



FINAL REPORT - PROJECT EXECUTIVE SUMMARY

EUGENE

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1.0	11/10/22	21	This is the first version of the document
1.1	11/11/22	55	This second version implements the RIDs agreed at FRM: <ul style="list-style-type: none"> ■ MAG-01: Figure 4-2 updated ■ MAG-02: Section 3.2.1.3 replaced ■ MAG-03: Section 3.2.1.4 deleted ■ MAG-04: Service requirements added in Annex A ■ MAG-05: Figure 3-1 caption corrected ■ MAG-06: Section 3.2.1.3 replaced ■ MAG-07: Text from section 3.3.1 updated ■ MAG-08: E-GNSS API requirements added in Annex B ■ MAG-09: Service tree added in Annex C ■ MAG-10: Included within the Executive Summary in section 4 ■ MAG-11: Included within the Executive Summary in section 4 ■ MAG-12: Service provision requirements added in Annex D ■ MAG-13: Included within the Executive Summary in section 4 ■ MAG-14: Text from section 3.4.4 updated ■ MAG-15: Text from section 3.5.1 updated. Included within the Executive Summary in section 4. ■ MAG-16: Included within the Executive Summary in section 4 ■ MAG-17: Included within the Executive Summary in section 4
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1. INTRODUCTION

1.1. PURPOSE

The purpose of this document is to summarise the activities and conclusions of the EUGENE project and. This project has been carried out by the EUGENE consortium, comprised by GMV, ESSP, VVA and UNIFLY.

The document is delivered as part of the Final Review Meeting (FRM) data package.

1.2. SCOPE

This document provides a list of the main deliverables of the EUGENE project. For each work package, the document summarizes the performed activities, key issues and conclusions. Besides, Section 3. provides the Executive Summary of the project.

1.3. DEFINITIONS AND ACRONYMS

1.3.1. DEFINITIONS

Concepts and terms used in this document and needing a definition are included in the following table:

Table 1-1 Definitions

Concept / Term	Definition
-	-

1.3.2. ACRONYMS

Acronyms used in this document and needing a definition are included in the following table:

Table 1-2 Acronyms

Acronym	Definition
AMC	Acceptable Means of Compliance
API	Application Programming Interface
CAA	Civil Aviation Authority
CBA	Cost Benefit Analysis
CFI	Customer Furnished Item
CIS	Common Information Services
ConOps	Concept of Operations
CV	Curriculum Vitae
DB	Database
EC	European Commission
EGNOS	European Geostationary Navigation Overlay Service
ETSO	European Technical Standard Order
EU	European Union
EUSPA	European Union Agency for the Space Programme
FRM	Final Review Meeting
GM	Guidance Material
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HTTP	Hypertext Transfer Protocol
KOM	Kick-off Meeting

Acronym	Definition
MoM	Minutes of Meeting
NPA	Notice of Proposed Amendment
NPV	Net Present Value
OS	Open Service
PM	Progress Meeting
PNT	Positioning, Navigation and Timing
PoC	Point of Contact
RFI	Radio Frequency Interference
RID	Review Item Discrepancy
SAIL	Specific Assurance and Integrity Level
SC	Special Condition
SDD	Service Definition Document
SiS	Signal in Space
SOA	Service Oriented Architecture
SoL	Safety of Life
SORA	Specific Operational Risk Assessment
SP	Service Provider
TSO	Technical Standard Order
UAS	Unmanned Aircraft Systems
USSP	U-Space Service Provider
WG	Working Group
WP	Work Package

2. REFERENCES

2.1. APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form part of this document to the extent specified herein. Applicable documents are those referenced in the Contract or approved by the Approval Authority. They are referenced in this document in the form [AD.x]:

Table 2-1 Applicable Documents

Ref.	Title	Code	Version	Date
[AD.1]	Invitation to Tender: EGNSS Service for unmanned aviation	DEFIS/2021/OP/0007	-	26/07/21
[AD.2]	Tender Specifications: EGNSS Service for unmanned aviation	DEFIS/2021/OP/0007	01.C2	-
[AD.3]	Service contract EGNSS Service for unmanned aviation	DEFIS/2021/OP/0007	-	25/01/22
[AD.4]	Technical proposal EUGENE (European GNSS Service for Unmanned Aviation). Technical Proposal	GMV 12465/21 V1/21	1.0	1/10/22

2.2. REFERENCE DOCUMENTS

The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.x]:

Table 2-2 Reference Documents

Ref.	Title	Code	Version	Date
[RD.1]	EUGENE. Service Requirements	D1.1 (EUGENE-GMV-TN-01)	2.1	11/11/22
[RD.2]	EUGENE. Service Requirements Justification File	D1.2 (EUGENE-GMV-TN-02)	2.0	11/10/22
[RD.3]	EUGENE. EGNSS API Requirements	D1.3 (EUGENE-GMV-TN-05)	1.2	08/09/22
[RD.4]	EUGENE. Impact Assessment	D1.4 (EUGENE-GMV-TN-04)	2.1	11/11/22
[RD.5]	EUGENE. User Segment Approach	D1.5 (EUGENE-GMV-TN-03)	2.1	11/11/22
[RD.6]	EUGENE. High Level Service Provision Model	D2.1 (EUGENE-GMV-TN-06)	1.4	11/11/22
[RD.7]	EUGENE. Detailed Service Provision Requirements and Design	D2.2 (EUGENE-GMV-TN-07)	1.3	11/11/22
[RD.8]	EUGENE. Detailed Service Provision Requirements Justification File	D2.3 (EUGENE-GMV-TN-08)	1.3	11/11/22
[RD.9]	EUGENE. Detailed Liability Scheme	D2.4 (EUGENE-GMV-TN-12)	1.1	11/11/22
[RD.10]	EUGENE. Analysis of a Service Definition Document for the new service	D2.5 (EUGENE-GMV-TN-13)	1.1	11/11/22
[RD.11]	EUGENE. Cost Benefit Analysis	D3.1 (EUGENE-GMV-TN-09)	2.1	11/11/22
[RD.12]	EUGENE. Expression of interest: Manufacturers, Operators and U-Space Service Providers	D3.2 (EUGENE-GMV-TN-10)	1.2	11/11/22
[RD.13]	EUGENE. Expression of interest: Civil Aviation Authorities	D3.3 (EUGENE-GMV-TN-11)	1.2	11/11/22
[RD.14]	EUGENE. Service Implementation Plan	D4.1 (EUGENE-GMV-TN-13)	1.1	11/11/22
[RD.15]	The JSON data interchange syntax	ECMA-404	2nd	2017

3. EXECUTIVE SUMMARY

The aim of the EUGENE project has been to help EC in achieving its objective to support the development of a E-GNSS (i.e. EGNOS and Galileo) Service for the Unmanned Aviation, by addressing phase 2 of EC/EUSPA's *High Level Strategy for the introduction of an EGNSS Service for Unmanned Aviation*, which intends to cover drone operations in the Specific category with a SAIL (Specific Assurance and Integrity Level) III or IV according to SORA (Specific Operation Risk Analysis) methodology.

The first task of the project was the identification of the user needs for the proposed new E-GNSS Service, taking into account the project assumption that no evolution of the E-GNSS system other than what is currently planned at the program level (e.g. HAS, OSNMA, DFMC EGNOS) can be proposed.

The users considered for this task were the GNSS receivers on-board the UAS, the U-Space Service Providers (USSPs), the Common Information Service providers (CISs), and the UAS operators.

Regarding the GNSS receivers on-board the UAS, the project made the assumption that only GNSS receivers that are *approved* in accordance with a certain procedure (to be proposed by the EUGENE project) would be considered users of the new E-GNSS service.

To identify the user needs a thorough review of the applicable Regulation (EU 2019/945, EU 2019/947, EU 2021/664, EASA NPA 2021-14, EASA AMC & GM to 2019/947 amendment 2) was performed.

However, from this analysis it was only possible to identify short term user needs (i.e. those required by the Regulation when it becomes effective) and, therefore, a second analysis was necessary in order to identify user needs in the mid to long term (beyond 2030) that may stem from the expected evolution of the Regulation (e.g. to include new U-Space services), the demand for more challenging UAS operations, or the capabilities of new E-GNSS services (e.g. HAS, OSNMA or other authentication methods, DFMC EGNOS) that are planned to entry into service. The main sources reviewed to carry out this second analysis have been the last version (edition 4) of the CORUS ConOps, the EUROCAE guidelines for the use of multi-GNSS solutions for low-risk operations (ED-301), and the deliverables of the SUGUS project (746/PP/GRO/RCH/19/305), which was the precursor of the EUGENE project.

Some relevant findings of the user needs identification task have been:

- The reviewed Regulation focuses on the required U-Space services to support UAS operations within U-Space airspace. However, the SORA methodology included in EASA AMC does not address the operational risk due to mid-air collisions between UAS, and so de-conflicting or not the UAS trajectories in a certain airspace (which is the key goal of U-Space services) or having a low or a high UAS traffic density (as assumed in U-Space airspace) have no effect on the resultant operational risk.

Consequently, in accordance with that Regulation, medium risk operations (those analysed in the EUGENE project) could take place both inside or outside U-Space airspace (because the operational risk would not change), and so user needs have to be identified in both scenarios

- Users need for UAS position integrity to support medium risk operations cannot be derived in a straightforward way from the reviewed documentation. Only indirect references have been found (e.g. in ED-301 and ED-269) to use upper bounds (a proxy for protection levels) to the UAS position accuracy performances to ensure UAS separation from obstacles and terrain.
- User needs for minimum UAS positioning performances to support medium risk operations were not identified during the execution of this task. Only at the very end of the EUGENE project, a UCP report has been found proposing performance requirements for SAIL III and IV operations.

The main user needs identified from this analysis are:

- The E-GNSS Signals-in-Space (SiS) must be able to provide, despite not defined yet, the required positioning performances service levels (accuracy, integrity, availability, continuity)

It is worth stressing that those performances would be achievable by E-GNSS *approved* receivers when working in the defined conditions of use. What is crucial for the unmanned aviation is that those conditions of use allow the execution of drone operations not only in open sky conditions but also in other degraded local environments (e.g. in urban corridors)

Note that the conditions of use in degraded local environment would not require changing the current (or planned) E-GNSS system nor the underlying integrity concept

- *Approved* GNSS receivers on-board UAS must be able to provide the information (e.g. achieved positioning performances) to be included in the position reports to be downlinked periodically

- The UAS Operators, USSPs and CISs need to know the positioning performances achievable by an *approved* GNSS receiver on-board UAS along the full UAS mission. This high-level user need can be split into four lower-level user needs, namely:
 - To know the minimum positioning performances (e.g. as described in an SDD)
 - To know the achieved positioning performances (e.g. statistics on measured data)
 - To know the forecasted positioning performances
 - To know the impact of detected RFIs on current and forecasted positioning performances

After the identification of the user needs, the next task of the project was the definition of the requirements of the new E-GNSS Service that would be able to meet those needs.

As a matter of fact, four different E-GNSS sub-services (each with its own requirements) have been identified, and are depicted in the figure below:

- The E-GNSS SiS (Galileo and EGNOS) that feed E-GNSS *approved* receivers
- A E-GNSS data service, which provides specific E-GNSS pieces of information through an Application Programming Interface (API) to stakeholders (UAS operators, USSPs, CISs)
- A E-GNSS website, which allows human operators of USSP, CIS and UAS operators to search for documents and past, current, or forecasted information pertaining to the E-GNSS service
- A E-GNSS help desk, which allows the interaction between human staff of the E-GNSS Service Provider and human operators of USSP, CIS and UAS operators

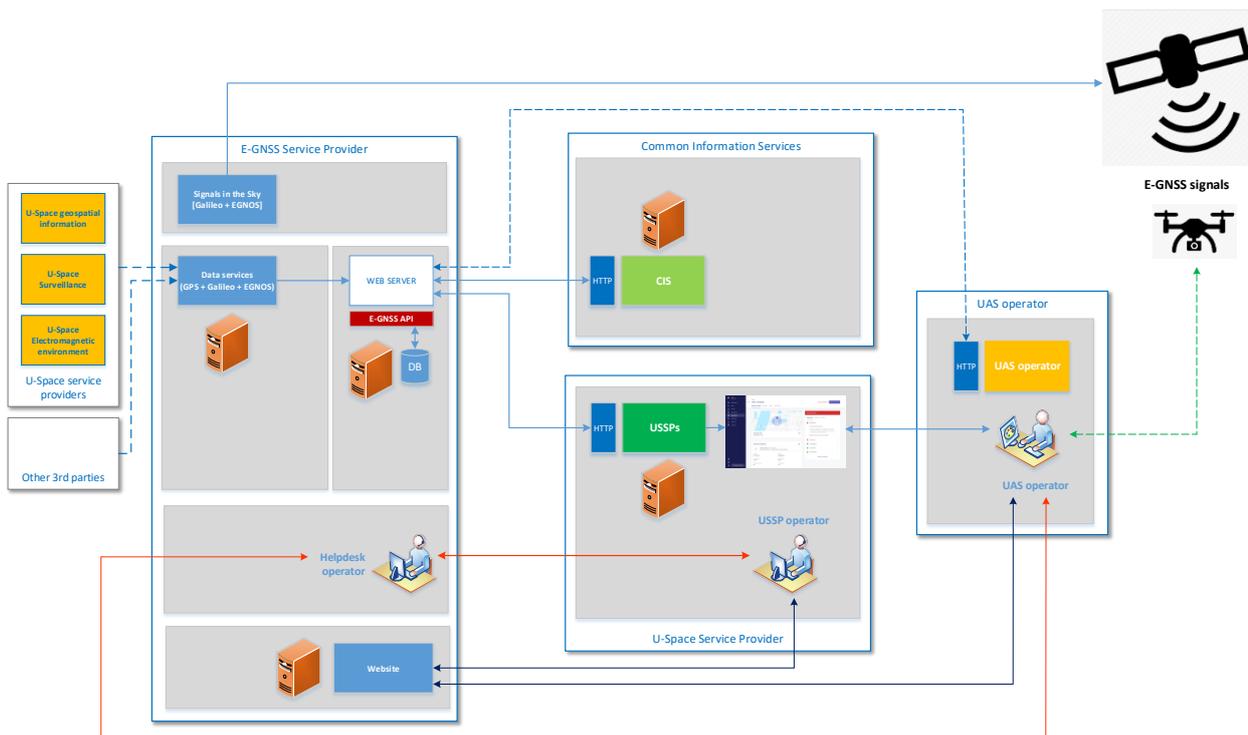


Figure 3-1 E-GNSS service high-level architecture

One key feature of this E-GNSS service high level architecture is that it shows the direct interface between the E-GNSS API and the UAS operator when operations are performed outside U-Space airspace, as well as the direct interfaces between the E-GNSS API and the USSPs and CISs when operations are performed inside U-Space airspace.

The main proposed E-GNSS sub-service is the data service, which consists of several functions that collect external data (e.g. terrain and obstacles models, GNSS almanacs and outages, measured positioning performances, location of detected RFIs) to feed the E-GNSS API, which stores temporarily the data to make it accessible to the stakeholders that request it.

Next figure shows the end users of the data service, the API components (webserver and database), the functions that compute the data to feed the API, and the external data sources

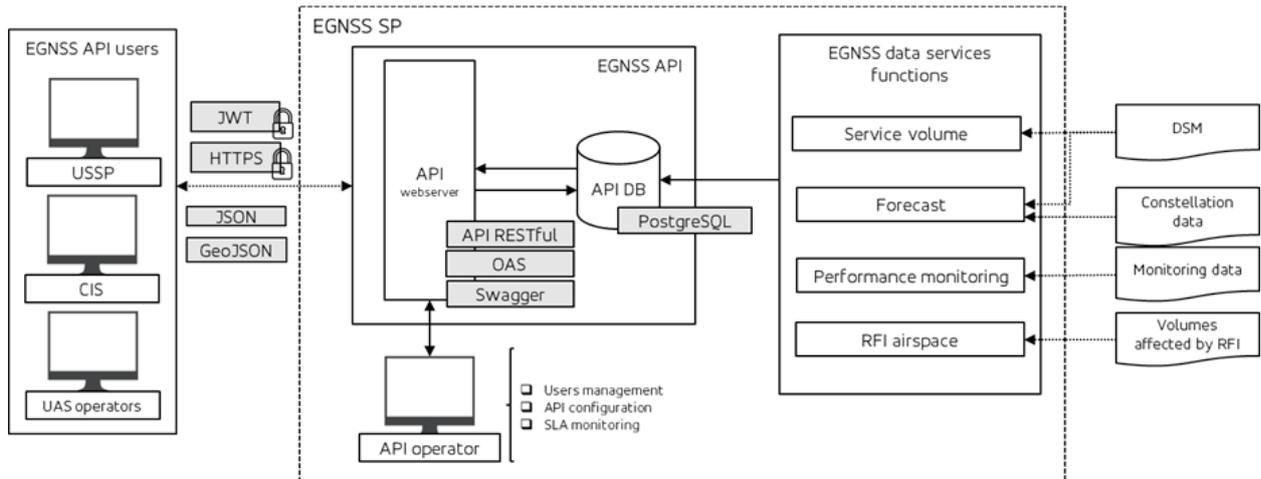


Figure 3-2 E-GNSS data service and API high-level architecture

To support the concept of using *approved* GNSS receivers, one task of the project was to justify the standardisation and approval of an E-GNSS receiver equipment for UAS operations and to propose the approach for the definition of a user receiver equipment for UAS in medium risk operations.

According to the applicable regulatory framework, it is the understanding of the EUGENE consortium that the existence of a standard or common rules to properly install and test the E-GNSS receiver equipment on-board the UAS has been found as the easiest way to ease the compliance with the applicable requirements.

Additionally, according to the applicable regulatory framework, Means of Compliance (MoC) for Special Conditions (SC) Light-UAS seem to be the best alternative for the approval process for medium risk operations in order to ease the compliance with SC L-UAS and design verification process by EASA.

Considering the different available options for the definition of this standard (EUROCAE/RTCA, IEC, ISO, ASTM, SAE, EU Standards and CWA), it is concluded that for medium risk operations, standardization of the E-GNSS receiver equipment with an ASTM standard seems to be the most adequate option.

Taking into account all this information and considering that SAIL III and IV operations will have different requirements, two different standardization and approval options are proposed for medium risk operations:

- For SAIL III operations, the development of a MoC based on a design review of the E-GNSS receiver equipment (and not based on a standard) is the most appropriate approach to meet applicable requirements (this proposal is currently under discussion within EUROCAE WG-105 SG-4).
- For SAIL IV operations, a standardization process seems to be the most suitable option. In this sense, an ASTM standard seems to be the most adequate option. It is then proposed that this standard will be used by EASA to define the MoC for SC L-UAS, as done with other requirements and ASTM standards (e.g. ASTM standard F3478-206 and F3322-18).

This table summarizes the recommended standardization and approval processes for the UAS and for the E-GNSS receiver equipment in the specific category and in particular for medium risk operations, according to the applicable regulatory framework:

Table 3-1: Standardization and approval options for E-GNSS receivers

	Specific category			
	SAIL I & II	SAIL III	SAIL IV	SAIL V & VI
Standardization option	N/A	MoC not based on a standard but a design review of the E-GNSS receiver equipment. Standardization process is not required.	One standard for the Navigation System ASTM "PNT standard for UAS"	Two standards (one for receiver and one for antenna) EUROCAE

Approval option	Declaration by UAS operator	MoC for SC Light-UAS (Design verification by EASA)	ETSO certification (EASA certification process)
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After the definition of the service requirements, the next step in the project was to define the service provision model more suitable for the new E-GNSS service for UAS to support medium risk operations.

The service provision model for the E-GNSS Service for UAS has been developed with the aim of supporting UAS navigation within and outside U-Space, easing compliance with OSO#13 for UAS operators and also the existing U-Space Services defined in Regulation 2021/664 and other U-Space services provided by the USSPs for which the E-GNSS Service for UAS could bring an added value.

An organization, identified as the "E-GNSS Service Provider for UAS", would be responsible for providing the E-GNSS Service to UAS operators, covering the responsibility of the provision of the E-GNSS Signal in Space (SiS) to the UAS, the interface to receive the E-GNSS performance and monitoring (E-GNSS API), E-GNSS website and helpdesk to ease the communications with the users of the service.

In this sense, it is the recommendation of the EUGENE consortium that the EGNOS Service Provider shall assume the role of E-GNSS Service Provider for UAS, in order to ease the compliance with medium and high-risk operations, providing a harmonized E-GNSS service provision scheme for all UAS operations of the specific category.

The proposed E-GNSS Service for UAS is consistent with the analysis that SAIL III and SAIL IV can take place within and outside U-Space airspace. Consequently, the proposed service provision scheme for the E-GNSS Service for UAS has been proposed to cover both UAS operations within and outside U-Space airspace:

- Within U-Space airspace → It is proposed that all E-GNSS information will be provided by the E-GNSS Service Provider for UAS to the USSP (who shall be a certified organization according to U-Space Regulation 2021/664) through the E-GNSS API.

USSPs would use the E-GNSS information for all U-Space services provided to UAS operators in which it is considered of added value.

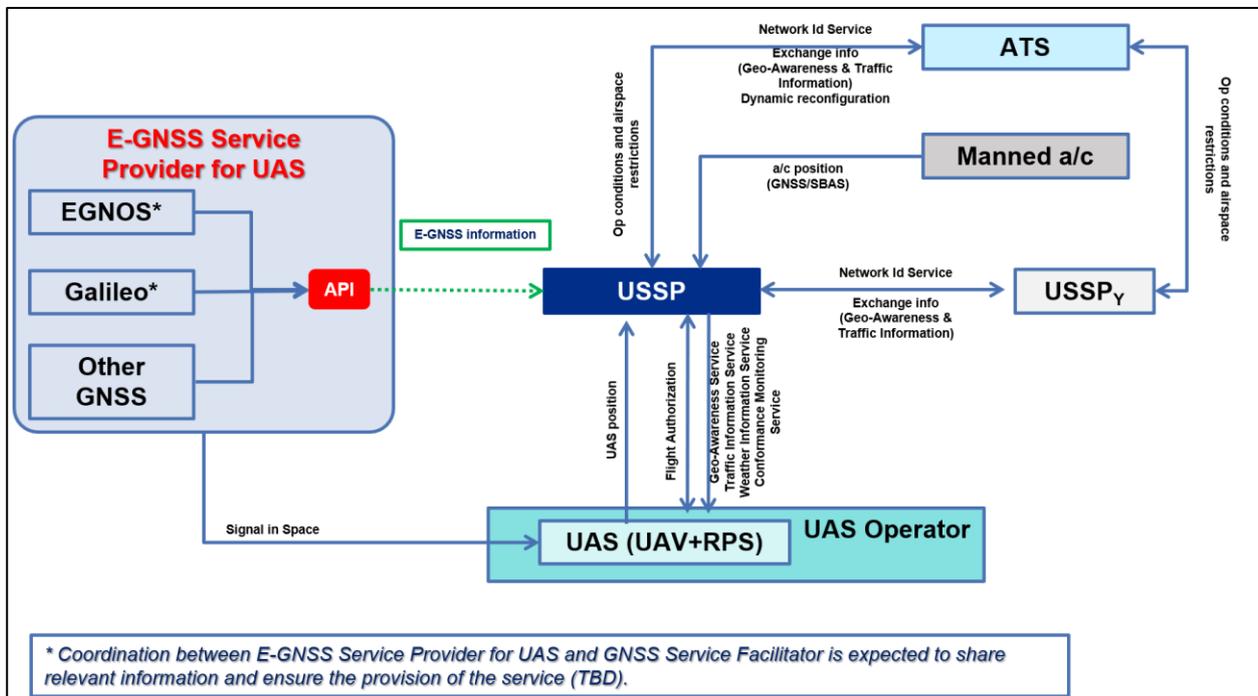


Figure 3-3 E-GNSS service provision model within U-Space airspace

- Outside U-Space airspace → It is proposed that all E-GNSS information will be directly provided by the E-GNSS Service Provider for UAS to the UAS operator (shall be authorized and registered as UAS operators through the competent authority of the Member State of intended operation, according to Regulation 2019/947) through the E-GNSS API.

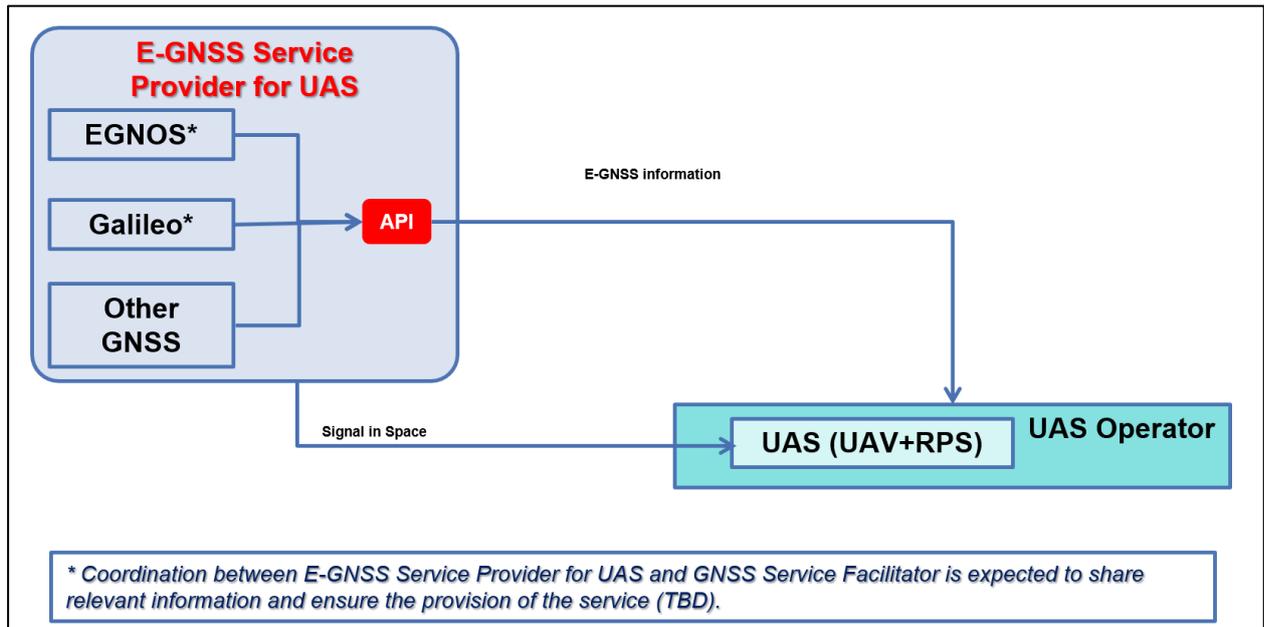


Figure 3-4 E-GNSS service provision model outside U-Space airspace

Considering the expected evolution of the E-GNSS Service for UAS and the great variety of UAS operations, two different service options have been analysed:

- E-GNSS Service for UAS without integrity. This option is tailored to support UAS operations with lower risks and which do not require integrity in the UAS position. E-GNSS Service for UAS is provided without liabilities to the SiS (use of SiS Open Service) but liabilities to the E-GNSS API information.
- E-GNSS Service for UAS with integrity. This option is tailored to support UAS operations with higher risks, which may require integrity in the UAS position. E-GNSS Service for UAS is provided with liabilities to the E-GNSS API and to E-GNSS SiS. EGNOS augmentation (in particular EGNOS SoL Service) ensures that liabilities to the SiS would be involved in the service provision model.

On the other hand, an important part of the E-GNSS Service for UAS is its description, definition, way to access the service and terms and conditions of use, which shall be identified in the Service Definition Document (SDD). It is then proposed to develop a new SDD for the deployment of the E-GNSS Service for UAS. In order to treat the E-GNSS service for unmanned aviation as a single service, there should be a specific SDD describing that service, rather than updating the EGNOS SDDs and Galileo SDDs to address the unmanned aviation as a new type of user.

Based on the proposal of the service provision scheme of the E-GNSS Service for UAS, the following elements of the liability scheme have been identified:

- **Within U-Space airspace:**
 - New SDD for the E-GNSS Service for UAS.
 - Service level agreement between Galileo operator / EGNOS Service Provider with the E-GNSS Service Provider for UAS.
 - Service level agreement between E-GNSS Service Provider and USSP (reference to new SDD to be included within this agreement).
 - Contract between UAS operator and USSP (reference to new SDD and service level agreement between E-GNSS Service Provider for UAS and the USSP to be included within the contract).
 - UAS shall count with an “approved” E-GNSS receiver equipment.
- **Outside U-Space airspace:**
 - New SDD for the E-GNSS Service for UAS (same as SDD identified for operations within U-Space airspace).

- Service level agreement between Galileo operator / EGNOS Service Provider with the E-GNSS Service provider for UAS.
- (Optional and if required only) Service level agreement between E-GNSS Service Provider for UAS and UAS operator. If an SLA is not established, it is then required that UAS operators shall accept a legal notice related to the terms and conditions of the E-GNSS Service for UAS (when accessing to the E-GNSS API).
- UAS shall count with an “approved” E-GNSS receiver equipment.

Finally, in order to ease compliance with OSO#13 by UAS operators, following tables summarize the proposal compliance for SAIL III and for SAIL IV operations.

First part of the tables identifies the proposed evidence for the E-GNSS Service for UAS to comply with the requirements of OSO#13 for SAIL III and SAIL IV operations. The second part of the tables lists the evidence that will be available for the UAS operators:

- SDD E-GNSS Service for UAS.
- Contract between UAS operator and USSP (only for operations within U-Space airspace).

Evidence available for UAS operator to show compliance with SAIL III and SAIL IV operations (medium risk) are the same, based on the proposed E-GNSS Service for UAS, and also compatible with high-risk operations. Consequently, this proposal provides a harmonized E-GNSS service provision scheme for all UAS operations of the specific category.

Table 3-2: OSO#13 compliance for SAIL III operations

COMPLIANCE OF OSO#13 FOR SAIL III					
UAS operation	Supporting evidence that the required level of performance can be achieved:	SLA or any official commitment that prevails between a service provider and the applicant on the relevant aspects of the service (including quality, availability, responsibilities):			Means to monitor externally provided services:
	E-GNSS API forecast (included in SDD)	New SDD: E-GNSS Service for UAS	SLA between E-GNSS SP and USSP	Contract between UAS operator and USSP	“Approved” E-GNSS receiver equipment
Within U-Space airspace	X	X	X	X	MoC not based on a standard for SC L-UAS (TBC)
Outside U-Space airspace	X	X	1		
EVIDENCE AVAILABLE FOR UAS OPERATOR TO SHOW COMPLIANCE WITH SAIL III					
UAS operation	New SDD E-GNSS Service for UAS (including E-GNSS API information, liabilities of the service and required “approved” E-GNSS receiver equipment)		Contract between UAS operator and USSP (Covering the E-GNSS receiver equipment and expected E-GNSS information to be provided, based on the agreement established between E-GNSS SP for UAS and USSP)		
Within U-Space airspace	X		X		
Outside U-Space airspace	X				

¹ Optionally, and if required by the NCA or the UAS operator, an SLA could be established between the E-GNSS Service Provider for UAS and UAS operator to support UAS operations outside U-Space airspace. If an SLA is not established, it is required that UAS operators shall accept a legal notice related to the terms and conditions of the E-GNSS Service for UAS (when accessing to the E-GNSS API), where the identification of the operator shall be also made.

Table 3-3: OSO#13 compliance for SAIL IV operations

COMPLIANCE OF OSO#13 FOR SAIL IV (SIMILAR TO SAIL V & VI)							
UAS operation	Supporting evidence that the required level of performance can be achieved:	SLA or any official commitment that prevails between a service provider and the applicant on the relevant aspects of the service (including quality, availability, responsibilities):			Means to monitor externally provided services:	Performance of the service is achieved through demonstrations:	Competent third party validates the level of integrity:
	E-GNSS API forecast (included in SDD)	New SDD: E-GNSS Service for UAS	Agreement between E-GNSS SP and USSP	Contract between UAS operator and USSP	"Approved" E-GNSS receiver equipment	New SDD: E-GNSS Service for UAS	EGNOS Service Provider as "E-GNSS Service Provider for UAS"
Within U-Space airspace	X	X	X	X	MoC based on a standard for SC L-UAS (TBC)	X	X
Outside U-Space airspace	X	X	²			X	X
EVIDENCE AVAILABLE FOR UAS OPERATOR TO SHOW COMPLIANCE WITH SAIL IV							
UAS operation	New SDD E-GNSS Service for UAS (including E-GNSS API information, liabilities of the service and required "certified" E-GNSS receiver equipment)			Contract between UAS operator and USSP (Covering the E-GNSS receiver equipment and expected E-GNSS information to be provided, based on the agreement established between E-GNSS SP for UAS and USSP)			
Within U-Space airspace	X			X			
Outside U-Space airspace	X						

² Optionally, and if required by the NCA or the UAS operator, an SLA could be established between the E-GNSS Service Provider for UAS and UAS operator to support UAS operations outside U-Space airspace. If an SLA is not established, it is required that UAS operators shall accept a legal notice related to the terms and conditions of the E-GNSS Service for UAS (when accessing to the E-GNSS API), where the identification of the operator shall be also made.

Once the specifications and the provision model of the proposed new E-GNSS service were determined on the one hand, and once the approach for the approval of the GNSS receivers was analysed on the other, a Cost Benefit Analysis (CBA) was undertaken to assess two different decisions:

- a) The development or not of a E-GNSS service for unmanned aviation (to support medium risk operations), and the scope of that E-GNSS service

To analyse the scope of the E-GNSS service eight different scenarios were analysed, each scenario being the combination of one of the values of the following three service features:

- E-GNSS SiS nature: Open Service (OS) vs OS + Safety of Life (SoL)
- E-GNSS service airspace: U-Space airspace vs U-space + outside U-Space airspace
- E-GNSS API deployment: centralized vs decentralized

- b) The selection of the approval method of E-GNSS receivers for UAS

Three options are analysed: Means of Compliance (MoC), Conformity Assessment, and ETSO

The CBA covered the 2023-2035 period, and its main conclusions have been:

- a) Concerning the development and scope of a E-GNSS service for unmanned aviation

The Net Present Value (NPV) is extremely positive, above 8.000 M€, even in the worst-case scenario, which supports the decision of implementing the E-GNSS service, and to address both OS and SoL SiS and to serve UAS operations both inside and outside U-Space airspaces. Concerning the API deployment, the centralized option (at the E-GNSS service provider) provides the highest NPV

The total cost of implementing the E-GNSS service for all stakeholders is below 50 M€ in all the scenarios, and the cost for the EC program is below 20 M€

- b) Concerning the selection of the approval method of E-GNSS receivers for UAS

The NPV considering all stakeholders is negative, and ranges from 1 M€ (MoC) to 266 M€ (ETSO). However, the NPV is positive for all stakeholders except for the *Members States and Society* because the benefit of increasing the safety of operations (e.g. fewer accidents) due to the utilization of *approved* GNSS receivers on-board UAS has not been assessed quantitatively.

Overall, the CBA for this second decision is seen positive regardless of which approval method is selected for the E-GNSS receiver for UAS.

The final task of the project has been the definition of an implementation plan for the new E-GNSS Service for unmanned aviation (ESU).

The main characteristic of this implementation plan is that it proposes two major deployments of the service. The main drivers for this implementation plan are the high-level roadmap of the European Commission for supporting medium risk operations, the future evolutions of the E-GNSS systems and the standardization process for E-GNSS equipment considering SBAS dual frequency and multi-constellation. Both deployments would cover operations within and outside U-Space airspace and two different liabilities schemes to provide positioning with or without integrity.

The two proposed versions of the E-GNSS Service for UAS are:

- ESU v1 to be deployed by 2025

This first version of the service would support UAS operations not requiring positioning integrity requirements, and so it would only address the use of Galileo and EGNOS open services, together with Galileo HAS and Galileo authentication services once they became operational.

This first version of the service would not provide liabilities to the E-GNSS SiS, but it would provide liabilities to the information provided by the E-GNSS API.

Considering the service liability scheme included within this version of the E-GNSS Service for UAS and keeping in mind that it does not provide positioning with integrity, the EUGENE consortium proposes that ESU v1 is aimed to support SAIL III operations

- ESU v2 to be deployed by 2028

This version would introduce the provision of a positioning service with integrity. Therefore, this version would mean a major improvement enabling higher risk operations. Furthermore,

considering the E-GNSS services planned by 2028, this version aims to support dual frequency and multi-constellation navigation modes based on Galileo and EGNOS V2 and V3 SoL services.

Support to navigation modes that involve ARAIM to provide positioning integrity might be considered in this second version of the service. However, since the purpose of ARAIM is to include multiple constellations and the means to provide the ISM are not clear yet, these modes have not been included in the liabilities analysis performed in the EUGENE project.

This second version of the service would provide liabilities both to the E-GNSS SiS and to the information provided by the E-GNSS API.

Due to the improvements of ESU v2 with respect to the previous version, and the inclusion of a E-GNSS service providing positioning integrity, the EUGENE consortium proposes that ESU v2 is aimed to enable SAIL IV operations.

The development of the core of the E-GNSS data services, i.e., the calculation software tools and the E-GNSS API, as well as the E-GNSS website and helpdesk would be developed within the first version of the service. On the other hand, the second version of the service would implement upgrades of the tools and service documentation to include the dual frequency and multi-constellation navigation modes.

The proposed implementation plan consists of different types of activities:

- Service development activities: they consist of engineering and technical tasks, as for example the development of the required software tools and their validation, or the elaboration of previous engineering studies to sort out some open points.
- Service provision activities: they aim to elaborate the service procedures and drawing up the required agreements between the E-GNSS Service Provider and other entities (e.g., USSPs or other E-GNSS facilitators). In addition, this classification covers the monitoring of the regulation and receiver approval since these are key elements to establish the content of the SDD.
- Support activities: they consist of dissemination activities, support to standardization and receiver approval and support to regulation.
- Service documentation activities: these activities must be carried out to generate all the service documentation. This includes both internal and external documentation. Some examples are the service internal procedures and the SDD.
- Service operation activities: these are the activities related to the operation of the service once it is declared available. They include maintenance and operational tasks to ensure the availability and nominal operation of the service.

Next figure depicts the proposed implementation plan

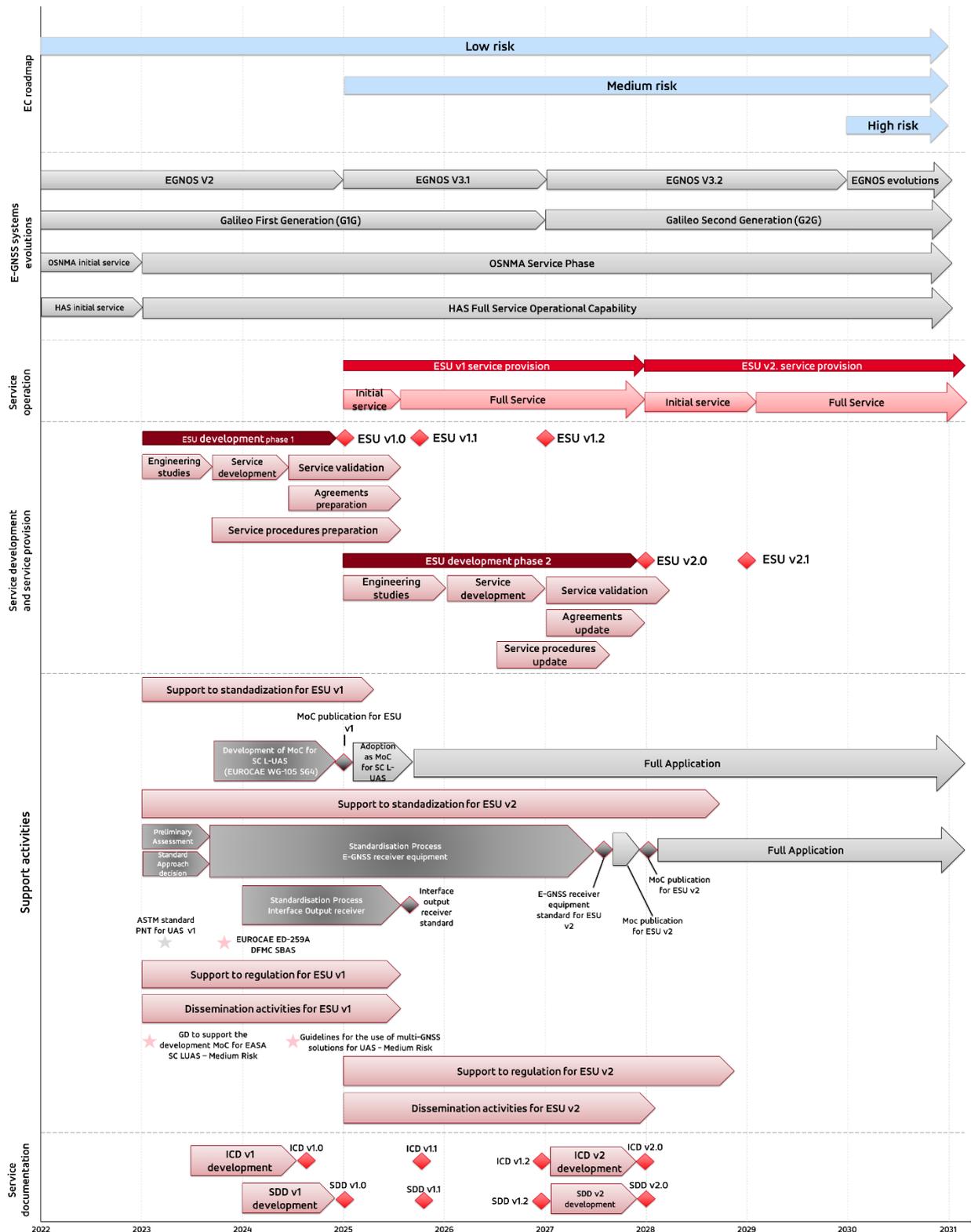


Figure 3-5 E-GNSS service implementation plan

A final task of the project was to collect declarations of interest from private and public U-Space stakeholders supporting the introduction of the new E-GNSS service for UAS. In order to collect feedback from U-Space stakeholders, a dedicated meeting was organized to present EUGENE’s project results and potential benefits to the stakeholders, requiring their opinion/assessment and potential interest.

With the aim of obtaining a reasonable equilibrium between all types of different stakeholders' attendees (both public and private), a widespread invitation was sent to all organizations whose business activities are related to UAS operations: CIS, USSP, UAS Operator, UAS manufactures and Competent Authorities.

After the consultation process, the following organizations expressed their interest in the development of the E-GNSS Service for UAS:

- ENAIRE (CIS & USSP)
- D-Flight (USSP)
- AESA (Spanish Competent Authority)
- UPV (UAS operator)
- Flying Basket (UAS operator)

To conclude, the main conclusions and recommendations of the EUGENE project are:

- A E-GNSS service for unmanned aviation is justified to help stakeholders to meet their needs, particularly in complying with the current and expected (future) Regulation
- The proposed E-GNSS service would be able to support operations within U-Space airspace and outside U Space airspace
- The EGNOS Service Provider would be the best suited to be the service provider of this new E-GNSS service for unmanned aviation
- The proposed approach for the *approval* of a E-GNSS receiver for UAS is commensurate with the operational risk, user needs and nature of the E GNSS service
- The CBA for this concept (E-GNSS service, E-GNSS receiver) is highly positive

A staggered implementation of this new E-GNSS service (to keep it aligned with the UAS market evolution) is strongly encouraged

4. PROJECT ACTIVITIES

4.1. OBJECTIVES

The objective of the project is to support the development of an E-GNSS Service for the Unmanned Aviation. In particular, to enable medium risk operations, which are traced to drone operations in the 'specific' category with a SAIL (Specific Assurance and Integrity Level) III or IV.

To fulfil this objective the project has been divided in the following work packages:

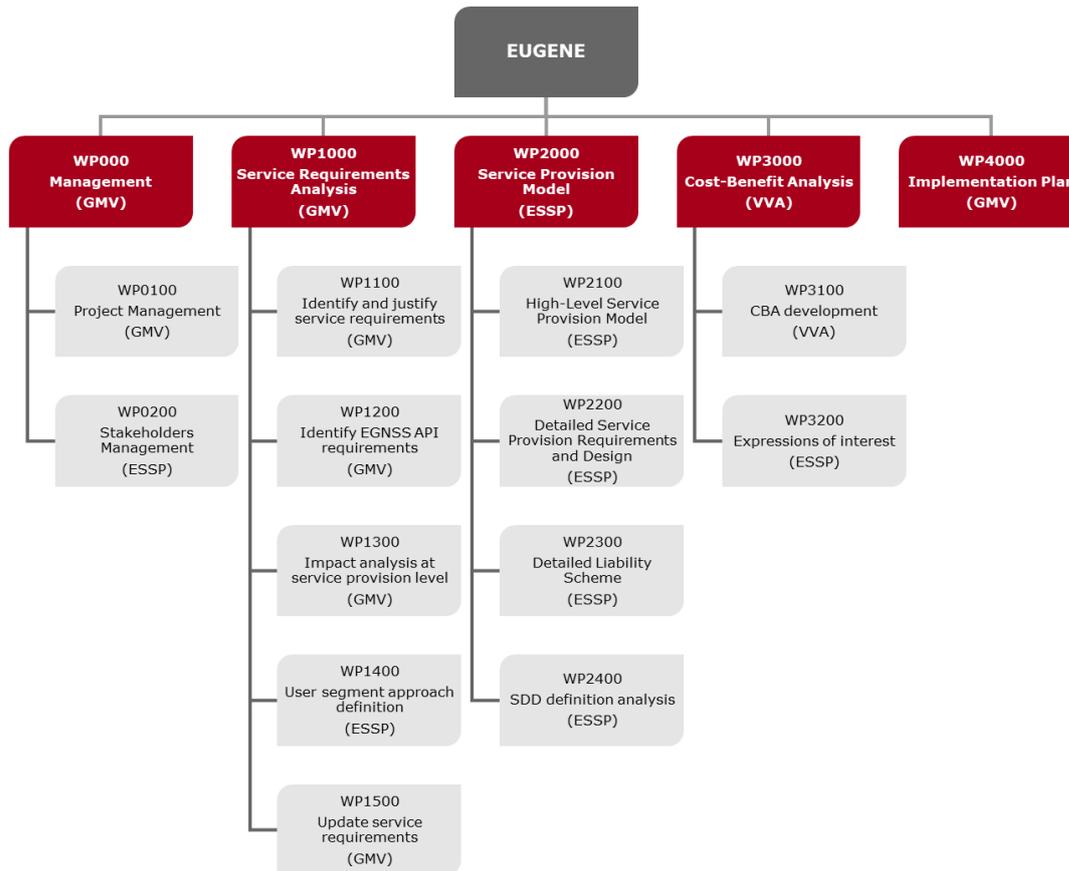


Figure 4-1 Work package structure

4.2. WP0000 MANAGEMENT

This work package encompasses all the activities related to management. It has been divided in two work packages: project management and stakeholders management. The first has been led by GMV, whereas the second has been led by ESSP.

4.2.1. WP0100 PROJECT MANAGEMENT

The project management has included the configuration and documentation management, the consortium management, and the technical coordination of the project. These activities have involved the tracking of the project's schedule, the actions and the risks. The organization of project's meetings and the preparation of the minutes have felt under this work package.

The project management plan and the monthly progress reports have also been generated within WP0100. Besides, GMV, as responsible of the project management and Prime contractor of EUGENE has been in charge of the interfaces with the European Commission.

4.2.1.1. SCHEDULE

Error! Reference source not found. shows the relationship of the activities carried out and their schedule from T0 (25/01/2022) up to organization of the FRM on T0+9 (25/10/2022). The original high-level schedule has been maintained for the project execution. However, some modifications of the milestones and data packages dates have been modified.

Some of the agreements between the EC and EUGENE consortium, concerning some of the initial dates' modifications were:

- D1.1 agreed to be delivered on 22/04/22
- D1.2 agreed to be delivered on 06/05/22
- D1.3 and D1.4 agreed to be delivered on 29/04/22
- PM2 agreed to be postponed to 19/05/22 (initially expected on 25/04/22)
- PM3 DP agreed to be delivered on 24/06/22
- PM3 agreed to take place on 11/07/22
- PM4 agreed to take place on 08/09/22

In addition, in order to ease the implementation of the RIDs raised during the progress meetings, some documentation updates were agreed to be delivered at T0+9:

- As result of PM2, EUGENE consortium and EC agreed a new version of D1.4 to be delivered at the end of the project
- As result of PM4, EUGENE consortium and EC agreed a new version of D3.1, D3.2 and D3.3 to be delivered within the Final Review Meeting data package

Other documentation updates were agreed for implementing the raised RIDs and as close-out for some of the milestones.

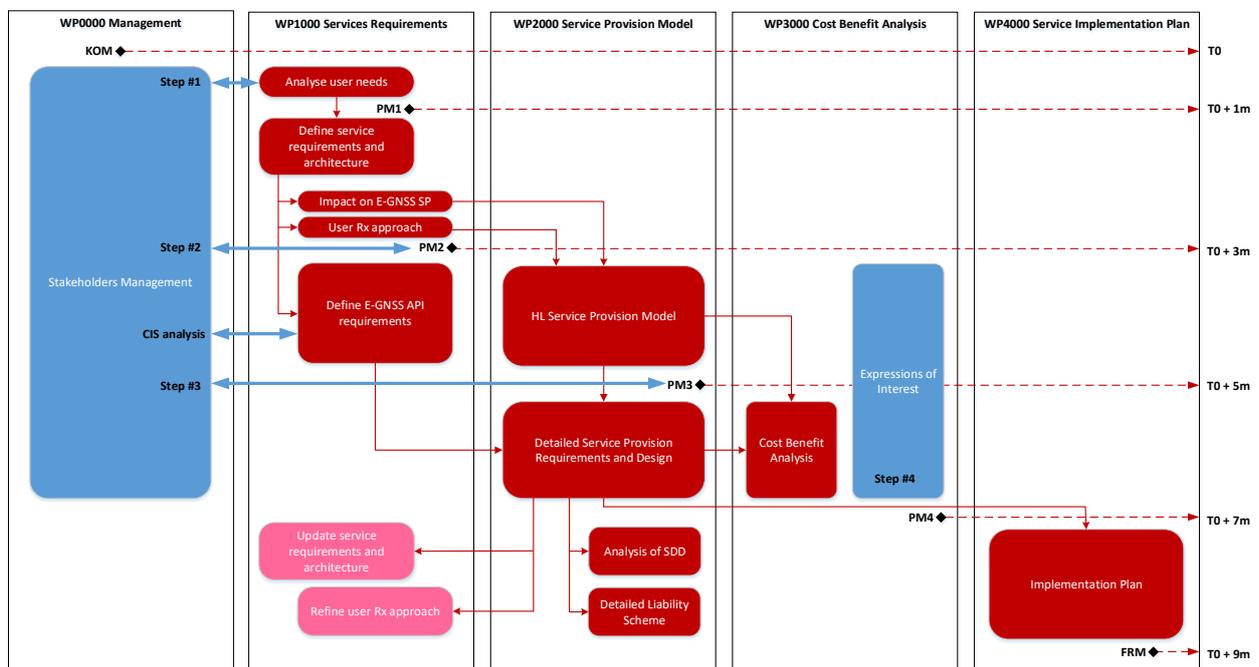


Figure 4-2 Project methodology and schedule

4.2.1.2. MEETINGS

The main milestones of the project and their planned and final dates are summarized in the following table:

Table 4-1 Project meetings

Milestone	Full Name	Objective(s)	Planned date	Final date
SOA	Start of Activities	Start of the performance of the contract (the day of the signature of the contract by the last party)	T0 (25/01/22)	25/01/22
KOM	Kick-Off Meeting (teleconference)	Review of draft version of Project Management Plan (D0.1)	T0+15 days at the latest (08/02/22)	08/02/22
PM#1	Progress Meeting 1 (teleconference)	Formal acceptance of deliverables D0.1	T0+1 month (25/02/22)	25/02/22
PM#2	Progress Meeting 2 (teleconference)	Formal acceptance of deliverables. D1.1 (draft), D1.2 (draft), D1.4, D1.5	T0+3 months (25/04/22)	19/05/22
PM#3	Progress Meeting 3 (teleconference)	Formal acceptance of deliverables. D1.3, D2.1	T0+5 months (24/06/22)	13/07/22
PM#4	Progress Meeting 4 (teleconference)	Formal acceptance of deliverables. D2.2, D2.3, D3.1, D3.2, D3.3	T0+7 months (25/08/22)	08/09/22
FRM	Final Review Meeting (EC, Brussels)	Conduction of SCR. D0.4 D1.1, D1.2, D2.4, D2.5, D4.1 Project conclusions and lessons learnt	T0+9 months (25/10/22)	24/10/22 & 25/10/22

4.2.1.3. PROJECT DELIVERABLES

The following table shows all the deliverables of the project:

Table 4-2 Project deliverables

ID	Code	Title	Issue	Initial date	Final date
D1.1	EUGENE-GMV-TN-01	Service Requirements	1.0	01-04-2022	02-05-2022
D1.1	EUGENE-GMV-TN-01	Service Requirements	1.1	-	22-06-2022
D1.1	EUGENE-GMV-TN-01	Service Requirements	2.0	11-10-2022	11-10-2022
D1.2	EUGENE-GMV-TN-02	Service Requirements Justification File	1.0	01-04-2022	06-05-2022
D1.2	EUGENE-GMV-TN-02	Service Requirements Justification File	2.0	11-10-2022	11-10-2022
D1.2	EUGENE-GMV-TN-02	Service Requirements Justification File	1.1	-	22-06-2022
D1.3	EUGENE-GMV-TN-05	EGNSS API Requirements Document	1.0	10-06-2022	22-06-2022
D1.3	EUGENE-GMV-TN-05	EGNSS API Requirements Document	1.1	-	27-07-2022
D1.3	EUGENE-GMV-TN-05	EGNSS API Requirements Document	1.2	-	08-09-2022
D1.4	EUGENE-GMV-TN-03	Impact Assessment	1.0	08-04-2022	11-05-2022
D1.4	EUGENE-GMV-TN-03	Impact Assessment	1.1	-	07-07-2022
D1.4	EUGENE-GMV-TN-03	Impact Assessment	2.0	-	11-10-2022
D1.5	EUGENE-GMV-TN-04	User Segment Approach	1.0	08-04-2022	29-04-2022
D1.5	EUGENE-GMV-TN-04	User Segment Approach	1.1	-	07-07-2022
D1.5	EUGENE-GMV-TN-04	User Segment Approach	2.0	11-10-2022	11-10-2022
D2.1	EUGENE-GMV-TN-06	High-Level Service Provision	1.0	10-06-2022	22-06-2022
D2.1	EUGENE-GMV-TN-06	High-Level Service Provision	1.1	-	27-07-2022
D2.1	EUGENE-GMV-TN-04	High-Level Service Provision	1.2	-	09-09-2022
D2.1	EUGENE-GMV-TN-04	High-Level Service Provision	1.3	-	11-10-2022
D2.2	EUGENE-GMV-TN-07	Detailed Service Provision Requirements and Design	1.0	11-08-2022	26-08-2022
D2.2	EUGENE-GMV-TN-07	Detailed Service Provision Requirements and Design	1.1	-	23-09-2022
D2.2	EUGENE-GMV-TN-07	Detailed Service Provision Requirements and Design	1.2	-	11-10-2022

ID	Code	Title	Issue	Initial date	Final date
D2.3	EUGENE-GMV-TN-08	Detailed Service Provision Requirements Justification File	1.0	11-08-2022	26-08-2022
D2.3	EUGENE-GMV-TN-08	Detailed Service Provision Requirements Justification File	1.1	-	23-09-2022
D2.3	EUGENE-GMV-TN-08	Detailed Service Provision Requirements Justification File	1.2	-	11-10-2022
D2.4	EUGENE-GMV-TN-12	Detailed Liability Scheme	1.0	11-10-2022	11-10-2022
D2.5	EUGENE-GMV-TN-13	Analysis of a Service Definition Document for the new service	1.0	11-10-2022	11-10-2022
D3.1	EUGENE-GMV-TN-09	Cost/Benefit Analysis	1.0	11-08-2022	26-08-2022
D3.1	EUGENE-GMV-TN-09	Cost/Benefit Analysis	2.0	-	11-10-2022
D3.2	EUGENE-GMV-TN-10	Expression of interest: Manufacturers, Operators and U-Space Service Providers	1.1	11-08-2022	01-09-2022
D3.2	EUGENE-GMV-TN-10	Expression of interest: Manufacturers, Operators and U-Space Service Providers	1.1	-	11-10-2022
D3.3	EUGENE-GMV-TN-11	Expression of interest: Civil Aviation Authorities	1.0	11-08-2022	01-09-2022
D3.3	EUGENE-GMV-TN-11	Expression of interest: Civil Aviation Authorities	1.1	-	11-10-2022
D4.1	EUGENE-GMV-TN-14	Service Implementation Plan	1.1	11-10-2022	11-10-2022

4.2.2. WP0200 STAKEHOLDERS MANAGEMENT

The stakeholder management has been led by ESSP. This has been a key task for some of the activities of the project where consultation with the EUGENE stakeholders was required. These activities were mainly carried out under WP3100 Cost/Benefit Analysis and WP3200 Expressions of Interest.

To ensure the engagement of the stakeholders, this activity has followed a stakeholder management plan included in the project's proposal [AD.4]. To disseminate the project outcomes and achieve the engagement of the stakeholders, two project presentations were planned at the beginning. However, due to a delay in some of the first deliverables of the project, and in order to consolidate the information to be disseminated, a unique session was organized.

On the other hand, the cost benefit analysis also required to contact receiver manufactures to provide or confirm those figures concerning receiver standardization cost.

4.3. WP1000 SERVICE REQUIREMENTS

The identification of requirements for the E-GNSS service for unmanned aviation supporting medium risk operations has been divided in several tasks that are described in the following subsections.

4.3.1. WP1100 IDENTIFY AND JUSTIFY SERVICE REQUIREMENTS

The objective of WP1100 was to capture the requirements for the development of a EGNSS service for UAS supporting medium risk operations. For this purpose, the first step performed was reviewing the relevant regulation and documentation about UAS, their operations and U-Space. In addition to the project's CFIs, some of the relevant documents reviewed were:

- Guidelines for the use of multi-GNSS solutions for UAS specific category – low risk operations SAIL I & II. EUROCAE
- ED Decision 2020/022/R AMC & GM to Commission Implementing Regulation (EU) 2019-947 – Issue 1, Amendment 1
- ED Decision 2020/022/R AMC & GM to Commission Implementing Regulation (EU) 2019-947
- Special Condition for Light Unmanned Aircraft Systems - Medium Risk. EASA
- Commission Delegated Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for the U-space

- NPA 2021-14 Development of acceptable means of compliance and guidance material to support the U-space regulation`
- CORUS ConOps update guidelines developed in the CORUS-X-UAM project

Subsequently, the potential users of the service and their needs were identified. These were classified in:

- E-GNSS enabled receiver needs
- UAS operators needs
- U-Space Service Providers needs
- Common Information Services needs

Then, the service requirements were registered in D1.1 and justified in D1.2. The service requirements have been classified in:

- Signal in space
- E-GNSS data services
- Website
- Helpdesk

Moreover, the high-level architecture and functional architecture of the service were provided within this task.

While performing the analysis of the user needs and the service requirements some of the following outcomes were reached:

- A centralized deployment of the E-GNSS API is recommended, where E-GNSS API is at the E-GNSS SP for UAS.
- From the analysis of the regulation and the SORA requirements, it has been highlighted that while the air risk assessment considers the risk of air-to-air collision between UAS and manned aircraft, it does not consider air collisions between drones. On the other hand, one of the key drivers for the declaration of U-Space airspace is the UAS traffic density.

As specified at the beginning of the project, the service requirements were updated at T0+9 taking into account the outcomes of other activities that were performed after the first release of the service requirements.

The service requirements list can be found in ANNEX A.

4.3.2. WP1200 IDENTIFY EGNSS API REQUIREMENTS

Another key activity within the service requirements capture was to identify the EGNSS API requirements. The objective of this deliverable is to ease the operational implementation of an API to disseminate the E-GNSS data provided by the service to the users in real time. The EGNSS API requirements have been gathered as an enhancement of the API prototype developed in the context of the SUGUS project.

As first step to develop the E-GNSS API requirements, the EUGENE consortium developed the API use cases to have an overall overview of the API operational concept. Then, the requirements were identified in the following categories: functional, operational, configuration, interface, performance, security and design requirements. Finally, some design elements to develop the API were also given within this activity, being the API RESTful the core technology to support the system design. Another key outcome delivered within WP1200 is the geographical data structure of the API, that would allow to optimize the calculations performed by the E-GNSS service software tool suite (in particular the performance forecast software tool).

The E-GNSS API requirements gathered during the WP1200 activities are included in ANNEX B.

4.3.3. WP1300 IMPACT ANALYSIS AT SERVICE PROVISION LEVEL

In parallel to the service requirements capture and justification, the EUGENE consortium carried out an impact analysis of at service provision level. To achieve this, the authors of the deliverable D1.4 analysed the service provision of current EGNSS services and identified the major changes that would be required to implement the service requirements.

Within WP1300, the EUGENE consortium provided the E-GNSS Service tree, that identified the following subservices layers required to provide the service:

- E-GNSS SIS
- E-GNSS data services
 - E-GNSS API
 - E-GNSS service volume provision
 - E-GNSS monitoring & forecast
 - E-GNSS RFI reporting
- E-GNSS website
- E-GNSS helpdesk

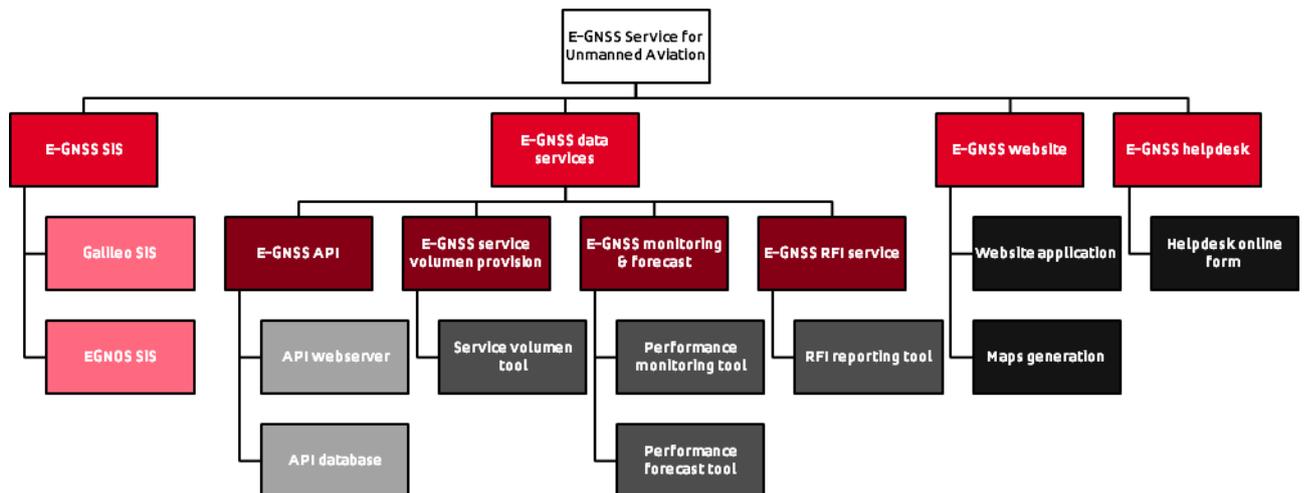


Figure 4-3 E-GNSS subservices layers and main SW tools

The service tree is included in the ANNEX C.

4.3.4. WP1400 USER SEGMENT APPROACH DEFINITION

The objective of the user segment is to justify the standardisation and approval of an EGNSS receiver equipment for UAS operations. WP1400 proposes the approach for the definition of a user receiver equipment for UAS in medium risk operations, which is consistent with the regulatory and standardisation framework.

Additionally, in order to have a receiver equipment aligned with the evolution of the service requirements that will be developed, this task was performed in two phases:

- A preliminary version is provided based on the inputs of the first part of the project.
- A final version will be developed at the end of the project.

The recommendations within this work package include the development of one standard for the navigation system developed by ASTM as "PNT standard for UAS" and the development of Means of Compliance for SC Light-UAS.

4.3.5. WP1500 UPDATE SERVICE REQUIREMENTS

To consider the outcomes of the project's main activities, the service requirements have been updated in WP1500. This task has been carried out at the end of the project to provide an update of the deliverable D1.1.

4.4. WP2000 SERVICE PROVISION MODEL

The definition of the service provision model or scheme have been performed through an approach in steps, going from a high-level definition of the full scheme (including liabilities) to a more detailed one which further developed the concepts already presented at a higher level.

4.4.1. WP2100 HIGH-LEVEL SERVICE PROVISION MODEL

The goal of WP2100 was to develop a high-level service provision model of the E-GNSS service for unmanned aviation able to support medium risk operations. The service provision model includes the assessment of the regulatory framework to identify the involved actors in the service provision and their roles, responsibilities and interfaces. One of the major outcomes of this analysis is to propose the service provision through a unique service provider identified as E-GNSS Service Provider for UAS. Moreover, several options for the provision model have been analysed in this sense:

- The service provision scheme considering U-Space:
 - Service provision within U-Space
 - Service provision outside U-Space
- The service provision modes regarding liabilities:
 - E-GNSS Service without providing integrity and without liabilities in the SiS (use of SiS Open Service), but liabilities on the E-GNSS API information
 - E-GNSS Services with integrity and providing liabilities in both the SiS and the information provided through the E-GNSS API

As summary of the conclusions of WP2100:

- The "E-GNSS Service Provider for UAS" shall be responsible for providing the E-GNSS service to UAS operators.
- The E-GNSS service would cover the provision of the E-GNSS SiS and the E-GNSS subservices identified in the WP1300
- The proposed interface to provide E-GNSS information is the E-GNSS API, which will be under the responsibility of the E-GNSS Service Provider for UAS
- According to the analysis of the SORA methodology and the risk assessment for the establishment of U-Space airspace, it cannot be concluded that medium risk operations will take place in U-Space
- It is proposed to develop a new SDD to describe the E-GNSS Service for UAS and include specific references from existing SDDs (EGNOS Sol/OS and Galileo OS) and to the E-GNSS approved receiver
- Considering the options for the service provision in relation to U-Space:
 - If the service is provided within U-Space
 - The provision of the E-GNSS Service for UAS would be based on a Service Level Agreement between the E-GNSS Service Provider for UAS and the USSP.
 - There would be a contract required between UAS operators and USSP
 - If the service is provided outside U-Space, the E-GNSS Service Provider for UAS would provide the API data directly to the UAS operator.

4.4.2. WP2200 DETAILED SERVICE PROVISION REQUIREMENTS AND DESIGN

The objective of WP2200 was to define the low-level requirements and the detailed processes for the provision of the E-GNSS Service for UAS, based on the proposed High-Level Service Provision Model developed in WP2100. The requirements were identified in the following categories:

- Service provision layer
- Liabilities
- Service performance requirements
- Service performance monitoring
 - Key performance indicators and metrics
 - Performance monitoring information to users
 - Service performance tools
 - Contingency procedures
 - Reporting
- Validation of the E-GNSS Service for UAS
- Evolutions of the E-GNSS Service for UAS
- Data Storage
- Service Support to UAS users
- Requirements related to UAS users

In addition to the identification of the service requirements, this work package provided a justification file providing the correspondent explanation for the selection of each requirement.

The service provision requirements are included in ANNEX D.

4.4.3. WP2300 DETAILED LIABILITY SCHEME

The objective of WP2300 was to further develop the liability scheme propose within WP2100. For this purpose, this activity identified and analysed the arrangements and/or contracts required to be established between the different actors of the liability scheme chain.

4.4.4. WP2400 SDD DEFINITION ANALYSIS

Within the service provision model, the SDD is a key element where the commitments of the service should be established. Some of the elements that were analysed are:

- The Service Description.
- The Terms and conditions of use of the Service (including liabilities).
- The Service performance characteristics.
- The Service commitments.

The proposed content for the new SDD for the E-GNSS Service for UAS is shown herein below:

- EXECUTIVE SUMMARY
 - Reference information
- INTRODUCTION
 - Introduction to the E-GNSS Service for UAS
 - Introduction to the U-Space framework
 - Description of the service
 - Terms and conditions of use of the E-GNSS Service for UAS

- Users of the service
- Liabilities
- Intended lifetime
- DESCRIPTION OF THE E-GNSS SYSTEMS AND SERVICE PROVISION FRAMEWORK
 - High Level Description of the E-GNSS supporting systems
 - EGNOS architecture
 - GALILEO architecture
 - E-GNSS Framework
 - Bodies involved in the E-GNSS Programme and Service delivery
 - How to get information on E-GNSS or contact the Service Provider
 - Regulatory framework
 - Service Level Agreement
- E-GNSS API
 - Function and purpose
 - Use Cases
 - Data structure
 - Management of the Service degradations
- E-GNSS SIGNAL IN SPACE
 - EGNOS Signal In Space
 - EGNOS SIS Interface Characteristics
 - EGNOS SIS RF Characteristics
 - EGNOS SIS Message Characteristics
 - EGNOS Time and Geodetic Reference Frames
 - EGNOS Terrestrial Reference Frame – ETRF
 - EGNOS Network Time: ENT – GPS Time Consistency
 - GALILEO Signal In Space
 - DUMMY NAVIGATION MESSAGE
 - Galileo SiS Status Flags
- E-GNSS RECEIVER EQUIPMENT
- E-GNSS PERFORMANCE
 - E-GNSS API performance
 - E-GNSS performance
 - Introduction
 - Service Level without integrity performance
 - Service Level with integrity performance
 - Limitations of the service and excluded errors

4.5. WP3000 COST-BENEFIT ANALYSIS

The WP3000 Cost-Benefit Analysis has been divided in two tasks:

- CBA development

- Expressions of interest

4.5.1. WP3100 CBA DEVELOPMENT

The aim of WP3100 was to perform a Cost-Benefit Analysis (CBA), financial analysis and economic analysis of the High-Level Service Provision Model of a E-GNSS service for unmanned aviation. In addition, the task also aimed to perform a CBA, financial and economic analysis on the introduction of Means of Compliance, Conformity assessment against standards, and ETSO/TSO certification of EGNSS receivers.

One of the main issues arose during WP3100 was the late response from receiver manufactures regarding the costs for receiver approval and standardization.

The performed CBA led to a highly positive NPV and the conclusion is that, under any architecture and uptake scenario, the investment in the E-GNSS service will bring very high net benefits to all the stakeholders directly involved and to the society as a whole.

4.5.2. WP3200 EXPRESSIONS OF INTEREST

The objective of this activity was to gather expressions of interest from stakeholders to support the implementation of the service. For this purpose, the project and some outcomes were presented to the stakeholders on 07/09/2022 via an online presentation. After the presentation, a questionnaire was disseminated to gather the feedback of the stakeholders about the different decisions made during the project.

Due to the final date of the stakeholder's session, the first version of the deliverables contained the templates of the document prior to the stakeholder's consultation. A second version of the documents was agreed with the EC to include the gathered expressions of interest and the feedback provided by the stakeholders through the circulated questionnaire.

Another arisen issue was one negative answer about the EUGENE outcomes (in contrast with 8 positive answers) from one of the stakeholders collected through an interactive poll launched during the session. The answers to this poll were anonymous, thus the identification of the negative answer was not possible.

The stakeholders that attended the session are listed in the following table:

Table 4-3 Stakeholders list

USSP / CIS	UAS Operator & Manufacturer	NCA
<ul style="list-style-type: none"> ■ Hungarocontrol (CIS) ■ Skyguide (USSP & CIS) ■ ENAIRE (USSP & CIS) ■ D-Flight ■ IAA 	<ul style="list-style-type: none"> ■ Flying Basket ■ UPV 	<ul style="list-style-type: none"> ■ IAA ■ AESA ■ DGAC- Spain ■ Eurocontrol ■ CAA Norway

4.6. WP4000 IMPLEMENTATION PLAN

The objective of the WP4000 was to provide an implementation plan for the EGNSS Service for UAS.

The main inputs for this high-level roadmap were the high-level roadmap of the European Commission for supporting medium risk operations, the future evolutions of the E-GNSS systems and the standardization process for E-GNSS equipment considering SBAS dual frequency and multi-constellation. The implementation plan of the E-GNSS Service for UAS (ESU) proposes two major deployments of the service: ESU v1 to be deployed in 2025 and ESU v2 to be deployed in 2028. Both deployments would cover operations within and outside U-Space.

The first version ESU v1 would provide navigation services neither with integrity nor liabilities on the SiS, whereas the second version ESU v2 would aim to provide navigation integrity and liabilities on the SiS (both options for the provision of the service and the liabilities scheme have been described in D2.1 and D2.4).

Finally, it has been proposed that ESU v1 would be focused on supporting SAIL III operations, whereas ESU v2 would aim to SAIL IV operations (and to improve the services for SAIL III operations already available during the provision of ESU v1).

ANNEX A. SERVICE REQUIREMENTS

A.1. SIGNAL IN SPACE

ID	E-GNSS service requirement
SR-050	An <i>approved</i> E-GNSS receiver shall be used to process the E-GNSS signals
SR-100	The minimum features required by a E-GNSS enabled receiver, its nominal (open sky) conditions of use for unmanned aviation, and the minimum positioning performances that it could achieve when using the E-GNSS signals in those nominal (open sky) conditions shall be defined and be accessible to the U-Space stakeholders.
SR-110	The minimum features required by a E-GNSS enabled receiver, its non-nominal (<i>degraded</i> local environment) conditions of use for unmanned aviation, and the minimum positioning performances that it could achieve when using the E-GNSS signals in the non-nominal conditions (<i>degraded</i> local environment) shall be defined and be accessible to the U-Space stakeholders
SR-120	The compliance with the minimum positioning performances achievable by a E-GNSS enabled receiver shall be monitored continuously within the E-GNSS service volume

A.2. DATA SERVICES

ID	E-GNSS service requirement
SR-200	The E-GNSS service volume for a E-GNSS enabled receiver shall be provided on request
SR-210	The reference terrain and obstacles model for the E-GNSS service volume shall be collected, as soon as a new model is available
SR-220	Statistical figures on the positioning performances achieved by a E-GNSS enabled receiver within the E-GNSS service volume for unmanned aviation shall be provided on request
SR-230	E-GNSS and GPS raw data from a ground stations network that covers the E-GNSS service volume shall be collected continuously
SR-240	Position reports from drones flying in the E-GNSS service area should be collected continuously
SR-250	A forecast of the performances achievable by a E-GNSS enabled receiver (optionally, in a specific navigation mode) in a defined region of the E-GNSS service volume and over a given time period shall be provided on request, including: <ul style="list-style-type: none"> • Horizontal accuracy (95%) • Vertical accuracy (95%) • Horizontal protection level • Vertical protection level at different locations within than region and at different epochs within that time period. And, for each defined service level: <ul style="list-style-type: none"> • Availability • Continuity risk at different locations within than region
SR-260	External data required to compute the performances forecast shall be collected whenever new external data is available
SR-270	Retrieval of a performances forecast by a user upon a request shall last less than TBD
SR-280	Users shall be alerted if the forecast of the performances achievable by a E-GNSS enabled receiver in a defined region of the E-GNSS service volume and time period is updated
SR-290	Measured positioning performances achieved by a E-GNSS enabled receiver shall be compared periodically with the performances forecast at the same locations and epochs
SR-300	A log of the collected data and of the data provided to users covering the last TBD period shall be archived for a TBD period
SR-310	The minimum set of collected and/or generated intermediate data necessary to re-generate the data provided to users over the last TBD period shall be archived for a TBD time period
SR-320	Detected jamming and spoofing threats detected by external parties shall be collected, upon detection reporting

ID	E-GNSS service requirement
SR-325	Jamming and spoofing threats should be detected within the E-GNSS service volume.
SR-330	The estimated regions of the E-GNSS service volume in which the positioning performances of a E-GNSS enabled receiver is affected (with different impact levels) by a jamming threat shall be provided on request
SR-340	Users shall be alerted if the estimated regions of the E-GNSS service volume affected by a jamming threat have been updated
SR-350	The estimated regions of the E-GNSS service volume in which the positioning performances of a E-GNSS enabled receiver is affected (with different impact levels) by a spoofing threat shall be provided on request
SR-360	Users shall be alerted if the estimated regions of the E-GNSS service volume affected by a spoofing threat have been updated
SR-370	Users shall be alerted of scheduled and unscheduled outages of the data services
SR-380	Availability of the data services shall be confirmed on request
SR-390	Data services shall be monitored to verify that their target service levels are achieved
SR-400	Data services shall use a common time reference and position coordinate reference system for the data exchanged with users
SR-410	Data services should be synchronized with an external time reference with TBD accuracy
SR-420	Data services should follow next design criteria: <ul style="list-style-type: none"> • Service-oriented architecture (SOA) • Published interfaces based on SWIM principles • Standard-based (preferably open standards) • Securely designed • Allowing variants (to ensure interoperability) • Supporting evolutionary development • Deployment agnostic • Scalable (to number of users)

A.3. WEBSITE FOR HUMAN ACCESS

ID	E-GNSS service requirement
SR-600	A SDD with the following information shall be accessible to users for download: <ul style="list-style-type: none"> • Ways to access to the service • Terms and conditions of use • Minimum E-GNSS enabled receiver features • Nominal and degraded conditions of use • Minimum achievable performances • Data service description
SR-610	A document with the following information should be accessible to users for download: <ul style="list-style-type: none"> • Service evolution roadmap
SR-620	The service volume of the E-GNSS service for unmanned aviation shall be presented as an interactive map to users
SR-630	Data services scheduled and unscheduled outages shall be published for consultation by users
SR-640	Periodic reports with the achieved data services KPIs shall be accessible to users for download
SR-650	A procedure for registration and be granted access to the data services should be accessible to users.

A.4. OTHER SUPPORT SERVICES TO HUMANS

ID	E-GNSS service requirement
SR-700	A helpdesk service shall be available to the users of the E-GNSS service for unmanned aviation

ANNEX B. E-GNSS API REQUIREMENTS

B.1. FUNCTIONAL REQUIREMENTS

B.1.1. SERVICE VOLUME AND PERFORMANCE MONITORING

EUGENE-API-FNC-001 EGNSS performance statistics	Version: 1.0
The EGNSS API shall store the EGNSS performance statistics received from the EGNSS SP's tool	

EUGENE-API-FNC-002 Get EGNSS performance statistics	Version: 1.0
The EGNSS API shall provide the EGNSS performance statistics on request	

EUGENE-API-FNC-003 EGNSS service volume	Version: 1.0
The EGNSS API shall store the EGNSS service volumes reported by the EGNSS SP's client tool	

EUGENE-API-FNC-004 Get EGNSS service volume	Version: 1.0
The EGNSS API shall provide the EGNSS service volume on request	

B.1.2. PERFORMANCE FORECAST

EUGENE-API-FNC-005 EGNSS forecast	Version: 1.0
The EGNSS API shall store the EGNSS performance forecasts reported by the EGNSS SP's client tool	

EUGENE-API-FNC-006 EGNSS service outage	Version: 1.0
The EGNSS API shall alert users about scheduled outages of EGNSS data services	

EUGENE-API-FNC-007 Get EGNSS forecast data	Version: 1.0
The EGNSS API should provide the EGNSS forecasted performance parameters on request	

EUGENE-API-FNC-008 Calculate NDZ forecast	Version: 1.0
When EGNSS performance forecasts are received, the EGNSS API shall identify the expected outages of the services provided to the EGNSS enabled receiver	

EUGENE-API-FNC-009 Get EGNSS forecasted NDZ	Version: 1.0
The EGNSS API shall provide NDZ (No Drone Zones) geofences where the EGNSS receiver is not expected to achieve the minimum performances defined by the EGNSS service for UAS	

EUGENE-API-FNC-010 EGNSS outages alerts	Version: 1.0
The EGNSS API shall alert the subscribed users about expected outages of the services provided to the EGNSS enabled receiver	

EUGENE-API-FNC-011 Subscribe to forecast alerts	Version: 1.0
The EGNSS API shall allow authorised users to subscribe to forecast alerts	

EUGENE-API-FNC-012 Unsubscribe from forecast alerts	Version: 1.0
The EGNSS API shall allow authorised users to unsubscribe to forecast alerts	

B.1.3. RFI AIRSPACE REPORTING

EUGENE-API-FNC-013 EGNSS RFI airspace	Version: 1.0
The EGNSS API shall store the RFI affected airspace reported by the EGNSS SP's client tool	

EUGENE-API-FNC-014 Get EGNSS RFI airspace	Version: 1.0
The EGNSS API shall provide NDZ (No Drone Zones) geofences from the RFI affected airspace reported by the EGNSS SP	

EUGENE-API-FNC-015 EGNSS RFI alerts	Version: 1.0
The EGNSS API shall alert the subscribed users about the airspace impacted by RFI	

EUGENE-API-FNC-016 Subscribe to RFI alerts	Version: 1.0
The EGNSS API shall allow authorised users to subscribe to RFI alerts	

EUGENE-API-FNC-017 Unsubscribe from RFI alerts	Version: 1.0
The EGNSS API shall allow authorised users to unsubscribe to RFI alerts	

B.1.4. SERVICE STATUS

EUGENE-API-FNC-018 Report scheduled service outages	Version: 1.1
The EGNSS API shall allow the operators from the EGNSS SP to report scheduled outages of the EGNSS data services	
<i>Comment: For example, if maintenance tasks are scheduled for a specific data service tool (e.g., forecast tool), the EGNSS SP should have means to inform the users through the API.</i>	

EUGENE-API-FNC-019 Services health status	Version: 1.0
<p>The EGNSS API shall provide the current status and scheduled outages of the following EGNSS data services:</p> <ul style="list-style-type: none"> ■ EGNSS performance statistics ■ EGNSS service volume provision ■ EGNSS performance forecast ■ EGNSS RFI airspace reporting 	

B.2. NON-FUNCTIONAL REQUIREMENTS

B.2.1. OPERATIONAL REQUIREMENTS

EUGENE-API-OPE-001 User registration	Version: 1.0
<p>The EGNSS API shall allow the administrator to register new users</p>	

EUGENE-API-OPE-002 User roles	Version: 1.0
<p>The EGNSS API shall enable to assign one of the following roles to each user:</p> <ul style="list-style-type: none"> ■ Administrator ■ Operator ■ Publisher ■ Consumer ■ Observer 	

EUGENE-API-OPE-003 User removal	Version: 1.0
<p>The EGNSS API shall allow the administrator to remove any user</p>	

EUGENE-API-OPE-004 Edit user data	Version: 1.0
<p>The EGNSS API shall allow the administrator to modify any data from the registered users</p>	

EUGENE-API-OPE-005 Edit user role	Version: 1.0
<p>The EGNSS API shall allow the administrator to modify the role of any user</p>	

EUGENE-API-OPE-006 Subscribe to airspace	Version: 1.0
<p>The EGNSS API shall require users to define the airspace volume associated to their subscriptions</p>	

EUGENE-API-OPE-007 Subscription start time	Version: 1.0
<p>The EGNSS API shall require users to define the start time associated to their subscriptions</p>	

EUGENE-API-OPE-008 Subscription end time	Version: 1.0
The EGNSS API should allow users to define the end time associated to their subscriptions	

EUGENE-API-OPE-009 Edit current subscriptions	Version: 1.0
The EGNSS API shall allow authorised users to edit any of their current subscriptions	

EUGENE-API-OPE-010 Forecast subscription configuration	Version: 1.0
The EGNSS API should allow users to select the EGNSS conditions of use, EGNSS navigation modes, EGNSS service level and EGNSS enabled receiver type associated to their subscriptions to forecasted outages alerts	

EUGENE-API-OPE-011 RFI subscription configuration	Version: 1.0
The EGNSS API should allow users to select the EGNSS navigation modes associated to their subscriptions to RFI alerts	

EUGENE-API-FNC-012 Manage access permissions	Version: 1.0
The EGNSS API shall manage permissions to access the stored data	

EUGENE-API-OPE-013 Format warning	Version: 1.0
The EGNSS API shall warn the users if the format of the requested data is not accepted	

EUGENE-API-OPE-014 Size limitation warning	Version: 1.0
The EGNSS API shall warn the users if the size of the requested data is above the maximum allowed size	

EUGENE-API-OPE-015 Endpoints	Version: 1.0
The EGNSS API endpoints shall documented as URLs and available to the users	

EUGENE-API-OPE-016 Objects	Version: 1.0
The EGNSS API objects shall documented and available to the users	

B.2.2. CONFIGURATION REQUIREMENTS

EUGENE-API-CFG-001 Configure performance statistics	Version: 1.0
The EGNSS API shall allow the operators from EGNSS SP to configure the accepted performance statistics parameters	

EUGENE-API-CFG-002 Access to performance statistics	Version: 1.0
The EGNSS API shall allow the administrator to configure the performance statistics parameters provided to the authorised users	

EUGENE-API-CFG-003 Configure forecast parameters	Version: 1.0
The EGNSS API shall allow the administrator of the EGNSS SP to configure the accepted forecast performance parameters	

EUGENE-API-CFG-004 Access to forecast parameters	Version: 1.0
The EGNSS API shall allow the administrator to configure the forecast performance parameters provided to the authorised users	

EUGENE-API-CFG-005 Conditions of use	Version: 1.0
The EGNSS API shall allow the administrator from the EGNSS SP to configure the accepted conditions of use	

EUGENE-API-CFG-006 Service levels	Version: 1.0
The EGNSS API shall allow the administrator from EGNSS SP to configure the accepted service levels	

EUGENE-API-CFG-007 Navigation modes	Version: 1.0
The EGNSS API shall allow the administrator from EGNSS SP to configure the accepted navigation modes	

EUGENE-API-CFG-008 EGNSS enabled receivers (types)	Version: 1.0
The EGNSS API shall allow the administrator from EGNSS SP to configure the accepted types of EGNSS enabled receivers	

B.2.3. INTERFACE REQUIREMENTS

EUGENE-API-INT-001 EGNSS performance statistics parameters	Version: 1.1
When the EGNSS performance statistics are exchanged, the EGNSS API should include the following values:	
<ul style="list-style-type: none"> ■ 95th percentile, maximum and minimum values of: <ul style="list-style-type: none"> - Horizontal error - Vertical error - Velocity error - Horizontal Protection Level (HPL) - Vertical Protection Level (VPL) - Position Dilution of Precision (PDOP) - Horizontal Dilution of Precision (HDOP) - Vertical Dilution of Precision (VDOP) ■ Service availability ■ Service continuity risk ■ EGNSS navigation mode ■ EGNSS condition of use ■ Service level 	

<ul style="list-style-type: none"> ■ EGNSS receiver type ■ Start time ■ End time ■ Geographical point (associated cell) <p><i>Comment:</i></p> <p><i>The performance statistics data should be provided from/to the following actors:</i></p> <ul style="list-style-type: none"> ■ Input data provided from EGNSS performance monitoring tool ■ Output data provided to EGNSS API users (USSP, CIS, UAS operators or authorities)

EUGENE-API-INT-002 EGNSS service volume parameters	Version: 1.1
<p>When the service volumes are exchanged, the EGNSS API shall include the associated conditions of use</p> <p><i>Comment:</i></p> <p><i>The performance statistics data should be provided from/to the following actors:</i></p> <ul style="list-style-type: none"> ■ Input data provided from EGNSS service volume tool ■ Output data (NDZ geofences) provided to EGNSS API users (USSP, CIS, UAS operators or authorities) 	

EUGENE-API-INT-003 EGNSS forecast parameters	Version: 1.1
<p>When the EGNSS performance forecasts are received, the EGNSS API should accept the following associated configuration:</p> <ul style="list-style-type: none"> ■ Horizontal Figure of Merit (HFOM) ■ Vertical Figure of Merit (VFOM) ■ Horizontal protection level (HPL) ■ Vertical protection level (VPL) ■ Position Dilution of Precision (PDOP) ■ Horizontal Dilution of Precision (HDOP) ■ Vertical Dilution of Precision (VDOP) ■ EGNSS navigation mode ■ EGNSS condition of use ■ Service level ■ EGNSS receiver type ■ EGNSS epoch ■ Geographical point (associated cell) <p><i>Comment:</i></p> <p><i>The EGNSS forecast data should be provided from/to the following actors:</i></p> <ul style="list-style-type: none"> ■ Input data provided from EGNSS forecast tool ■ Output data following this format could be provided to EGNSS API users (USSP, CIS, UAS operators or authorities). However, the EGNSS API users might only get the NDZ geofences 	

EUGENE-API-INT-004 Exchange data format	Version: 1.1
The EGNSS API shall sent the data to users in JSON format [RD.15]	

EUGENE-API-INT-005 Geofences format	Version: 1.0
The geofences exchanged with the EGNSS API shall be compatible with the ED-269 standard	

EUGENE-API-INT-006 RFI airspace data	Version: 1.1
When RFI affected airspaces are received, the EGNSS API shall accept the following associated data to each received airspace:	
<ul style="list-style-type: none"> ■ Affected EGNSS navigation mode(s) ■ Start time ■ Active status 	
<i>Comment:</i>	
<i>The airspaces affected by RFI should be provided from/to the following actors:</i>	
<ul style="list-style-type: none"> ■ <i>Input data provided to the API database from the EGNSS RFI reporting tool (airspaces affected by RFI could be previously collected by the EGNSS SP from third parties reporting RFI events)</i> ■ <i>Output data provided to EGNSS API users (USSP, CIS, UAS operators or authorities)</i> 	
<i>Note that the affected airspaces are stored and exchanges as NDZ geofences</i>	

EUGENE-API-INT-007 Ellipsoid reference	Version: 1.0
The EGNSS API shall store the geographical points referenced to WGS84	

EUGENE-API-INT-008 Time format	Version: 1.2
The EGNSS API shall use UTC time reference for all time-stamped or time-dependent data	

EUGENE-API-INT-009 Connection protocol	Version: 1.0
The EGNSS API shall be available through the Internet via HTTPS protocol	

B.2.4. PERFORMANCE REQUIREMENTS

EUGENE-API-PER-001 Maximum dataset size	Version: 1.1
The maximum size per transaction of the data exchanged in a single call to get data from the EGNSS API shall be 45 MB	
<i>Comment: This limitation applies to each single transaction data exchanged through the API webserver (e. g., if the user requests forecast data, the provided dataset must be less than 45 MB, otherwise more transactions would be required).</i>	

EUGENE-API-PER-002 Response latency	Version: 1.1
The 99th percentile of the response time latency to get available data from the EGNSS API shall be below or equal to 30 ms	

Comment: The response latency is the measured time between a data request made to the API and its reception.

EUGENE-API-PER-003 Availability	Version: 1.1
The API webserver shall be available the 99,99% of the time	
<i>Comment: The availability should be measured as the percentage of time per month that the API webserver is accessible by the users.</i>	

B.2.5. SECURITY REQUIREMENTS

EUGENE-API-SEC-001 Authentication	Version: 1.0
The EGNSS API shall request authentication to the users	

EUGENE-API-SEC-002 Tokens generation	Version: 1.0
The EGNSS API shall generate tokens for user authentication	

EUGENE-API-SEC-003 Data encryption	Version: 1.0
The EGNSS API shall sent encrypted data	

B.2.6. DESIGN REQUIREMENTS

EUGENE-API-DES-001 API architecture	Version: 1.0
The EGNSS API shall implement the RESTful architecture	

ANNEX C. SERVICE TREE

C.1. SOFTWARE TOOLS

Calculation & API SW tools	
Interface SW tools	R: Required
Support SW tools	O: Optional

E-GNSS subservices			SW tools	Description
E-GNSS SIS	Galileo SIS			
	EGNOS SIS			
E-GNSS data services	E-GNSS API	R	API webserver	The webserver implements the interface between the E-GNSS API and the users. It should allow data requests and alerts provision.
		R	API database	The API database stores all the data provided by the E-GNSS service volume provision, the E-GNSS monitoring & forecast and the RFI reporting calculation tools.
		O	Data services SLA monitoring	It should monitor the data services SLA and KPIs (e.g., latency and availability of the data provided through the API). This is an optional development, because it can be performed by human operators following a procedure.
	E-GNSS service volume provision	R	Service volume tool	This tool calculates the service volume of the E-GNSS service on a periodic basis. It should perform the following functions: - Service volume calculation (open-sky conditions) - Service volume calculation (degraded conditions) - Geospatial data collection (i.e., DEM) - Note: this function might need inputs from the human operators.
	E-GNSS monitoring & forecast	R	Performance monitoring tool	It calculates E-GNSS navigation performance statistics based on E-GNSS SIS measurements across the service volume (open-sky and degraded conditions). These calculations would allow to obtain the minimum performances achievable before deploying the service. Once the service is in operation, the tool would obtain the figures on a periodic basis.
		R	Ground monitoring data	It covers the functions required to retrieve, in real-time, the data from the E-GNSS ground monitoring network. Software modules should be developed to implement this function through pre-defined protocols for receiving the data.
R		Data collection from GNSS facilitators	This tool should retrieve the external data required by the E-GNSS monitoring & forecast tools (e.g., NANU, NAGU, constellation data, etc.).	

E-GNSS subservices		SW tools	Description
		O	U-Space SUR data It covers the functions required to retrieve, in real-time, the data from the U-Space surveillance systems. Software modules should be developed to implement this function through pre-defined protocols for receiving the data.
		R	Performance forecast tool Estimates positioning performance achievable by a E-GNSS enabled receiver throughout the service volume and over a forecast horizon. The tool considers the models for the local environment (i.e., those defined by the use conditions).
		R	Performance forecast validation This tool should compare the measured positioning performances of a E-GNSS enabled receiver with the forecasted performances. Although this tool should enable high level of automation, human operators might be involved in the validation.
			Committed performance monitoring The tool should compare the committed performances established by the SDD and measured performances obtained through the E-GNSS performance monitoring SW tool. Although this tool should enable high level of automation, human operators might be involved in the validation.
	E-GNSS RFI reporting	R	RFI reporting tool This tool should implement an interface to gather RFI (jamming & spoofing) data from third parties. This tool should estimate the E-GNSS service volumes affected by RFI, and it might implement the following functions: - RFI source location from data provided by third parties, and optionally from the E-GNSS monitoring & forecast subservice (e.g. from the U-Space SUR data) - RFI affected airspace estimation (if this is not provided by third parties, it should be calculated by the tool)

E-GNSS subservices		SW tools	Description
E-GNSS website	R	Website application (front-end)	<p>The website should have the following public information available:</p> <ul style="list-style-type: none"> - SDD - Service evolutions roadmap - Data service availability status (scheduled and unscheduled outages) - Service level agreement compliance reports - Periodic reports with the achieved data services KPIs - Registration procedure for new users of the E-GNSS data services - Interactive maps
	R	Maps generation	<p>Software to support the generation of the interactive maps of the service volume. The maps could display the following data:</p> <ul style="list-style-type: none"> - Service volume - Statistics on the measured positioning performances - Current positioning performances forecast - Current service volume regions affected by RFIs
E-GNSS helpdesk	R	Helpdesk online form	It could be integrated with the website.

C.2. INFRASTRUCTURE AND STAFF

	Staff	
	Facilities	R: Required
	Infrastructure	O: Optional

E-GNSS subservices			Elements	Description
E-GNSS SIS	Galileo SIS			
	EGNOS SIS			
E-GNSS data services	E-GNSS API	R	API facilities	Required facilities to host the API infrastructure (servers, stations, communication infrastructure, etc.) and staff. The infrastructure should be equipped with the required means to ensure security and service availability.
		R	API Servers (HW)	HW dedicated to run the API webserver and database. The API servers should be redundant to ensure the system availability.
		R	API Operator & maintenance stations	Desktop computers for API operators and maintenance staff.
		R	API operators	The operators of the API must follow the required procedures to ensure the availability of the system.
		R	API maintenance staff	Technical staff responsible for implementing and deploying SW updates
	E-GNSS service volume provision	R	Service volume facilities	Required facilities to host the service volume tool (servers, stations, communication infrastructure, etc.) and staff. The infrastructure should be equipped with the required means to ensure security and service availability.
		R	Servers (HW)	HW dedicated to run the E-GNSS service volume tool and store the geospatial data.
		R	Operator & maintenance stations	Desktop computers for tools operators and maintenance staff.
		R	Service volume tool operators	The operators of the service volume tool must follow the required procedures to ensure the availability of the system. They might be responsible to run the tool when a new set of geospatial data is available.
		R	Service volume maintenance staff	Technical staff responsible for implementing and deploying SW updates
	E-GNSS monitoring & forecast	R	Monitoring & forecast service facilities	Required facilities to host the E-GNSS performance monitoring and E-GNSS performance forecast tools (servers, stations, communication infrastructure, etc.) and staff. The infrastructure should be equipped with the required means to ensure security and service availability.
		O	Ground monitoring network	The E-GNSS ground monitoring network is the infrastructure (E-GNSS stations) to gather real-time data from the E-GNSS constellations. The ground stations should be deployed in multiple locations that fulfil the conditions defined in the SDD (open-sky and degraded). Note: this item infrastructure refers to the addition of new E-GNSS monitoring stations. Therefore, it is an optional item, since the current ground monitoring networks from Galileo and EGNOS systems could be also used by the E-GNSS SP for Unmanned Aviation.
		R	Servers (HW)	HW dedicated to run the E-GNSS performance monitoring and E-GNSS performance forecast tools and store. This should include the required HW to store geospatial data and record the data calculated by the tools.
		R	Operator & maintenance stations	Desktop computers for tools operators and maintenance staff.

E-GNSS subservices		Elements	Description	
E-GNSS RFI reporting	R	Monitoring & forecast service operators	The operators of the E-GNSS monitoring & forecast subservice must follow the required procedures to ensure the availability of the system.	
	R	Monitoring & forecast maintenance staff	Technical staff responsible for implementing and deploying SW updates	
	R	RFI service facilities	Required facilities to host the RFI tools (servers, stations, communication infrastructure, etc.) and staff. The infrastructure should be equipped with the required means to ensure security and service availability.	
	R	Servers (HW)	HW dedicated to run the RFI reporting tool and store the RFI events data. This should include the required HW to store geospatial data and record the data calculated by the tools.	
	R	Operator & maintenance stations	Desktop computers for tools operators and maintenance staff.	
	R	RFI service maintenance staff	Technical staff responsible for implementing and deploying SW updates	
	R	RFI service operators	The operators of the RFI service must follow the required procedures to ensure the availability of the system.	
	E-GNSS website	R	Website service facilities	Required facilities to host the Website infrastructure (servers, stations, communication infrastructure, etc.) and staff. The infrastructure should be equipped with the required means to ensure security and service availability.
		R	Servers (HW)	HW dedicated to run the Website application. This should include the required HW to store geospatial data and record the data calculated by the tools.
		R	Operator stations	Desktop computers for tools operators and maintenance staff.
R		Website maintenance staff	Technical staff responsible for implementing and deploying SW updates	
E-GNSS helpdesk	R	Helpdesk support stations	Desktop computers for the helpdesk support staff.	
	R	Helpdesk support staff	Support staff "24/7" that must follow the procedures to attend the helpdesk service	

C.3. DOCUMENTS AND PROCEDURES

	Internal procedures	
	Product documents	R: Required
	Public documents	O: Optional

E-GNSS subservices			Elements	Description
E-GNSS SIS	Galileo SIS	R	Report E-GNSS SIS service notices	Procedure required to notify E-GNSS SIS service notices to the users. The procedure should include the interfaces between the E-GNSS SP for UAS and the Galileo and/or Galileo SP.
	EGNOS SIS			
E-GNSS data services	E-GNSS API	R	Monitor data services SLA	The SLA requirements must be monitored by the API operators (e.g., E-GNSS API latency, availability, data integrity, etc.)
		R	Report scheduled and unscheduled API outages	Procedure followed by the API operators required to notify users about API outages.
		R	User registration and authorization	Procedure followed by the API operators to register users and provide access to the API. This can include the drawing up of agreements with the users (e.g., to prepare an agreement with USSP and CIS).
		R	API system documentation	API system documentation (System requirements, system design, ICD, etc.). Previous engineering studies can also be included in this category.
		R	API operation manual	API manual available to EGNSS SP operators.
		R	ICD	This document would describe the API data structure and the required procedures to access the data. It must be provided to each registered user.
	E-GNSS service volume provision	R	Report scheduled and unscheduled outages of the E-GNSS service volume provision	This procedure should include the required steps and actions to notify users about outages of the service.

E-GNSS subservices		Elements	Description
		R Update geospatial data	This procedure should include the steps to update the geospatial data that serves as input of the E-GNSS service volume tool.
		R Service volume tool documentation	E-GNSS service volume tool documentation (System requirements, system design, ICD, etc.). Previous engineering studies can also be included in this category.
		R Service volume tool operation manual	E-GNSS service volume tool manual available to E-GNSS SP operators.
E-GNSS monitoring & forecast		R Report scheduled and unscheduled outages of the E-GNSS monitoring & forecast service.	This procedure should include the required steps and actions to notify users about outages of the E-GNSS monitoring and/or forecast subservices. It should also include contingency measures for the scenario where any of these services is unavailable.
E-GNSS monitoring & forecast		R Ground monitoring data collection	It should describe the steps and actions to be followed by the E-GNSS monitoring & forecast operators to perform maintenance tasks of the E-GNSS U-Space ground monitoring network.
E-GNSS monitoring & forecast		R GNSS facilitators data collection	The procedure should describe the steps required to collect external data (e.g., NANU, NAGU, constellation data, etc.) from GNSS facilitators. This data should be collected by a software tool; however the procedure should include the required actions to prepare a working agreement with the corresponding GNSS facilitators.
E-GNSS monitoring & forecast		O U-Space SUR data collection	It should describe the steps and actions to be followed by the E-GNSS monitoring & forecast operators to perform maintenance tasks of the infrastructure related to U-Space surveillance data collection.
E-GNSS monitoring & forecast		R Performance forecast validation	This procedure should cover the validation of the performance monitoring tool. It should include the operation of the performance monitoring validation tool. This validation is based on the comparison of the measured positioning performances of a E-GNSS enabled receiver with the forecasted performances.
E-GNSS monitoring & forecast		R Committed performance monitoring	This procedure should cover the validation of the performance forecast tool. It should include the operation of the performance forecast validation tool. The validation is based on the comparison of the measured the committed performances established by the SDD and measured performances obtained through the E-GNSS performance monitoring SW tool

E-GNSS subservices		Elements	Description	
		R	Performance monitoring tool documentation	E-GNSS performance monitoring tool documentation (System requirements, system design, ICD, etc.). Previous engineering studies can also be included in this category.
		R	Performance monitoring tool operation manual	E-GNSS performance monitoring tool manual available to E-GNSS SP operators.
		R	Performance forecast tool documentation	E-GNSS service volume tool documentation (System requirements, system design, ICD, etc.). Previous engineering studies can also be included in this category.
		R	Performance forecast tool operation manual	E-GNSS service volume tool manual available to E-GNSS SP operators.
	E-GNSS RFI reporting	R	RFI event reporting	The procedure should include the steps to report any RFI event to the relevant authorities and entities.
		R	RFI reporting tool documentation	RFI reporting tool documentation (System requirements, system design, ICD, etc.). Previous engineering studies can also be included in this category.
		R	RFI reporting tool operation manual	RFI reporting tool manual available to EGNSS SP operators.
			Report scheduled and unscheduled outages of the E-GNSS RFI reporting service	This procedure should include the required steps and actions to notify users about outages of the E-GNSS RFI service. It should also include contingency measures for the scenario where this service is unavailable.
E-GNSS website	R	Achieved performances reports (procedure)	The procedure should describe the steps and actions required to release the E-GNSS measured performance reports.	
	R	Achieved performances reports	The E-GNSS achieved performance reports should contain measurements of the performance achieved by the E-GNSS enabled receiver and comparison with the committed navigation performances of the service.	
	R	Prepare and update SDD	The procedure should describe the steps and actions required to release or update the SDD.	

E-GNSS subservices		Elements	Description
	R	SDD	The SDD should contain the following information: - Description of the service and its provision at high-level - Terms and conditions of use of the service - Characteristics of the EGNSS enabled receivers - Service minimum performance and if applicable, the definition of service levels (e.g., in terms of accuracy, integrity and availability) - Navigation modes considered in the EGNSS service for UAS
	R	Prepare and update the service evolution map	The procedure should describe the steps and actions required to release or update the service evolution roadmap.
	R	Service evolution roadmap	It should contain the planned evolutions of the service.
	R	Update website maps	The procedure should be followed by E-GNSS website operators to update and upload the service maps displayed on the website (these maps could show the E-GNSS achieved performance through the service volume).
	R	User registration and authorization	Procedure followed by the E-GNSS website operators to register users and provide access to some of the website services.
	R	Report website outages	This procedure should include the required steps and actions to notify users about outages of the website.
	R	Website documentation	Web application documentation (Website requirements, website design, website validation document, etc.).
E-GNSS helpdesk	R	Helpdesk support procedures	The procedure should describe the steps to be followed by the helpdesk staff to respond to the received enquiries through the available means (e.g., phone, email or online form).
	R	Report helpdesk outages	The procedure should include the required steps and actions to notify users about outages of the E-GNSS helpdesk.

ANNEX D. SERVICE PROVISION REQUIREMENTS

Requirement reference	Service requirement
1. Service Provision layer	
EUGENE-SPS-01	E-GNSS Service Provider for UAS shall be responsible towards the UAS user of the provision of E-GNSS SiS, to support UAS operations within and outside U-Space airspace.
EUGENE-SPS-02	E-GNSS Service Provider for UAS shall be responsible towards the UAS user of the E-GNSS API, expected to demonstrate that the required level of performance for the E-GNSS Service for UAS can be achieved for the full mission of the flight.
EUGENE-SPS-03	E-GNSS Service Provider for UAS shall be responsible towards the UAS users of the E-GNSS website, where UAS users can obtain and find all needed information about the E-GNSS Service for UAS.
EUGENE-SPS-04	E-GNSS Service Provider for UAS shall be responsible towards the UAS users of the provision of E-GNSS helpdesk, which will be a direct point of contact with UAS users in relation to the E-GNSS Service for UAS.
EUGENE-SPS-05	E-GNSS Service Provider for UAS shall support E-GNSS Programme in the development, definition and description of the E-GNSS Service for UAS in a new Service Definition Document (SDD), which shall include among other aspects: way to access to the service, the terms/conditions of use, clear identification of the roles, the service area and commitments (EUGENE-SPS-13), minimum required performances and maps (EUGENE-SPS-12) and also the expected E-GNSS receiver equipment.
EUGENE-SPS-06	E-GNSS Service Provider for UAS shall be responsible for providing a 24h/7d service, to support day and/or night UAS operations (including E-GNSS SiS, E-GNSS API, E-GNSS website and E-GNSS helpdesk) according to the service conditions established in the SDD.
2. Liabilities	
EUGENE-SPS-07	E-GNSS Service for UAS shall be provided by the E-GNSS Service Provider for UAS, who shall be responsible towards the UAS user for the provision of E-GNSS SiS, E-GNSS API, E-GNSS website and E-GNSS helpdesk. The service provided shall be equivalent for all UAS users within EU Member States and, if previously authorised by EC, also to UAS users outside EU.
EUGENE-SPS-08	E-GNSS Service Provider for UAS shall be responsible for establishing the appropriate service level agreements with GNSS Service Facilitators (e.g. EGNOS service provider and/or Galileo operator) to ensure the provision of the E-GNSS SiS and the liabilities towards the UAS users.
EUGENE-SPS-09	E-GNSS Service Provider for UAS shall be responsible for establishing the required agreements with appropriate UAS users (USSP or UAS Operator / CIS - to be confirmed) to clearly identify the roles and responsibilities of each counterpart and support UAS operations within and outside U-Space airspace.
EUGENE-SPS-10	E-GNSS Service Provider for UAS shall analyse and participate in the establishment of the E-GNSS information flow between USSP and CIS, in order to ensure the provision of E-GNSS information within U-Space airspace.

Requirement reference	Service requirement
EUGENE-SPS-11	E-GNSS Service Provider for UAS shall verify the adequacy of UAS users accessing to the E-GNSS API (USSP or UAS Operator / CIS - to be confirmed), using as input the 'EASA Repository of Information', as per Art.74 from Regulation 2018/1139.
3. Service Performance Requirements	
EUGENE-SPS-12	The E-GNSS Service Provider for UAS shall support the E-GNSS Programme in the definition and tailoring of the E-GNSS performances for the intended operational requirements (in terms of e.g., availability, continuity, integrity, and accuracy). The E-GNSS Service Provider for UAS shall support the definition and implementation of the methodology to demonstrate the level of performance achieved during the full duration of the flight. This methodology could be the basis for the performance maps to be included in the SDD (EUGENE-SPS-05).
EUGENE-SPS-13	The E-GNSS Service Provider for UAS shall support the E-GNSS Programme in the definition of the corresponding commitments in term of performances (e.g. in the form of tables and/or maps) in the new SDD (EUGENE-SPS-05) in order to provide UAS users the E-GNSS performances and/or extension of the E-GNSS service volume.
4. Service Performance Monitoring requirements	
4.1. Key performance indicators and metrics	
EUGENE-SPS-14	E-GNSS Service Provider for UAS shall monitor the quality of the provided service, based on the commitment defined in the new SDD (EUGENE-SPS-05), by means of Key Performance Indicators (KPI) and metrics in order to properly monitor the behaviour of the service.
4.2. Performance monitoring information to users	
EUGENE-SPS-15	The E-GNSS Service Provider for UAS shall provide to UAS users information on past, current and predicted E-GNSS performances through the Website or the E-GNSS API.
4.3. Service Performance Tools	
EUGENE-SPS-16	As the responsible organization for the E-GNSS API (EUGENE-SPS-02), the E-GNSS Service Provider for UAS shall operate, evolve and maintain the E-GNSS API tool.
EUGENE-SPS-17	The E-GNSS Service Provider for UAS shall be responsible for ensuring that functional and non-functional requirements (identified in D1.3) for the E-GNSS API are met.
EUGENE-SPS-18	The E-GNSS Service Provider for UAS shall ensure that the tools required for the provision of the E-GNSS service are available, operated and maintained, including the development (if needed) of missing E-GNSS tools which could improve the provision of the service (e.g. Galileo Forecast tool).

Requirement reference	Service requirement
4.4. Contingency procedures	
EUGENE-SPS-19	E-GNSS Service Provider for UAS shall be responsible for defining the contingency procedures, to be followed in case there is any degradation of the E-GNSS Service commitments.
4.5. Reporting	
EUGENE-SPS-20	E-GNSS Service Provider for UAS shall make available to the UAS users periodic publications related to the E-GNSS performances information.
5. Validation of the E-GNSS Service for UAS	
EUGENE-SPS-21	The E-GNSS Service Provider for UAS shall define a validation scheme for the E-GNSS Service for UAS to be used as the validation basis and agreed with a competent third party.
EUGENE-SPS-22	The E-GNSS Service Provider for UAS shall perform a validation of the service, following the validation scheme defined in EUGENE-SPS-21, before21 before the E-GNSS Service for UAS is declared or a major service evolution is introduced.
6. Evolution of the E-GNSS Service for UAS	
EUGENE-SPS-23	Several evolutions for E-GNSS services are already planned and the corresponding service commitments will be published by the E-GNSS Programme. E-GNSS Service Provider for UAS shall be responsible for analysing and developing those evolutions in order to align the E-GNSS Service for UAS with EGNOS and Galileo services.
EUGENE-SPS-24	The E-GNSS Service Provider for UAS shall make public to UAS users a document describing the expected evolutions of the E-GNSS Service for UAS.
EUGENE-SPS-25	The E-GNSS Service Provider for UAS shall be aware of the evolution of the E-GNSS Services in order to properly address requirements EUGENE-SPS-23 and EUGENE-SPS-24.
EUGENE-SPS-26	The E-GNSS Service Provider for UAS shall be also responsible for monitoring and following-up the evolution of the applicable UAS regulatory framework and also the standards related to the E-GNSS receiver equipment, with an active participation at International and/or European standardization and regulatory working groups.
7. Data storage	
EUGENE-SPS-27	The E-GNSS Service Provider for UAS shall keep records of the E-GNSS Service information for a period of at least 5 years (in line with EUGENE-SPS-15).

Requirement reference	Service requirement
8. Service Support to UAS users	
EUGENE-SPS-28	<p>The E-GNSS Service Provider for UAS shall be responsible for the E-GNSS helpdesk (24h/7d service), using different channels (e.g. email, phone, web form) and technologies in order to provide an immediate, reliable and secure access to the UAS users.</p> <p>The E-GNSS helpdesk shall provide support UAS users with information related to the E-GNSS Service, its performance and applications.</p>
EUGENE-SPS-29	<p>The E-GNSS Service Provider for UAS shall be responsible for a E-GNSS website accessible for UAS users to check recorded E-GNSS information about the E-GNSS Service for UAS.</p>
EUGENE-SPS-30	<p>To cover the provision of the E-GNSS Service for UAS outside U-Space airspace, the E-GNSS Service Provider for UAS shall develop a website tool accessible for UAS operators to check actual and forecast E-GNSS information (for flight planning purposes).</p>
9. Requirements related to UAS users	
EUGENE-SPS-31	<p>Within U-Space airspace, E-GNSS Service Provider for UAS shall only provide the E-GNSS Service to certified USSP (CIS – to be confirmed) by the national competent authority according to Regulation 2021/664.</p>
EUGENE-SPS-32	<p>Within U-Space airspace, E-GNSS Service Provider for UAS should support USSP (CIS – to be confirmed) accessing to the E-GNSS API according to the published ICD, in the development of a tool for processing E-GNSS data provided which will be integrated into the USSP (CIS – to be confirmed) interface with UAS operators.</p>
EUGENE-SPS-33	<p>Outside U-Space airspace, E-GNSS Service Provider for UAS shall only provide the service to UAS operators having a proper approval from a competent authority, according to Regulation 2019/947.</p>



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