.

The UAV, as a 3GPP UE configured for UAS services, can be identified by the UAV identifier, which makes it possible for charging differentiation.

For the scenario of using 3GPP network as the transport network for supporting UAS services, the charged party and charging party can be:

- Charged party: UAS-SC who accesses the 3GPP network.

- Charging party: UAS-MNO who provides UAS services to UAS-SC.

The potential charging requirements for this Use Case are: REQ-CH\_ UAS\_ID-01.

### 5.1.2 Potential charging requirements

**REQ-CH\_ UAS\_ID-01:** The 5G system should support converged charging per UAV.

### 5.1.3 Key issues

The following key issues are identified to support charging considering REQ-CH\_ UAS\_ID-01:

- **Key Issue #1a**: the charging information collecting and reporting per UAV.

### 5.1.4 Possible solutions

#### 5.1.4.1 Solution #1.1: Data Connectivity Charging between SMF and CHF

##### 5.1.4.1.1 General description

This solution #1.1 which relying on 5G data connectivity converged charging architecture defined in TS 32.255 [10], with the extension of including UAV indication, addressing the Key Issue#1a.

In order to distinguish the UAV from other 3GPP UEs for charging differentiation, the UAV indication can be involved to support UAV charging, which is not applicable to UAVC. SMF can determine whether the UE is an UAV during the USS UAV Authorization/Authentication (UUAA) procedures according to TS 23.256 [3].

##### 5.1.4.1.2 Procedures description

The message flows for the PDU session establishment, PDU session modification, PDU session release of 5G data connectivity charging in non-roaming scenarios, Home routed scenarios and Local breakout scenarios would be the same as in clause 5.2.2.2, clause 5.2.2.12 and clause 5.2.2.18 of TS 32.255 [10], with:

- UAV indication added in charging data request messages.

#### 5.1.4.2 Solution #1.2: Connection and Mobility Charging between AMF and CHF

##### 5.1.4.2.1 General description

This solution #1.2 which relying on 5G connection and mobility converged charging architecture defined in TS 32.256 [12], with the extension of including UAV indication, addressing the Key Issue#1a.

In order to distinguish the UAV from other 3GPP UEs for charging differentiation, the UAV indication can be involved to support UAV charging, which is not applicable to UAVC. For AMF, the UAV indication can be an indicator to show whether the UE is an UAV together with the corresponding 3GPP UAV ID, which can be obtained from UDM as defined in TS 29.503 [14].

The AMF may collect the following charging information:

Table 5.1.4.2.1-1: Extent to Common Structure of the Registration Charging Information

|  |  |  |
| --- | --- | --- |
| Information Element | Category | Description |
| UAV Information | OC | This field contains the UAV Information. |
| UAV Indication | OC | This field indicate the UE is a UAV or not. |
| 3gppUavId | OC | This field contains contain the 3GPP UAV ID, if the UAV indication is "True".  It is encoded as GPSI in the format of External Identifier. |

##### 5.1.4.2.2 Procedures description

The message flows for the 5G connection and mobility converged charging would be the same as in clauses 5.2.2 of TS 32.256 [12], with:

- UAV indication added in charging data request messages.

#### 5.1.4.3 Solution #1.3: Generic User Information to identify UAV

##### 5.1.4.3.1 General description

This solution #1.3 addresses Key Issue#1a. To distinguish the UAV or any other future proofed 3GPP UE types for charging differentiation, a generic IE can be introduced to hold the specific type of a UE.

As per TS 23.256 [3] clause 5.2.2 and clause 5.2.3, AMF / SMF can receive the UAV information (e.g. CAA-Level UAV ID or the UAV) in the UE Registration / PDU Session Establishment request. In this case, both AMF and SMF can identify the specific type of the UE, e.g. whether it is a UAV or any other specific type of UE.

The User Information IE, which are part of the PDU session charging information in TS 32.255 [10] and Registration charging information in TS 23.256 [3], can be extended to include a new sub IE, e.g. User Identifier Ext, to indicate the specific type of UE defined in the 3GPP system. Table 5.1.4.3.1-1 demonstrate the example of the extended User Information.

Table 5.1.4.3.1-1: Extension to the User Information IE

|  |  |  |
| --- | --- | --- |
| Information Element | Category | Description |
| User Information | OM | Group of user information. |
| User Identifier | OC | This field contains the identification of the user (i.e. GPSI). |
| User Equipment Info | OC | This field holds the identification of the terminal (i.e. PEI, MAC Address)  It is used for identifying the user in case SUPI is not present during emergency service. The detail identification of the wireline access is specified in clause 4.7.7 of TS 23.316 [15]. |
| unauthenticated Flag | OC | This field indicates the served SUPI is not authenticated. |
| Roamer In Out | OC | This field holds an indication if the roamer is in-bound or out-bound. This field is present only if UE is identified as a roamer. |
| User Identifier Ext | OC | This field indicates the specific type of UE defined in the 3GPP system, e.g. UAV when charging for the UAV scenario. This field can be used to provide additional information for user identifier. |

### 5.1.5 Evaluation

Solutions #1.1, #1.2 and #1.3 all addresses Key issue #1a with no impact on the charging architecture and operation.

Solution #1.1 applies to data connectivity charging between SMF and CHF with new parameter (i.e. UAV Indication) required.

Solution #1.2 applies to connection and mobility charging between AMF and CHF with new parameters (i.e. UAV Indication, 3GPP UAV ID) required.

Solution #1.3 applies both to SMF and AMF with the introduction of a generic User Identifier Ext IE to hold the specific type of a UE, including the UAV, which can also be further extended to other specific types of UE.

### 5.1.6 Conclusion

Based on the evaluation in clause 5.1.5, solution #1.3 is recommended for the normative work, considering the flexibility for future extension. New parameters need to be added for the UAV charging.

## 5.2 Topic 2：Charging support of C2 Communication

### 5.2.1 Use cases

#### 5.2.1.1 Use case #2a: Charging support of UTM-Navigated C2 Communication

As described in TS 22.125 [2], UTM-Navigated C2 communication is used by the UTM to provide cleared flying routes and routes updates, with UTM maintaining a C2 communication link with the UAV.

For this case, the charged party and charging party can be:

- Charged party: UAS-SP (i.e. USS/UTM) providing the navigation information.

- Charging party: UAS-MNO supporting the C2 Communication.

The potential charging requirement for this Use Case is: REQ-CH\_ UAS\_C2-01.

#### 5.2.1.2 Use case #2b: Charging support of Direct C2 Communication

As described in TS 22.125 [2] and TS 23.256 [3], a UAV that supports Direct C2 Communication may establish direct PC5 link with a UAV controller, and is generally used by a human-operator using a UAV controller.

For this case, the charged party and charging party can be:

- Charged party: UAS-SC (i.e. UAV) using the Direct C2 Communication.

- Charging party: UAS-MNO supporting Direct C2 Communication.

### 5.2.2 Potential charging requirements

**REQ-CH\_ UAS\_C2-01:** The 5G system should support collecting charging information for UTM-Navigated C2 Communication.

### 5.2.3 Key issues

The following key issues are identified to support charging considering REQ-CH\_ UAS\_C2-01:

- **Key Issue #2a**: determination of which entity/entities in the 5G system are suitable to provide the charging information to support C2 Communication.

- **Key Issue #2b**: identification and classification of the chargeable event and charging information for C2 Communication.

### 5.2.4 Possible solutions

#### 5.2.4.1 Solution #2.1: C2 Communication over Uu reference point

##### 5.2.4.1.1 General description

This solution#2.1 which relying on CHF/5G Converged Charging System for C2 Communication Charging, addresses the Key Issue#2a and #2b.

C2 communication may be over Uu reference point or PC5 reference point. Direct C2 Communication may establish direct PC5 link between a UAV and a UAV-C, and UTM-Navigated C2 communication is based on Uu reference point. Considering C2 communication over PC5 reference point, there is currently no network function collecting the usage information defined in SA2 specifications. Therefore, this solution only considers the C2 communication over Uu reference point.

The mechanisms defined in TS 23.501 [4] and TS 23.502 [5] can be used to establish the suitable PDU Sessions. The PDU Session/PDN connection for C2 communication may use separate PDU Sessions/PDN Connections or use the common PDU Session/PDN Connection, as defined in TS 32.256 [12].

##### 5.2.4.1.2 Architecture description

The 5G System high level charging architecture for SMF Charging can support the C2 communication.

##### 5.2.4.1.3 Procedures description

The high-level charging procedure for C2 communication over Uu reference point is referred the PDU session charging as specified in the TS 32.255 [10], with a key difference:

- The Tenant Identifier holds the USS Identity.

### 5.2.5 Evaluation

The solution #2.1 addresses Key issue #2a and #2b using SMF to provide the C2 Communication charging information to CHF including the USS Identity. However, the USS Identity transferred to SMF is not supported in this release according to TS 23.256 [3].

### 5.2.6 Conclusion

No normative work is proposed for this topic.

## 5.3 Topic 3: Service Exposure to the USS

### 5.3.1 Use Case

#### 5.3.1.1 Use Case #3a: Service Exposure for UAV Tracking

The UAS-SP (e.g. USS) and the UAS-MNO has the service agreement about the service exposure for UAV Tracking.

According to the TS 23.256 [3] clause 4.3.2, the UAS-SP can perform one or multiple service invocation for the safe and efficient use of airspace. The UAS-MNO can collect the charging information based on the following chargeable events, for example:

- location reporting, presence monitoring, obtaining list of Aerial UEs in a geographic area.

The charging party: the UAS-MNO.

The charged party: the UAS-SP for the chargeable event of service exposure.

The potential charging requirements for this UC are: REQ-3GPPCH-SE-01.

#### 5.3.1.2 Use Case #3b: Service Exposure for QoS controlling

The UAS-SP (e.g. USS) and the UAS-MNO has the service agreement about the service exposure for QoS control on the differentiate traffic transmission.

For the UAV communication scenarios, the different QoS information will be provision by USS for differentiate communication bandwidths for different traffic, for example:

- the large-bandwidth and low-latency communication services for video transmission.

- small-bandwidth and low-latency communication services for control signals transmission.

- special communications for the traffic and bandwidth emergency assurance service, in the emergency cases. The UAS-MNO can provide the special charging package, which is distinguish with other services communication, e.g. free of charge.

The charging party: the UAS-MNO.

The charged party: the UAS-SP for the chargeable event of service exposure for QoS controlling.

The potential charging requirements for this UC are: REQ-3GPPCH-SE-01.

### 5.3.2 Potential charging requirements

**REQ-3GPPCH-SE-01:** The 5G System should support converged charging for service exposure per UAS-SP basis.

### 5.3.3 Key issues

#### 5.3.3.1 Key issue #3a: Chargeable events and charging information required

This key issue is for investigating how to support the charging considering REQ-3GPPCH-SE-01. This investigation covers the following:

- identification of the charging information for service invocation;

- identification of the chargeable event for service invocation;

### 5.3.4 Solutions

#### 5.3.4.1 Solution #3.1: API invocation via UAS NF/NEF

##### 5.3.4.1.1 General description

This solution#3.1 which relying on CHF/5G Converged Charging System for UAS NF/NEF Charging, addresses the Key Issue#3a.

The NEF charging specified in the TS 32.254 [13] can be used to support the charging of UAS service exposure.

- "Tenant Identifier" specified in the clause 6.2a.1.2.1 of TS 32.254 [13] in the Charging Data Request can be used to identify the USS/TPAS.

- The "UAV identity" (e.g. 3GPP UAV ID, CAA Level UAV ID) can be included in the "External Individual Identifier" or "External Individual Id List" in NEF API Charging Information specified in the 6.3.1.4 of TS 32.254 [13], indicating the UAS UE(s).

##### 5.3.4.1.2 Architecture description

Figure 5.3.4.1.2-1 shows the 5G System high level charging architecture for UAS NF/NEF Charging, in the Service-based interfaces for non-roaming:



Figure 5.3.4.1.2-1: UAS NF/NEF converged charging architecture non-roaming

##### 5.3.4.1.3 Procedures description

The figure 5.3.4.1.3-1 describes the high-level charging procedure for UAS NF/NEF charging for service invocation about UAV Tracking, based on the figure 5.3.2-1 UAV Location Reporting, Figure 5.3.3-1 UAV Presence Monitoring and Figure 5.3.4-1 List of Aerial UEs in a geographic area, specified in the TS 23.256 [3]. The event-based charging. i.e. IEC, PEC and ECUR specified in TS 32.290 [7] are supported.



Figure 5.3.4.1.3-1: Charging Procedure for service invocation for the UAS-SP (PEC)

1. USS to UAS NF/NEF: The USS/TPAE sends the service request to UAS NF.

- For immediate location reporting request, USS (i.e. the UAS-SP) should include an indication of reliable UE location information required in the request.

- For UAV presence monitoring request, USS subscribes the target UAV presence events from 3GPP network (e.g. moving in or out of the monitoring area) and should include the GPSI corresponding to the target UAV for the presence monitoring, the geographic area info (e.g. longitude/latitude, zip code, etc.), an indication of reliable UE location information required in the request.

- For obtaining UAV list request, USS request the UAV identity (e.g. 3GPP UAV ID, CAA Level UAV ID). And should include geographic area info, an indication of reliable UE location information required and indication for immediate reporting in the request.

1. UAS NF/NEF determines the relevant NF, e.g. AMF/MME or GMLC for location reporting based on the UAV's capability or network capability, location accuracy, geographic area info etc.

2. UAS NF/NEF receives the UE location, UAV presence monitoring report or UAV location from AMF/MME or GMLC.

3. UAS NF/NEF responds to USS and sends the notifications/responses about the UAV location UAV presence in the geographic area, or USS/TPAE with the list of filtered UAVs.

4cha. UAS NF/NEF sends the Charging Data Request [Event] to CHF for the service response/service notification.

4chb. The CHF creates a CDR related to the service response/notification.

4chc. The CHF grants authorization to UAS NF/NEF for the response/notification.

### 5.3.5 Evaluation

#### 5.3.5.1 Solutions evaluation for Key issue #3a

The solution #3.1 addresses Key issue #3a using UAS NF/NEF to provide the charging information collecting and reporting based on the chargeable events about API invocation/notification from/to USS/TPAE.

### 5.3.6 Conclusion

It is concluded that the solution #3.1 is the only one and therefore recommended into the normative work.

## 5.4 Topic 4: Aircraft-to-Everything (A2X) services for UAS Charging

### 5.4.1 Use cases

#### 5.4.1.1 Use Case #4.1: AF-based service parameter provisioning for A2X communication

The UAS-SP (A2X Application Server as AF) and the UAS-SC (A2X Application in UE as the UAV) has the service agreement about the A2X service subscription. The UAS-SP and UAS-MNO have the service agreement and subscription for 5GS network access.

The A2X Application Server performs the AF-based service parameter provisioning for A2X communications via NEF, as specified in TS 23.256 [3] clause 4.3.9. The NEF stores the A2X service parameters in the UDR.

The charging party: UAS-MNO.

The charged party: UAS-SP.

The potential charging requirements for this Use Case is: REQ-3GPPCH-A2X-01.

#### 5.4.1.2 Use Case #4.2: Non-roaming 5G System for A2X communication

The UAS-SP (A2X Application Server) and the UAS-SC (A2X Application in UE as the UAV) has the service agreement about the A2X service subscription.

The UAS-SC and UAS-MNO have the service agreement and subscription for 5GS network access that can support A2X communication. The subscription to A2X services based on the user's profile stored in the UDM.

- The A2X communication is supported between UAS-SC (UAV) and UAS-SP (A2X Application Server), as specified in TS 23.256 [3] clause 4.3.9. The 5G data connectivity for A2X communication between UAS-SC and UAS-SP should be charged.

The charging party: UAS-MNO.

The charged party: UAS-SC.

The potential charging requirements for this Use Case is: REQ-3GPPCH-A2X-02.

#### 5.4.1.3 Use Case #4.3: Roaming 5G System architecture for A2X communication

The UAS-SP (A2X Application Server) and the UAS-SC (A2X Application in UE as the UAV) has the service agreement about the A2X service subscription. The UAS-SC and Home UAS-MNO have the service agreement and subscription for 5GS network access.

- In the local breakout roaming scenarios, the UAS-SC (UAS UEs) are roamed into Visited UAS-MNO, the A2X Application Server is located in the Visited UAS-MNO.

- In the home routed roaming scenarios, the UAS-SC (UAS UEs) are roamed into Visited UAS-MNO, the A2X Application Server is located in the Home UAS-MNO.

The A2X services for UAS charging including the following aspects:

- The A2X communication is supported between UAS-SC (UAV) and UAS-SP (A2X Application Server), as specified in TS 23.256 [3] clause 4.3.9. The 5G data connectivity for A2X communication between UAS-SC and UAS-SP should be charged.

The Retail charging party: Home UAS-MNO.

The Retail charged party: UAS-SC.

The wholesale charging is between the Home UAS-MNO and Visited UAS-MNO, which is outside the scope of the present document.

The potential charging requirements for this Use Case is: REQ-3GPPCH-A2X-03.

### 5.4.2 Potential charging requirements

The following are potential high-level charging requirements for A2X service for UAS Charging:

**REQ-3GPPCH-A2X-01:** The 5G System should support converged charging for service provision invocation per UAS-SP basis.

**REQ-3GPPCH-A2X-02:** The 5G System should support converged charging for A2X communication per UAS-SC basis.

**REQ-3GPPCH-A2X-03:** The 5G System should support converged charging for LBO and HR roaming case A2X communication per UAS-SC basis.

### 5.4.3 Key issues

#### 5.4.3.1 Key issue #4a: Charging information required for A2X service parameter provisioning

This key issue is for investigating how to support the A2X services for UAS charging considering REQ- 3GPPCH-A2X-01. This investigation covers the following:

- identification of the charging architecture for A2X service parameter provisioning;

- identification of triggers and charging information required to A2X service parameter provisioning.

#### 5.4.3.2 Key issue #4b: Charging information required for non-roaming A2X communication

This key issue is for investigating how to support the A2X services for UAS charging considering REQ- 3GPPCH-A2X-02. This investigation covers the following:

- identification of the charging architecture for non-roaming A2X communication;

- identification of triggers and charging information required to non-roaming A2X communication.

#### 5.4.3.3 Key issue #4c: Charging information required for roaming A2X communication

This key issue is for investigating how to support the A2X services for UAS charging considering REQ- 3GPPCH-A2X-03. This investigation covers the following:

- identification of the charging architecture for roaming A2X communication;

- identification of triggers and charging information required to roaming A2X communication.

### 5.4.4 Solutions

#### 5.4.4.1 Solution #4.1: Provisioning for A2X communication via UAS NF/NEF

##### 5.4.4.1.1 General description

This solution#4.1 which relying on CHF/5G Converged Charging System for UAS NF/NEF Charging, addresses the Key Issue#4a.

##### 5.4.4.1.2 Architecture description

The 5G System high level charging architecture for UAS NF/NEF Charging to support the AF-based service parameter provisioning for A2X communication is the same with figure 5.3.4.1.2-1 in clause 5.3.4.1.

##### 5.4.4.1.3 Procedures description

The high-level charging procedure for UAS NF/NEF charging for AF-based service parameter provisioning for A2X communication is same with figure 5.3.4.1.3-1, with the difference in steps:

- Step1: AF (A2X Application Server) sends the service parameter provisioning for A2X communication request to NEF.

- Step 3: Not required.

#### 5.4.4.2 Solution #4.2: Non-roaming A2X Communication over Uu reference point

##### 5.4.4.2.1 General description

This solution#4.2 which relying on CHF/5G Converged Charging System for Non-roaming A2X Communication Charging, addresses the Key Issue#4a.

A2X communication over PC5 reference point or over Uu reference point are supported, and this solution only considers the A2X communication over Uu reference point.

- the mechanisms defined in TS 23.501 [4] and TS 23.502 [5] can be used to establish the suitable PDU Sessions, and V2X messages are routed towards V2X Application Server or towards UEs with existing unicast routing, as specified in the clause 5.2.2.1 TS 23.287 [8];

- The mechanisms defined in TS 23.247 [9] can be used to establish the suitable MBS sessions, and V2X messages are routed from the V2X Application Server towards UEs via broadcast MBS sessions or multicast MBS sessions, as specified in the clause 5.2.2.2 TS 23.287 [8].

##### 5.4.4.2.2 Architecture description

The 5G System high level charging architecture for SMF/MB-SMF Charging to support the A2X communication.

##### 5.4.4.2.3 Procedures description

The high-level charging procedure for A2X communication over Uu reference point is referred the PDU session charging as specified in the TS 32.255 [10] and MBS session charging as specified in the TS 32.255 [10] and TS 32.279 [11].

#### 5.4.4.3 Solution #4.3: Roaming A2X Communication over Uu reference point

##### 5.4.4.3.1 General description

This solution#4.3 which relying on CHF/5G Converged Charging System for Roaming A2X Communication, addresses the Key Issue#4a.

The charging for A2X communication over Uu reference point using the PDU session in roaming case, including HR and LBO scenarios, refers to TS 23.501 [4] and TS 23.502 [5]. As defined in TS 23.247 [9], multicast/broadcast service for roaming is not supported in this release.

##### 5.4.4.3.2 Architecture description

The 5G System high level charging architecture for SMF charging in roaming cases to support the A2X communication roaming scenarios.

##### 5.4.4.3.3 Procedures description

The high-level charging procedure for A2X communication over Uu reference point in roaming case can refer to the PDU session charging as specified in the TS 32.255 [10].

### 5.4.5 Evaluation

#### 5.4.5.1 Solutions evaluation for Key issue #4a

The solution #4.1 addresses Key issue #4a for A2X service parameter provisioning using UAS NF/NEF to provide the charging information collecting and reporting based on the chargeable events about Provisioning for A2X communication API invocation from USS/TPAE. The NEF charging specified in the TS 32.254 [13] can be used for the UAS NF/NEF charging with the identifiers of AF (A2X application Server) and UAS UE (A2X application), see the clause 5.3.5.1.

#### 5.4.5.2 Solutions evaluation for Key issue #4b

The solution #4.2 addresses Key issue #4b for non-roaming A2X communication using SMF/MB-SMF support the unicast, broadcast and multicast communication. The SMF charging specified in TS 32.255 [10] can be used to support the charging for non-roaming A2X communication with PDU session. The MB-SMF charging specified in TS 32.279 [11] can be reused to support the charging for non-roaming A2X communication with MBS session.

#### 5.4.5.3 Solutions evaluation for Key issue #4c

The solution #4.3 addresses Key issue #4c for roaming A2X communication over Uu, using SMF support unicast service roaming communication. As defined in TS 23.247 [9], multicast/broadcast service for roaming is not supported in this release. The SMF charging specified in TS 32.255 [10] can be used to support the charging for roaming A2X communication with PDU session.

### 5.4.6 Conclusion

For A2X service parameter provisioning, NEF charging specified in the TS 32.254 [13] can be reused, i.e. solution #4.1.

For non-roaming A2X communication, SMF charging specified in the TS 32.255 [10] and MB-SMF charging specified in TS 32.279 [11] can be reused, i.e. solution #4.2.

For roaming A2X communication, SMF charging specified in the TS 32.255 [10] can be reused, i.e. solution #4.3.

# 6 Conclusions and Recommendations

The present technical report studied 4 Topics for charging aspects of uncrewed aerial systems with the following conclusions:

- Converged charging with UAV Information: the solution #1.3 with adding a generic UE Type to identify the UAV is selected in clause 5.1.6.

- Charging support of C2 Communication: the solution #2.1 is the only solution with no normative work in this release according to clause 5.2.5 and 5.2.6.

- Service Exposure to the USS: the solution #3.1 based on the UAS NF/NEF charging is selected in the clause 5.3.6.

- A2X services for UAS Charging: the solution #4.1 based on NEF charging is recommended to support the charging for A2X service parameter provisioning. The solution #4.2 based on SMF charging and MB-SMF charging is recommended to support the charging for non-roaming A2X communication. The solution #4.3 based on SMF charging is recommended to support the charging for roaming A2X communication.

To support converged charging for UAS in normative work, it is recommended to specify the charging principles and charging enhancements to support converged charging with UAV Indication, service exposure to the USS and A2X communication based on the above conclusions.

Annex A:  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Change history | | | | | | | |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2024-08 | SA5#156 | S5-243525 |  |  |  | Initial skeleton | 0.0.0 |
| 2024-08 | SA5#156 | S5-244072  S5-244073  S5-244077  S5-244522  S5-244523  S5-244524  S5-244525  S5-244526  S5-244527 |  |  |  | Update skeleton  Add scope  Add reference  Add definitions of terms, symbols and abbreviations  Introduction of background  Add use cases and key issues for charging with UAV Identifier  Add use cases and key issues for C2 Communication charging  Introduce the charging for Services Exposure to the USS  New solution on the charging for Services Exposure to the USS | 0.1.0 |
| 2024-10 | SA5#157 | S5-245904  S5-245905  S5-245906  S5-245907  S5-245602  S5-245605 |  |  |  | Add solution for charging with UAV Identifier  Introduce the Aircraft-to-Everything for UAS Charging  New charging solution for non-roaming A2X Communication  New charging solution for roaming A2X Communication  New charging solution for provisioning for A2X communication  Update charging solution for UAS service invocation | 0.2.0 |
| 2024-11 | SA5#158 | S5-246584  S5-246974  S5-246975  S5-246980  S5-246976  S5-246977  S5-246978  S5-246979 |  |  |  | Correction on roaming A2X communication solution  Evaluation and conclusion for UAS charging topic 3  Evaluation and conclusion for UAS charging topic 4  Conclusion for UAS Charging  Remove editor's note for UAV indication  Add Evaluation and Conclusion for charging with UAV Indication  Add use cases for direct C2 Communication charging  Add Solution for C2 Communication charging | 0.3.0 |
| 2024-12 |  |  |  |  |  | EditHelp's cleanup | 0.3.1 |
| 2024-12 | SA#106 | SP-241603 |  |  |  | Presentation to SA for Information | 1.0.0 |
| 2025-02 | SA5#159 | S5-250737  S5-250738  S5-250739  S5-250740  S5-250741 |  |  |  | New solutions for UAV information  Add Evaluation and Conclusion for UAV Indication  Add Evaluation and Conclusion for C2 Communication charging  Conclusion for A2X communication charging  Update Conclusions and Recommendations | 1.1.0 |
| 2025-02 | SA5#159 |  |  |  |  | EditHelp cleanup | 1.1.1 |
| 2025-03 | SA#107 | SP-250147 |  |  |  | Presentation to SA for approval | 2.0.0 |
| 2025-03 | SA#107 |  |  |  |  | Upgrade to change control version | 19.0.0 |
| 2025-06 | SA#108 | SP-250534 | 0001 | 1 | D | Correction of reference | 19.1.0 |