

FINAL REPORT

SUGUS

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1. INTRODUCTION

1.1. PURPOSE

This document is the Final Report of SUGUS summarizing the activities performed during SUGUS project.

According to the consortium proposal, the Final Report shall contain at least:

- status of all accomplished by FR;
- problems, limitations or unexpected points, if any, that have arisen;
- list of all meetings attendance
- list of all submitted deliverables
- Risk Register
- Travel Plan
- Action Items list (including action owner, responsible and deadline).

Additionally, a final section including the main conclusions and recommendations identified during the project are provided.

The different sections included in this document provide all the information requested above.

This is the first version (V1.0) of the document.

1.2. SCOPE

The present document has been organized as follows:

Chapter 1. gives an introduction to the document, including purpose and scope of the document.

Chapter 2. provides the list of project applicable and reference documents.

Chapter 3. provides the list of definitions and acronyms used throughout the document.

Chapter 4. presents the overview of the technical activities, including a description of the activities developed in SUGUS project.

Chapter 5. describes the project management status, including the status of the raised actions and the travel plan.

Chapter 6. includes the description of the contractual aspects.

Chapter 7. provides the identified risks of the project and their status.

Chapter 8. provided the main SUGUS conclusions and recommendations

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]	746/PP/GRO/RCH/19/11305 "H2020: EGNOS and GALILEO as a U-Space service" Invitation to Tender No 746/PP/GRO/RCH/19/11305	746/PP/GRO/RCH/19/11305	-	14/05/19
[AD.2]	Tender Specifications. Call for tenders No 746/PP/GRO/RCH/19/11305 "H2020: EGNOS and GALILEO as a U-Space service"	746/PP/GRO/RCH/19/11305	-	14/05/19
[AD.3]	Service Contract. 746/PP/GRO/RCH/19/11305	746/PP/GRO/RCH/19/11305	-	14/05/19
[AD.4]	SUGUS KOM MoM	GNSS-GMV-SUGUS-MEX-001	1.1	19/12/2019
[AD.5]	SUGUS PM1 MoM	GNSS-GMV-SUGUS-MEX-002	1.1	12/03/2020
[AD.6]	SUGUS PM1 Closeout MoM	GNSS-GMV-SUGUS-MEX-003	1.0	02/04/2020
[AD.7]	SUGUS PM2 MoM	GNSS-GMV-SUGUS-MEX-004	1.1	04/09/2020
[AD.8]	SUGUS MTR MoM	GNSS-GMV-SUGUS-MEX-005	1.0	02/12/2020
[AD.9]	SUGUS PM3 MoM	GNSS-GMV-SUGUS-MEX-006	1.1	02/03/2021
[AD.10]	SUGUS PM4 MoM	GNSS-GMV-SUGUS-MEX-007	1.1	28/05/2021
[AD.11]	Inventory List	SUGUS_GMV_TN_D0.4_V1.0	1.0	13/08/2021
[AD.12]	SUGUS FRM MoM	GNSS-GMV-SUGUS-MEX-008	1.0	27/08/2021

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

3. TERMS, DEFINITIONS AND ABBREVIATED TERMS

3.1. DEFINITIONS

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

Table 3-1 Definitions

Concept / Term	Definition

3.2. ACRONYMS

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

Table 3-2 Acronyms

Acronym	Acronym
AB	Advisory board
AD	Applicable Document
AESA	Agencia Estatal de Seguridad Aérea
ATM	Air traffic management
CAS	Commercial Authentication Services
CORUS	Concept of Operation for EuRoPean UTM Systems
DG	Directorate General
EASA	European Union Aviation Safety Agency
EC	European Commission
EDAS	EGNOS Data Access Service
EGNOS	European Geostationary Navigation Overlay Service
EGNSS	European GNSS
GNSS	Global Navigation Satellite System
GSA	European GNSS Agency
HAS	High Accuracy Service
ITT	Invitation To Tender
KOM	Kick Of Meeting
OS	Open Service
OS-NMA	OS Navigation Service
PM	Progress Meeting
PMP	Project Plan Management
PR	Progress Report
PRS	Public Regulated Service
RD	Reference Document
SAR	Search and Rescue
SBAS	Satellite-based Augmentation System
SESAR	Single European Sky ATM Research
SoL	Safety of Life
SORA	Specific Operational Risk Assessment
TBC	To be confirmed/completed
TBD	To be discussed

Acronym	Acronym
TN	Technical Note
UA	Unmanned Aircraft
WP	Work Package
WPD	WP Description

4. OVERVIEW OF TECHNICAL ACTIVITIES

4.1. WORK PACKAGES

The figure below shows the work breakdown structure, and indicates the company leading each WP/task and the companies of the consortium supporting the leader as contributors to the corresponding tasks:

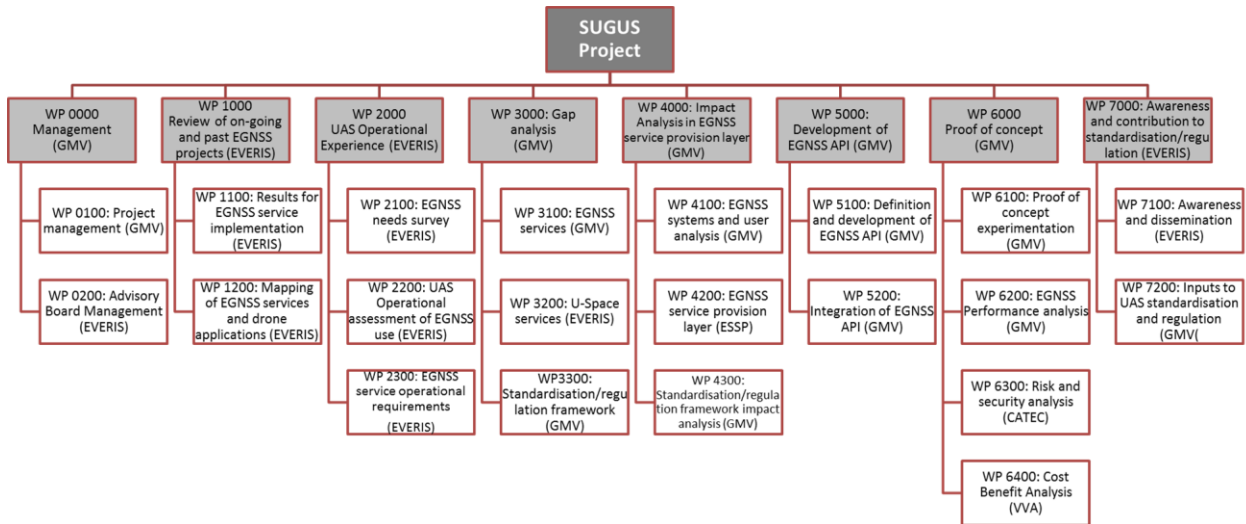


Figure 4-1: Work Breakdown Structure.

All Work Packages (WP) included in the consortium’s proposal were launched in due time and the activities were properly performed, as expected:

- WP0100: Project Management
- WP0200: Advisory Board Management
- WP1100: Results for EGNSS service implementation
- WP1200: Mapping of EGNSS services and drones applications
- WP2100: EGNSS needs survey
- WP2200: UAS Operational assessment of EGNSS use
- WP2300: EGNSS service operational requirements
- WP3100: EGNSS services
- WP3200: U-Space services
- WP3300: Standardisation/regulation framework
- WP4100: EGNSS systems and user analysis
- WP4200: EGNSS Service Provision layer
- WP4300: Standardization/Regulation framework impact
- WP5100: Definition and development of EGNSS API
- WP5200: Integration of EGNSS API
- WP6100: Proof of Concept Experimentation
- WP6200: EGNSS Performance Analysis
- WP6300: Risk and Security Analysis
- WP6400: Cost Benefits Analysis
- WP7100: Awareness and Dissemination
- WP7200: Inputs to UAS standardization and regulation

Please note that WP6100 activities started before the expected schedule to avoid further programmatic issues.

The following sections provide a summary of the main activities performed as part of the aforementioned Works Packages.

4.2. WP0100: PROJECT MANAGEMENT

Objective: Overall management of the project, coordination and interface with the customer.

Overall activities done:

- Activities related to SUGUS management, in particular:
 - Contractual management
 - Organization and coordination of internal communication flow.
 - Documentation management
 - Tracking project status
 - Risks & actions tracking
 - Organization of milestones, meetings teleconferences and reviews with client/partners
 - Ensure coordination between the different activities as necessary
 - Preparation of Progress Reports, monthly reports, MoMs and other managerial deliverables.

Problems, limitations or unexpected points, if any, have arisen.

- No problem or limitation was raised.

4.3. WP0200: ADVISORY BOARD MANAGEMENT

Objective: To set up an Advisory board (AB) with the objective of providing guidance to the project on fundamental aspects as indicated in the Tender Specifications. It is necessary to coordinate and manage their involvement of the Advisory Board during the project

Activities done during the WP work:

After consulting the members' availability, the first AB meeting has been held the 28th of October 2020 via teleconference for traveling difficulties due to the COVID-19 disease

Before the meeting, the Board received a summary of the main outcomes of the project so far, and some inputs related with the feedback that was expected by them.

The Advisory Group that has been invited to the meeting and represents the current composition of the Board is the following:

1. Mr. Daniel García-Monteavaro (ENAIRES) - President
2. Mr. Andrés López Morales (Spanish civil aviation)
3. Mr. Juan José Sola (Spanish Aviation Safety Agency - AESA)
4. Mr. Ludovic Legros (SESAR)
5. Mr. Israel Quintanilla (Universidad Politecnica Valencia)
6. Mrs. Julia Sánchez (EUROCONTROL)
7. Mr. Alain Vallee (EUROCAE)
8. Mr. Xavier Quiles (ENAIRES)
9. Mr. Gonzalo Alonso Pacheco (ENAIRES)
10. Mrs. Marta Krywanis-Brzostowska (European GNSS Agency-GSA).
11. Mr. Victor Gordo (INECO)
12. Mrs. Sophie Damy (EC Joint Research Centre)
13. Mrs. Carmen Bonillo Martinez (EASA)

Some of the Board members that could not participate to the meeting have sent a substitute.

After the meeting, a report with the meeting conclusions has been distributed, joint with the meeting presentation.

After consulting the AB members through a doodle, the second AB meeting has been called for June 29th, 2021. The invitation have been sent to the participants, and some of them have already accepted.

The meeting date has been chosen to allow the AB to give some last advices (revision of the trial scenario, etc.) before the celebration of the trials on July 6th.

A couple of weeks before the meeting, the AB members have received the update of the results of the project gathered so far, and some general indications on the objectives of the meeting.

As planned, on June 29th the second AB meeting has been held. The AB board slightly changed between the first and the second meeting, so the Advisory Group that has been invited to the meeting and represents the final composition of the Board is the following:

1. Mr. Daniel García-Monteavaro (ENAIRES) - President
2. Mr. Andrés López Morales (Spanish civil aviation)
3. Mr. Juan José Sola (Spanish Aviation Safety Agency - AESA)
4. Mr. Ludovic Legros (SESAR)
5. Mr. Israel Quintanilla (Universidad Politécnica Valencia)
6. Mrs. Julia Sánchez (EUROCONTROL)
7. Mrs. Carmen Aguilera (European GNSS Agency-EUSPA)
8. Mr. Sergiu Marzac (EUROCAE)
9. Mr. Xavier Quiles (ENAIRES)
10. Mr. Gonzalo Alonso Pacheco (ENAIRES)
11. Mr. Victor Gordo (INECO)
12. Mrs. Sophie Damy (EC Joint Research Centre)
13. Mrs. Carmen Bonillo Martinez (EASA)

Some of the participants have replaced board members that could not assist to the meeting, or have simply reinforced the presence of a member:

- Mr. Marc Olmo (ENAIRES)
- Ms. Abinaya Kannan (EUROCAE)
- Mr. Giancarlo Ferrara (EUROCONTROL)
- Mrs. Mónica de Frutos Ortega (AESA)
- Mr. Jordi Vidal (UPV)

The Advisory Board Meetings represented a very important and interesting moment in the SUGUS lifecycle, since they gave to all the Project participants the occasion to present the outcomes of the Project and receive valuable feedback on it. During the second meeting, the presented outcomes have encompassed almost all the activities that are included in the SUGUS scope:

- The regulation and U-Space services proposals
- The API that has been developed
- The integration with an advanced UTM platform
- The trial flights.
- The economical (Cost&Benefits) aspects.

During the meetings neither blocking point nor incompatibility with other normative initiatives has been spotted, confirming that the approach followed by SUGUS can be reputed valid and useful.

The final consideration that can be obtained looking at the feedback received during the Advisory Board meetings by its members is that SUGUS can be surely accounted a highly relevant project to complete the set of U-Space services that will guarantee to the UAS an easier and safer access to the airspace.

Problems, limitations or unexpected points, if any, have arisen.

The COVID-19 crisis has limited the possibilities to travel and hold a meeting in person, so all members have participated through a conference call. Due to the length and nature of these meetings, a face-to-face meeting is always advisable.

4.4. WP1100: RESULTS FOR EGNSS SERVICE IMPLEMENTATION

Objective: Examine the results of past and on-going EGNSS projects which could be of interest for U-Space to capitalize on the outcomes of different studies which have been funded by the public sector. The goal is to understand whether the results achieved could be re-used for the implementation of an EGNSS service for U-Space.

Activities done during the WP work:

- Literature research of relevant E-GNSS projects for U-Space, taking into account on-going or recent projects which could be of interest of U-Space from Horizon 2002, FP6, FP7, GSA, etc
- Elaboration of one list of deliverables that could be of interest to have to complete this study. Review all public available information of projects related to U-space and EGNSS funded throughout SESAR JU and GSA.
- Request of the support to DE DEFIS of EC for collecting private deliverables of the identified projects.
- Gather information about projects scope, results and results availability.
- Reviewing of available documents.
- Deliverable D1.1. Identification of available results for implementation of a EGNSS service for U-Space.

We identified 7 projects related to EGNSS (EGNSS4RPAS, GAUSS, REAL, SKYOPENER, ARIADNA, AIOSAT, GMCA) and 14 projects related to U-space (DOMUS, CORUS, CLASS, SECOPS, PODIUM, GOF U-space, IMPETUS, MULTIDRONE, PERCETIVE, TERRA, AIRPASS, EURODRONE, DREAMS and DROC2OM).

Some projects that were initially considered were finally discarded due to lack of any documentation. These projects are LOGAM, VUTURA, DIODE, SAFIR, SAFEDRONE and GEOSAFE.

As a result of this process we have checked that the public documents related to the different projects do not provide too useful information for getting a valid input for the following deliverable, WP1200. In that sense there is not a common pattern in these projects that we can identified as a right reference.

Problems, limitations or unexpected points arisen during the WP work.

- Little public documentation for the project objective.
- Very heterogeneous information from which it is difficult to extract a common pattern.
- Not availability of additional private documents. GSA proposed to the project to contact directly with the Project Coordinator of each Consortium. There were not planned nor available efforts to do it.
- SESAR JU did not provide any additional document related to the U-space demonstrators.

4.5. WP1200: MAPPING OF EGNSS SERVICES AND DRONES APPLICATIONS

Objective: Based on the identified projects in WP1100, undertake a literature research in order to map one -to-one correspondence of E-GNSS services (navigation, surveillance, tracking, geo-fencing, e-identification) to deliver specific performance to drones in the Open and Specific categories.

Activities done during the WP work:

The following activities were completed along the past quarterly:

- Review of U-spaces services associated to CORUS project.
- Review the last version of the Draft of U-space Regulation provided by European Union Aviation Safety Agency (EASA).

- Review the activity of the following EUROCAE workings groups:
 - WG-105 SG 61 SORA: Specific Operations Risk Assessment.
 - WG-105 SG 62 GNSS for UAs.
- Review of EGNSS services related to Galileo and EGNOS, both currently and projected services in the short and medium term:
 - Galileo Open Service (OS).
 - Galileo Public Regulated Service (PRS).
 - Galileo Search and Rescue Service (SAR).
 - Galileo High Accuracy Service (HA).
 - Galileo Open Service Navigation Service (OS-NMA).
 - Galileo Commercial Authentication Services (CAS).
 - EGNOS Open Service (OS).
 - EGNOS Safety of Life (SoL).
 - EGNOS Data Access Service (EDAS).
- Analysis of the mapping proposal among EGNSS and U-space services in accordance with the sources analyzed.
- Deliverable D1.2. Mapping of EGNSS services and drone applications.
- Management of the comments received to the first version of the document that will be evaluated, agreed, approved and incorporated to the updated version.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.6. WP2100: EGNSS NEEDS SURVEY

Objective: Organize a survey about the use of E-GNSS by UAS stakeholders (e.g. Advisory Board or others) assessing the aspects proposed by Task 2 in ITT. The survey shall allow the consortium to understand U-space stakeholders (in particular U-Space service providers, operators and pilots) needs and improve the user experience of E-GNSS services in real operations.

Activities done during the WP work:

- Management of the comments received to the first version of the survey that will be evaluated, agreed, approved and incorporated to the updated version.
- Preparation, execution and collection of the results.
- Investigation of how U-space services can benefit from integrating a new layer of information about E-GNSS (e.g. prediction of service availability and performance), and to identify the potential benefits and conditions for their generation.
- D2.2. Survey results on EGNSS service needs to U-space stakeholders.
- Define the survey methodology and identify the key stakeholders to be contacted.
- Elaboration of the first draft of questions of the survey.
- Analysis of how integrate the survey in the website of the project.
- Analysis of how apply the General Data Protection Regulation (GDPR) to the survey.
- D2.1. Survey methodology on E-GNSS service needs to U-space stakeholders.
- Management of the comments received to the first version of the document D2.2 that have been evaluated, agreed, approved and incorporated to the updated version.

Problems, limitations or unexpected points, if any, have arisen.

It was planned to collect this survey in the stand of everis in the next World ATM Congress in Madrid as an additional source of surveyed, but the WATM Congress was cancelled due to the COVID-19 crisis.

4.7. WP2200: UAS OPERATIONAL ASSESSMENT OF EGNSS USE

Objective: Compile operational lessons about the operational use of E-GNSS (e.g. current access to E-GNSS information and integration with user's workflow; needs to improved access to E-GNSS information during all phases of flight) with a focus on relatively complex scenarios (including drones of Specific category)

Activities done during the WP work:

- On the basis of the compiled lessons learned, define a reference operational scenario (with medium to high risk both in the ground side and air side) in which the implementation of the required mitigations with a medium to high level of robustness would be based on an improved access to and use of E-GNSS information.
- Determine if an existing EASA standard scenario could be adapted to the defined reference operational scenario and, if so, analyze how to adapt that standard scenario; otherwise, perform a risk analysis following the SORA methodology of that reference scenario, in particular to assess the effectiveness of E-GNSS in implementing some of the required mitigations.
- Management of the comments received to the first version of the document that will be evaluated, agreed, approved and incorporated to the updated version.
- D2.3a. Methodology for assessing operational experience.
- D2.3b Operational experience and reference scenario
- D2.3c Safety assessment of EGNSS mitigations in the reference scenario
- Management of the comments received to the first version of the document 2.3a, 2.3b, 2.3c that have evaluated, agreed, approved and incorporated to the updated version.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.8. WP2300: EGNSS SERVICE OPERATIONAL REQUIREMENTS

Objective: To assess E-GNSS service requirements from UAS operational needs identified in WP2200.

Activities done during the WP work:

- On the basis of the UAS operational experience and reference operational scenarios defined in previous task, extract the operational requirements to be enabled by the appropriate E-GNSS services.
- Translate the operational requirements into E-GNSS service needs and positioning requirements (i.e. accuracy, integrity, availability and continuity) enabling the comparison with the current E-GNSS service performance and the identification of gaps.

- Management of the comments received to the different versions of the document that were evaluated, agreed, approved and incorporated to the updated version.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.9. WP3100: EGNSS SERVICES

Objective: to analyse the gaps that need to be filled to accelerate and facilitate the adoption of the seamless use of EGNSS in U-Space, but just focusing on the EGNSS system evolutions.

Activities done during the WP work:

- Step 1: Review outcomes from previous tasks:
 - Identify elements that could be reused to facilitate the penetration of EGNSS in UAS market and U-Space
 - Collect EGNSS requirements derived from UAS operational needs
- Step 2: Gap identification
 - Compare elements already existing in EGNSS programmes with UAS operational needs
 - To identify gaps of the use of EGNSS in terms of improvements or new services implementation
- Step 3: Implementation plan
 - Propose corresponding implementation plan (high level) considering EGNSS programmes and evolutions

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.10. WP3200: U-SPACE SERVICES

Objective: To perform gap analysis between the elements already implemented in EGNSS Programmes and the needs for a fast acceptance as an additional service in U-Space, considering:

- Open and specific categories
- Evolution of U-Space services (U1 to U4) and architecture

To propose an implementation plan for the introduction of an E-GNSS service for UAS

Activities done during the WP work:

1. Review of the outcomes identified from previous tasks in the WP2300, WP2200 and WP2100
2. Gaps at U-Space level for open & specific categories
 - 2.1. Identification of gaps in current U-space conceptions. The task is focused on two aspects:
 - Gaps in current U-space requiring new services.
 - Gaps in current U-space that don't need additional services.
 - 2.2. Implementation plan of the gaps that have been identified.

3. Gaps at standardisation & regulation level for open & specific categories
 - 3.1. Identification of gaps at standardisation & regulation level
 - 3.2. Implementation plan of the gaps that have been identified

D3.1 deliverable gathered the main achievements related to the Open Category. Outcomes related to the Specific Category were provided in D3.2 deliverable.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.11. WP3300: STANDARDISATION/REGULATION FRAMEWORK

Objective: to analyse the elements that shall be implemented at standardisation/regulation level derived from the needs for a fast acceptance of EGNSS as an additional service in U-Space.

Activities done during the WP work:

- Step 1: Review outcomes from previous tasks
 - Identify elements that could be reused to facilitate the penetration of EGNSS in UAS market and U-Space
 - Collect U-Space requirements derived from UAS operational needs
- Step 2: Gap identification
 - Identify gaps linked to EGNSS standardisation/regulation
 - Identify gaps linked to UAS standardisation/regulation
- Step 3: Implementation plan
 - Propose corresponding implementation plan (high level) considering current status and expected evolutions

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.12. WP4100: EGNSS SYSTEMS AND USER ANALYSIS

Objective: to analyse the identified gaps for a fast EGNSS acceptance in U-Space services, and to assess the impact in the EGNSS service provision layer focusing on the EGNSS systems and users' perspective and interfaces.

Activities done during the WP work:

- Review outcomes from WP3000: To review the gaps identified in WP3000 to identify whether they could affect the EGNSS systems and user interfaces.
- Impact analysis: to analyse the impact of the modifications proposed in WP3000, taking into account the objectives defined for this WP4100.

- Propose corresponding implementation plan: To propose the corresponding implementation plan for such modifications, including that services that the service provision layer offer from its different ground infrastructure elements to end users (e.g. generation of NAGUs, generation of NOTAMs, EDAS service), and the corresponding implementation plan.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.13. WP4200: EGNSS SERVICE PROVISION LAYER

Objective: Based on the outcomes from WP3000 (gap analysis), to analyze the impact of introducing E-GNSS in U-space in terms of service provision.

Activities done during the WP work:

- Review and analyze:
 - Commission Implementing Regulation (EU) 2021/664 of 22 April 2021 on a regulatory framework for the U-space.
 - Commission Implementing Regulation (EU) 2021/665 of 22 April 2021 amending Implementing Regulation (EU) 2017/373 as regards requirements for providers of air traffic management/air navigation services and other air traffic management network functions in the U-space airspace designated in controlled airspace.
 - Commission Implementing Regulation (EU) 2021/666 of 22 April 2021 amending Regulation (EU) No 923/2012 as regards requirements for manned aviation operating in U-space airspace.
 - Findings requiring further considerations have been shared with WP4100 and WP4300, feeding as well the next activity.
- Propose and consolidate a final Service Provision Layer Proposal (taking into account both 'open' and 'specific' categories) for E-GNSS covering aspects related to:
 - U-space Service Providers.
 - UAS equipment/system manufacturers.UAS Operators, and in special those relevant inputs from SORA depending on the operation to be performed, in particular for SORA#13.
 - GNSS Service facilitators.
 - ANSPs in the surrounding airspace and manned aviation.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.14. WP4300: STANDARDIZATION/REGULATION FRAMEWORK IMPACT ANALYSIS

Objective: analysis of the needed changes at standardisation/regulation level derived from WP4100 and WP4200 modifications at EGNSS provision side, together with the corresponding implementation roadmap.

Activities done during the WP work:

- Step 1: Review outcomes from previous tasks
- Step 2: Changes identification
 - linked to EGNSS standardisation/regulation (GMV)
 - linked to UAS standardisation/regulation (Everis)
- Step 3: Implementation plan
 - Propose corresponding implementation plan (high level) considering current status and expected evolutions.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.15. WP5100: DEFINITION AND DEVELOPMENT OF EGNSS API

Objective: The main goal of this sub-work package is the development of the EGNSS API, i.e. the specification, requirements definition, design, coding and verification of the software application that implements that API.

Activities done during the WP work:

- Update of D5.1 "EGNSS API requirements definition and specification" (v1.1 and v1.2)
- Update of D5.2 "EGNSS application module development" (v1.1 and v1.2), including the E-GNSS API SW data package (releases v1.0.1 and v1.0.2)
- Complete the development of emulators of a generic GNSS server and UTM tools for the verification of the E-GNSS API specifications using standalone tests
- Verification of the E-GNSS API specifications (with review and standalone tests)
- Update and delivery of D5.3 "EGNSS API Integration Test Plan, Test Specifications and Test Results" (v1.1) with the results of the E-GNSS API standalone tests

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.16. WP5200: INTEGRATION OF EGNSS API

Objective: The objective of this sub-work package is to validate the operational use of the developed EGNSS API

Activities done during the WP work:

- Adaptation of GMV's GNASSURE tool and UNIFLY's UTM operations management tool for their integration with the E-GNSS API
- Preparation and execution of the integration tests
- Update and delivery of D5.3 "EGNSS API Integration Test Plan, Test Specifications and Test Results" (v1.2) with the results of the E-GNSS API integration tests
- Preparation and delivery of D5.4 "EGNSS API Concept of Operations and User Manual" (v1.0)

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.17. WP6100: PROOF OF CONCEPT EXPERIMENTATION

Objective: to prepare and execute a flight trial as proof of concept to analyze and assess the performances of the proposed EGNSS service for U-Space by integrating the developed EGNSS API and demonstrate the added value of the service provision elements identified during the project.

Activities done during the WP work:

- Step 1: Preparation and consolidation of Experimentation Plan draft (D6.1), which was prepared and sent in advance (30/04/21) to the expected project schedule (T0+19m, former T0+16m, i.e., 29/06/21)
- Step 2: Flight trial execution in line with the experimentation test plan. Collection of the required data
- Step 3: Analysis of the benefits achieved thanks to the use of EGNSS API in the flight phases and test cases
- Step 4: Proof of concept flight trial report preparation, including analysis and recommendations

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.18. WP6200: EGNSS PERFORMANCE ANALYSIS

Objective: to analyse the data collected during the test flight from WP6100 to highlight the added value of EGNSS solutions with regard to GPS-only.

Activities done during the WP work:

- to process offline the positioning information recorded during the trial
- to compare EGNSS technologies (including GPS-only, requested in the TS) against the corresponding reference trajectory. Due to the limitations of the drones payload carriage (e.g. not enough space for separate antennas), no devoted trajectory assessment equipment can be embarked in the drone. Therefore, the reference trajectory will be computed using PPP (in batch mode) over the recorded solution during the flight.
- "EGNSS Performance analysis report" (SUGUS-D6.3) preparation, including analysis conclusions.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.19. WP6300: RISK AND SECURITY ANALYSIS

Objective:

- Conduct a risk analysis following the SORA methodology (or EASA standard scenario if it exists) of the mission defined for the proof of concept experimentation
- Assess how the new elements in the service provision layer developed under this project help to mitigate the risks or can simplify the authorisation process with the Member State Authority
- Analyse the positive impact on safety achieved thanks to security features implemented in Galileo

Activities done during the WP work:

- Review of the adequacy of the risk analysis to the current scenario
- Review and Identification of the operational safety objectives (OSOs) associated to the ConOps
- Development of comprehensive safety portfolio describing mitigations applied to reduce GRC, ARC, adjacent airspace considerations and OSOs with the required level of robustness.

Problems, limitations or unexpected points, if any, have arisen.

N/A

4.20. WP6400: COST AND BENEFIT ANALYSIS

Objective:

The objective is to develop a comprehensive model that captures the costs and benefits associated to implementing the EGNSS API as developed in the framework of this study. These costs and benefits will be carefully described and analyzed in order to obtain a meaningful economic impact stemming from its implementation.

Activities done during the WP work:

The Cost-benefit Analysis consists of 4 subtasks:

- 1. Identification of the value chain

The drone ecosystem has been investigated in order to as to identify the active actors and their stream of activities relevant for the creation of value in the drone and drone-related fields. This allows to identify and analyze industry business cases for the EGNSS API throughout the value chain. Four relevant stakeholders have been identified as relevant for the purposes of this analysis, namely drones manufacturers, U-Space service providers and ANSPs, UAS operators and pilots, as well as the Member States and wider society.

- 2. Development of the CBA Model

A Cost-Benefit Model is a commonly used analytical tool in policy-making decisions, given that a well-constructed model can give help building an informed, replicable and fact-based decision that assesses the attributable impacts.

The CBA of the API is structured along these general lines: quantifiable and qualitative benefits, estimation of costs of introducing the API and a financial and economic analysis of both for all stakeholder categories involved.

Applications in both the Open and specific drone categories are considered. Specifically, photography is the application considered in the open category, while agriculture, building inspection and parcel delivery are analyzed as part of the specific category.

The costs concerns the deployment, operating and maintenance costs of the API, considering 3 different possible API architecture, which would mainly affect the multiplication of ITC infrastructure and standardization needs.

The benefits are categorized by drone category, open and/or specific, by stakeholder (drones manufacturers, U-Space service providers and ANSPs, UAS operators and pilots, Member States and wider society). The benefits are quantified considering a single drone mission, and then multiplied by the expected number of drones operative for each of the considered application. The timeline spans from 2023 to 2035.

- 3. Financial and economic analysis

This subtask served to verify the financial sustainability for and interest of the key stakeholders identified in the value chain to implement the API. The benefits and costs that appear until 2035 has been discounted for in order to calculated the discounted net benefits and the Net Present Value. This has allowed to conclude that the benefits exceed the initial and recurrent costs.

The CBA analysis clearly highlights the fact that the overall financial and economic results for the implementation of the API will be positive. However, it is worth noting here that the extremely positive results are hardly comparable to studies focused on market quantification and overall growth of the drone market (e.g. SESAR outlook, 2016). In fact this study, rather than performing market quantification, focuses on the time saving linked to the introduction of the API. Benefits in term of time saving are monetized providing a quantification of what the different stakeholders might be able to save thanks to the deployment of the API. The results of the CBA are summarised in Table 6.

Architecture	Uptake scenario	Net Present Benefits						Costs	Net Present Value
		Open Category	Specific Category				Total benefits		
			Photography	Agriculture	Building inspection	Parcel delivery			
Architecture 1	Scenario 1: Mandatory uptake	€ 83.705.321	€ 3.995.319.057	€ 22.815.161.484	€ 856.407.222.492	€ 883.217.703.034	€ 883.301.408.355	€ 1.748.068	€ 883.299.660.287
	Scenario 2a Voluntary uptake - Optimistic: fast uptake	€ 56.418.750	€ 2.670.760.823	€ 15.377.166.321	€ 747.168.493.895	€ 765.216.421.039	€ 765.272.839.790		€ 765.271.091.722
	Scenario 2b Voluntary uptake - Realistic: regular uptake	€ 42.861.192	€ 2.029.072.378	€ 11.682.052.652	€ 580.639.197.054	€ 594.350.322.084	€ 594.393.183.275		€ 594.391.435.207
	Scenario 2c Voluntary uptake - Pessimistic: slow uptake	€ 20.613.439	€ 976.787.253	€ 5.618.933.651	€ 277.646.990.916	€ 284.242.711.820	€ 284.263.325.259		€ 284.261.577.191
Architecture 2	Scenario 1: Mandatory uptake	€ 83.705.321	€ 3.995.319.057	€ 22.815.161.484	€ 856.407.222.492	€ 883.217.703.034	€ 883.301.408.355	€ 2.641.195	€ 883.298.767.160
	Scenario 2a Voluntary uptake - Optimistic: fast uptake	€ 56.418.750	€ 2.670.760.823	€ 15.377.166.321	€ 747.168.493.895	€ 765.216.421.039	€ 765.272.839.790		€ 765.270.198.595
	Scenario 2b Voluntary uptake - Realistic: regular uptake	€ 42.861.192	€ 2.029.072.378	€ 11.682.052.652	€ 580.639.197.054	€ 594.350.322.084	€ 594.393.183.275		€ 594.390.542.081
	Scenario 2c Voluntary uptake - Pessimistic: slow uptake	€ 20.613.439	€ 976.787.253	€ 5.618.933.651	€ 277.646.990.916	€ 284.242.711.820	€ 284.263.325.259		€ 284.260.684.065
Architecture 3	Scenario 1: Mandatory uptake	€ 83.705.321	€ 3.995.319.057	€ 22.815.161.484	€ 856.407.222.492	€ 883.217.703.034	€ 883.301.408.355	€ 43.529.865	€ 883.257.878.490
	Scenario 2a Voluntary uptake - Optimistic: fast uptake	€ 56.418.750	€ 2.670.760.823	€ 15.377.166.321	€ 747.168.493.895	€ 765.216.421.039	€ 765.272.839.790		€ 765.229.309.925
	Scenario 2b Voluntary uptake - Realistic: regular uptake	€ 42.861.192	€ 2.029.072.378	€ 11.682.052.652	€ 580.639.197.054	€ 594.350.322.084	€ 594.393.183.275		€ 594.349.653.411
	Scenario 2c Voluntary uptake - Pessimistic: slow uptake	€ 20.613.439	€ 976.787.253	€ 5.618.933.651	€ 277.646.990.916	€ 284.242.711.820	€ 284.263.325.259		€ 284.219.795.395

Table 4-1: Summary table on overall results

• 4. Sensitivity analysis

As a general rule, a CBA Model introduces many variables, some of which influence the model itself (as regards hypothesis or construction) to a larger extend than other variables. By identifying such critical variables of the project, a sensitivity analysis can explain in more detail their financial/economic impact and its effect on the change of the NPV. Capturing the uncertainty of certain costs/benefit parameters in the business environment can lead to a more conscientious assessment of the readiness for future investments. The CBA model includes a Control Panel, which isolated key parameters that can serve to introduce variation in the underlying assumptions.

In addition, two uptake scenarios are considered, namely Scenario 1 foresees the mandatory uptake of the API form 2025 onwards, while Scenario 2 foresees a voluntary uptake of the API.

Problems, limitations or unexpected points:

During the quantification exercise, some limitation for the quantification of benefits emerged, forcing the team to either formulate conservative hypotheses, or switch some benefits form quantitative to qualitative. In particular, this is the case of the optimization of UAS route thanks to the API. In addition, the team was not in the position of monetizing some parts of some benefits, where the data available are not specific enough. This is the case of No Drone Zones (NDZ).The team identified a list of critical infrastructures that are common throughout Member States (government buildings, military zones, energy plants, etc.) but was not able to then quantify the potential cost of incursion into such zones or the cost of a collision, and, as a consequence, the benefit offered by the API as mitigating tool. As a way to overcome this difficulty, it was chosen to limit the analysis to airports with ATM services, for which there are available data on the perturbations caused by drones' intrusions.

In addition, the available data on the total addressable market for each of the four applications considered, namely the (expected) number of drones used in each of those, have been multiplied by the value of each benefit offered by the API for a single mission, allowing to reconstruct the full picture.

4.21. WP7100: AWARENESS AND DISSEMINATION

Objective: Dissemination of the progress and project outcomes within U-space community

Activities done during the WP work:

- Definition of contents to include in the website of the project. Hiring the website of the project for two years (<http://projectSUGUS.eu>). Updating these contents in the website that will be published.
- Update of the project website (<http://projectSUGUS.eu>) to include the announcement of the project survey
- Participation to following events:
 - **User Consultation Platform 2020 (GSA) in European Space Week** (7-11 December 2020, Bonn, Germany)
 - **EUROCAE WG-105 SG-62 Plenary Session**

Both events have been celebrated online, so the forecasted activity as exhibitors has not been performed.

- Update of the project website (<http://projectSUGUS.eu>) to include news about the project status or echo in the press or participation to events:
 - Publication of a news regarding the participation to EUROCAE WG 105 SG-62 Meeting.
 - Publication of a news regarding the acceptance of the paper on SUGUS project by the ION 2021 scientific Committee
 - Update of the state of the deliverables on the related website page. After an internal consultation regarding the possibility to publish on the web some delivered documents, it has been decided to wait for the end of the project
 - The possibility for the EC to maintain the site two years more after the final date of the project has been assessed
- Identify more potential events to participate, defining the best way to perform the dissemination action
 - The project has chosen, as target event to participate, the World ATM Congress 2021 (WAC) that will be celebrated in Madrid from 26 to 28 October 2021. Everis and GMV committed to participate to the congress to inform about the SUGUS project leveraging their participation logistic and effort
- Elaboration of the project video script. The video will be carried out and released by GMV close to the project end using images and clips shot during the trials in Villacarrillo.
- Perform an internal review to assess if any deliverable can be published before the end of the project.
- Preparation of the project video
- Elaboration of the project paper

Problems, limitations or unexpected points, if any, have arisen.

The COVID-19 disease has strongly or completely avoided the celebration of meetings and events, that have been transformed in online events, where the possibility to disseminate the project are fewer.

4.22. WP7200: INPUTS TO UAS STANDARDIZATION AND REGULATION

Objective: To provide valuable inputs to regulation under development (more specifically for the Specific category) thanks to the developments of the project

Activities done during the WP work:

- Attendance to EUROCAE WG105 SG62 meetings along the project execution and preparation of summary reports for the EC.
- Support to the GNSS Guidelines under preparation in EUROCAE WG105 SG62.
- Preparation & review of several versions of D7.1 deliverable
- U-Space Opinion Review, including:
 - Draft Regulation Summary
 - Impact on EGNSS services
- Analysis of the SC Light UAS, including:
 - Draft Regulation Summary
 - Impact on EGNSS services
- Organization of meeting with DACUS project to share project outcomes and look for synergies, and further iterations

Problems, limitations or unexpected points, if any, have arisen.

- N/A

5. MANAGEMENT STATUS

5.1. SCHEDULE STATUS

The next image shows the high level schedule for SUGUS project (KOM date: 19/12/2019), updated taking into account the 3 months extension of the project agreed with the EC.

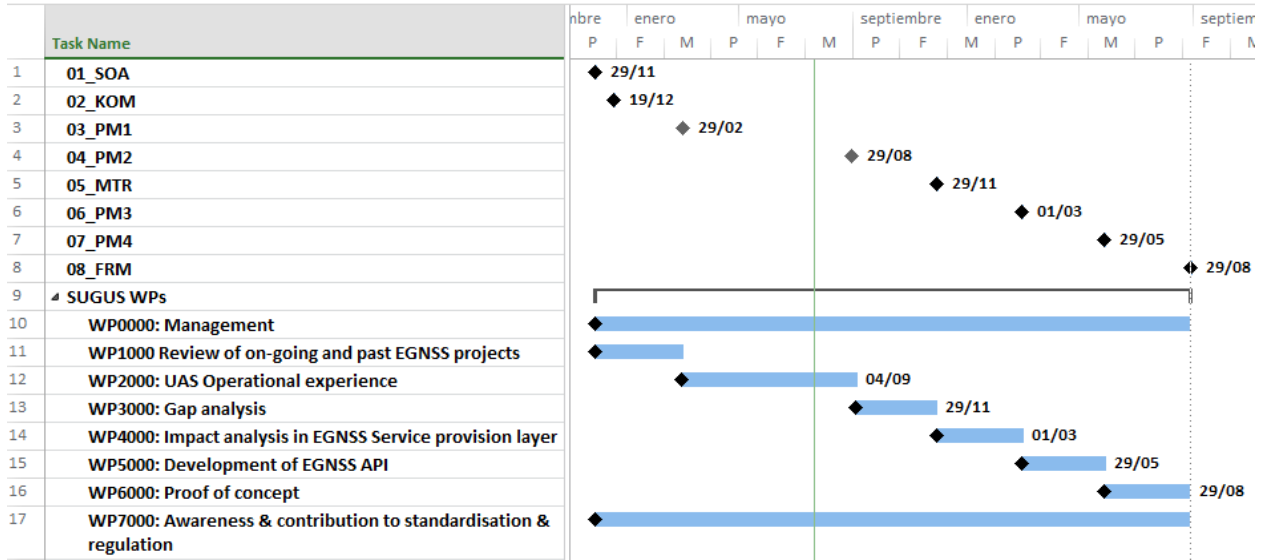


Figure 5-1: SUGUS updated schedule.

5.2. MEETINGS

Next table includes all SUGUS meetings held in the context of the project.

Milestone	Date	Place	Objective	Status	Remarks
SUGUS KOM	19/12/2019	Brussels	Project Kick of meeting	Closed	See [AD.4]
SUGUS PM1	12/03/2020	Teleconference	Progress Meeting 1	Closed	See [AD.5] & [AD.6]
SUGUS PM2	04/09/2020	Teleconference	Progress Meeting 2	Closed	See [AD.7]
SUGUS MTR	02/12/2020	Teleconference	Mid Term Review	Closed	See [AD.8]
SUGUS PM3	02/03/2021	Teleconference	Progress Meeting 3	Closed	See [AD.9]
SUGUS PM4	28/05/2021	Teleconference	Progress Meeting 4	Closed	See [AD.10]
SUGUS FRM	27/08/2021	Teleconference	Final review meeting	Closed	See [AD.12]

Table 5-1: Project meetings

Please note that the first meeting of SUGUS Advisory Board was successfully held on the 28th of October 2020 by teleconference, whereas the second meeting of SUGUS Advisory Board was successfully held on the 29th of June 2021, also by teleconference due to COVID issues.

5.3. TRAVEL PLAN

The next table shows the travel plan proposed for SUGUS project, as well as its status. Please note that the travel plan has been updated taking into account the 3 months extension of the project agreed with the EC.

WP	Meeting Nature	Meet ID	Date	Participants from						Location	Duration (days)	Status
				GMV (2)	Everis (2)	Unify	CATEC	VVA (1)	ESSP (2)			
WP0100	Kick Off Meeting	KOM	T0+15d	2	1	1	1	1	1	Brussels	1	Closed
WP0100 WP1000 WP2000 WP7000	Milestone/PM	PM1	T0+3m	1	1					Teleconf	1	Closed
WP0100 WP2000	Milestone/PM	PM2	T0+9m	2	1	1			1	Teleconf	1	Closed
WP0200	Advisory Board	AB1	T0+11m	1	1					Teleconf	1	Closed
WP0100 WP3000 WP7000	Milestone	MTR	T0+12m	2	1	1	1	1		Teleconf	1	Closed
WP0100 WP4000 WP5000 WP7000	Milestone/PM	PM3	T0+15m	1	1	1	1	1	1	Teleconf	1	Closed
WP0100 WP4000 WP5000 WP7000	Milestone/PM	PM4	T0+18m	2	1	1	1	1	1	Teleconf	1	Closed
WP0200	Advisory Board	AB2	T0+21m	1	1					Teleconf	1	Closed
WP0100 WP6000 WP7000	Milestone	FR	T0+21m	2	1	1	1	1	1	Teleconf	1	Closed
WP7000	Congress/awareness activities	FR+1m	T0+22m	1	1					Videconf	1	Open

Table 5-2 SUGUS travel plan.

- (1) For project meetings in Brussels, as long as VVA is located in Brussels travel budget is 0€ for VVA for travels to Brussels.
- (2) For project meetings in Madrid, as long as GMV, EVERIS and ESSP are located in Madrid travel budget is 0€ for these companies for travels to Madrid.
- (3) It is assumed that the second meeting with the Advisory Board (AB2) will take place in the same travel that the Final Review meeting.

5.4. DOCUMENT DELIVERY STATUS

See the Inventory list of all SUGUS deliverable for the different project milestones in [AD.11].

5.5. ACTION STATUS

All actions raised during SUGUS milestones have been closed. Next table shows the closing details of SUGUS actions:

Code	Description	Origin	Creation date	Closing date	Closing Description	Status	Action
SUGUS_KOM_Action_1	To identify projects/documents to be useful for the project and justify their added value for the project's objectives.	SUGUS KOM	2019.02.19	30.12.2019	Information gathered in an excel file and sent to the EC on the 30/12/2019	Closed	GMV
SUGUS_KOM_Action_2	To check how coordination with AESA/EASA will be performed through the project.	SUGUS KOM	2019.12.19	12.02.2020	Coordination discussed by email between GMV and the EC	Closed	EC, GMV
SUGUS_KOM_Action_3	To fix SUGUS meetings' dates to be held in Brussels 3 months in advance to the corresponding meeting.	SUGUS KOM	2019.12.19	22.04.2021	PM4 and FR invitations (Teams) already sent to attendees	Closed	EC, GMV
SUGUS_MR_0120_Action_1	GMV to prepare the press release of the start of the project.	SUGUS January MR	2020.01.28	06.02.2020	Draft prepared and sent to Everis	Closed	GMV
SUGUS_MR_0120_Action_2	EC to review the press release and publish in EC website.	SUGUS January MR	2020.01.28	14.02.2020	PR reviewed by the EC	Closed	EC
SUGUS_PM1_Action_1	To complete contractor's answers for JRC RIDs and send them to the EC. In case something is not clear for JRC, a teleconference will be organized to discuss them.	SUGUS PM1	2020.03.12	18.03.2020	Answers completed and sent to the EC in due time	Closed	GMV
SUGUS_PM1_Action_2	To internally check the need of including SpaceOpal in the Advisory Board to cover the service provision layer aspects.	SUGUS PM1	2020.03.12	20.03.2020	It was internally decided not to include SpaceOpal in the AB, these aspects are expected to be covered by ESSP & GMV	Closed	GMV
SUGUS_PM1_Action_3	To send the Press Release to the EC.	SUGUS PM1	2020.03.12	16.03.2020	PR sent to the EC in due time	Closed	GMV
SUGUS_PM1_Action_4	To analyze if the participation of any small drones company in the Advisory Board could provide a benefit and include them if necessary	SUGUS PM1	2020.03.12	26.06.2020	Potential participation was analysed and no significant benefit was identified	Closed	Everis /GMV

Code	Description	Origin	Creation date	Closing date	Closing Description	Status	Action
SUGUS_PM1_Action_5	To send an email after Eve to check Advisory Board availability to hold the first Advisory Board meeting during week 7-13 September.	SUGUS PM1	2020.03.12	13.07.2020	After several iterations, the preferred date for the first AB meeting is the 28 th October in Madrid.	Closed	Everis
SUGUS_PM1_Action_6	To publish the Press Release through the corresponding EC/GMV/Everis channels.	SUGUS PM1	2020.03.12	31.03.2020	PR published in due time	Closed	GMV
SUGUS_PM1_Action_7	To prepare and send to the EC a brief plan (by email is enough) to propose actions for future awareness activities (taking into account the changing COVID scenario).	SUGUS PM1	2020.03.12	19.03.2020	Invitation sent in due time	Closed	GMV
SUGUS_PM1Closeout_Act_1	To send an introductory text to the EC to be disseminated together with the survey.	SUGUS PM1 Closeout	2020.04.02	06.04.2020	Text sent to the EC in due time	Closed	GMV
SUGUS_PM1Closeout_Act_2	To disseminate the survey together with the introductory text through Unmanned Airspace.info.	SUGUS PM1 Closeout	2020.04.02	15.04.2020	Survey disseminated in due time	Closed	GMV
SUGUS_PM1Closeout_Act_3	To disseminate the survey together with the introductory text through EUROCAE, GSA, ASD-STAN and VS International.	SUGUS PM1 Closeout	2020.04.02	15.04.2020	Survey disseminated in due time	Closed	GMV
SUGUS_PM1Closeout_Act_4	To disseminate the survey together with the introductory text through GUTMA and ANSP association	SUGUS PM1 Closeout	2020.04.02	15.04.2020	Survey disseminated in due time	Closed	GMV
SUGUS_PM1Closeout_Act_5	To include in the conclusions section a table summarizing the benefits that EGNOS and Galileo can provide to the different U-Space services. The table will include a first column with the U-Space services, a second column with EGNOS benefits for each U-Space service, and a third column with Galileo benefits for each U-Space service	SUGUS PM1 Closeout	2020.04.02	08.04.2020	The table was included in the updated version of the deliverable	Closed	GMV
SUGUS_PM1Closeout_Act_6	To check with JRC if they agree on the implementation of their RIDs in the updated deliverables.	SUGUS PM1 Closeout	2020.04.02	06.04.2020	Implementation checked, no new comments on their side	Closed	GMV
SUGUS_PM1Closeout_Act_7	To prepare and send to the EC a brief plan (by email is enough) to propose actions for future awareness activities (taking into account the changing COVID scenario).	SUGUS PM1 Closeout	2020.04.02	15.04.2020	Awareness plan sent in due time	Closed	GMV

Code	Description	Origin	Creation date	Closing date	Closing Description	Status	Action
SUGUS_PM1Closeout_Act_8	To periodically monitor the need of asking for such delay in the development of project activities.	SUGUS PM1 Closeout	2020.04.02	27.05.2020	Delay officially requested to the EC by email on the 27/05/2020	Closed	GMV
SUGUS_PM2_Action_1	EC to provide to everis the EUROCAE contacts to try to involve some of them in the AB.	SUGUS PM2	2020-09-04	09.09.2020	Contacts provided to Everis by email in due date.	Closed	EC
SUGUS_PM2_Action_2	Everis to contact EUROCAE contacts to try to involve them in the AB.	SUGUS PM2	2020-09-04	16.09.2020	EUROCAE contacts contacted by Everis by email in due time	Closed	Everis
SUGUS_PM2_Action_3	Everis to analyze the possibility to ask for participation of some participant in EUROCAE WG105 SG62 in the AB.	SUGUS PM2	2020-09-04	26.06.2020	Potential participation was analysed and no significant benefit was identified	Closed	Everis
SUGUS_PM2_Action_4	Action 4 (EC): EC to contact the JRC to decide how to proceed with pending JRC 's PM2 RIDs.	SUGUS PM2	2020-09-04	16.09.2020	EC contacted JRC by email in due time	Closed	EC
SUGUS_PM2_Action_5	EC, GMV & everis to identify a set of critical points for which AB feedback during the first AB meeting is expected.	SUGUS PM2	2020-09-04	01.10.2020	Critical points already discussed and agreed between Everis, GMV and EC by email and teleconference	Closed	EC, Everis, GMV
SUGUS_PM2_Action_6	GMV to send to the EC, JRC, GSA and SUGUS consortium an invitation for SUGUS MTR meeting (30/11/2020).	SUGUS PM2	2020-09-04	23.09.2020	Invitation sent by GMV to all attendees in due time	Closed	GMV
SUGUS_MTR_Action_1	Everis to contact Carlos Hernández (WG62 chairman) to ask him on the expectations from SUGUS project on SUGUS presentation for WG-62 next meeting and on WG-62 expectations for SUGUS contribution to the guidelines.	SUGUS MTR	2020-12-02	22.12.2020	Email sent to Everis in due date.	Closed	Everis
SUGUS_MTR_Action_2	EC to internally check if there is any administrative issue for the proposed updated schedule.	SUGUS MTR	2020-12-02	09.09.2020	EC confirmed by email that there is no administrative issue for the proposed updated schedule.	Closed	EC
SUGUS_MTR_Action_3	Everis, GMV & EC to check the possibility of preparing an abstract for IONGNSS meeting in September 2021 and to analyze other potential contributions to dissemination activities.	SUGUS MTR	2020-12-02	27.01.2021	IONGNSS abstract already under preparation by GMV.	Closed	EC, Everis, GMV
SUGUS_MTR_Action_4	GMV & Everis to send to the EC the new version of D3.1 and D3.2 deliverables for MTR Close-out implementing MTR RIDs actions.	SUGUS MTR	2020-12-02	15.12.2020	Signed new version of MTR deliverables sent to the EC by email.	Closed	Everis, GMV

Code	Description	Origin	Creation date	Closing date	Closing Description	Status	Action
SUGUS_MTR_Action_5	GMV to send to the EC, JRC, GSA and SUGUS consortium an invitation for SUGUS PM4 meeting (02/03/2021).	SUGUS MTR	2020-12-02	14.09.2020	Invitation sent by email	Closed	GMV
SUGUS_PM3_Action_1	To send the Advisory Board an email on the status of the project (summarizing the main activities performed and the tasks to be performed in the following months) and to agree on a feasible date for the Board to meet.	SUGUS PM3	2021-03-02	27.05.2021	Email sent in due time. AB2 will be held on the 29th of June 2021.	Closed	Everis
SUGUS_PM3_Action_2	To internally discuss and inform SUGUS consortium on the deliverables to be able to be made public through SUGUS website, and inform GMV & Everis.	SUGUS PM3	2021-03-02	16.03.2021	No restriction was identified from EC	Closed	EC
SUGUS_PM3_Action_3	To periodically (1-2 times a month) propose to EC & GMV some information to be updated in the website on SUGUS activities [e.g. participation of SUGUS members in EUROCAE SGs, User consultation platform, or inform on other external events (e.g. USpace regulation update)], and to public it in the website after the agreement, and share it in 2-3 social media.	SUGUS PM3	2021-03-02	02.08.2021	SUGUS website is being periodically updated including relevant project outcomes (e.g. AB" meeting, trials execution,...)	Closed	Everis
SUGUS_PM3_Action_4	To internally check if it is feasible for both companies to prepare a video on the proof of concept.	SUGUS PM3	2021-03-02	13.04.2021	After internal check, it was agreed with the EC to prepare a video on SUGUS trial by GMV and Everis.	Closed	Everis ,GMV
SUGUS_PM3_Action_5	To internally check if it is feasible for both companies to organize a webinar.	SUGUS PM3	2021-03-02	13.04.2021	After internal check, and discussion with the EC, it was agreed to prepare a video on SUGUS trial and discard webinar option due to expected impact vs video option and effort needs.	Closed	Everis ,GMV
SUGUS_PM3_Action_6	to send to the EC the new version of PM3 deliverables, implementing PM3 RIDs actions (12/3/2021).	SUGUS PM3	2021-03-02	12.03.2021	PM3 close out deliverables sent to the EC by email in due time	Closed	GMV
SUGUS_PM3_Action_7	EC, GMV, Everis & CATEC: To check if it is feasible to organize in parallel the trials and the Advisory Board Meeting 2.	SUGUS PM3	2021-03-02	13.04.2021	Due to covid issues it is agreed with the EC to separate SUGUS trial from AB meeting 2.	Closed	EC, Everis ,GMV

Code	Description	Origin	Creation date	Closing date	Closing Description	Status	Action
SUGUS_PM3_Action_8	to send to the EC, JRC, GSA and SUGUS consortium an invitation for SUGUS PM4 meeting (28/05/21).	SUGUS PM3	2021-03-02	18.03.2021	Invitation (Teams) sent by email in due time	Closed	GMV
SUGUS_PM4_Action_1	to ask someone to be involved in the AB from SJU	SUGUS PM4	2021-05-27	21.06.2021	It was not finally feasible to involve any SJU member in AB2	Closed	Everis
SUGUS_PM4_Action_2	to include a small demonstration (live or video) of the API for AB2	SUGUS PM4	2021-05-27	13.08.2021	A video summarizing the main project outcomes have been included in SUGUS FR delivery	Closed	Everis & GMV
SUGUS_PM4_Action_3	to prepare a table summarizing the consortium view on pros/cons for considering the PFMS as a new U-Space service, to be used as input for AB2 discussion.	SUGUS PM4	2021-05-27	11.06.2021	Table prepared and included in the document to be shared with the AB to introduce the critical points discussions.	Closed	ESSP, Everis & GMV
SUGUS_PM4_Action_4	to check with JRC the availability of a receiver for recording OSNMA data.	SUGUS PM4	2021-05-27	06.07.2021	JRC receiver was not finally available for the SUGUS trials dates	Closed	EC
SUGUS_PM4_Action_5	to propose to the EC an intermediate milestone to check intermediate results with the EC.	SUGUS PM4	2021-05-27	01.06.2021	Agreed meeting date: Thursday 24th of June	Closed	VVA
SUGUS_PM4_Action_6	to send to the EC the text (statement) proposed to be said by the EC representative in SUGUS trial video.	SUGUS PM4	2021-05-27	15.07.2021	Text was discussed and agreed with the EC by email	Closed	Everis
SUGUS_PM4_Action_7	if finally a statement from an EC representative is agreed to be included in the video, to send to the EC the characteristics of the video to be potentially recorded by EC representative.	SUGUS PM4	2021-05-27	14.06.2021	The main characteristics of the video to be potentially recorded by EC representative were sent by email on the 14th of June.	Closed	GMV
SUGUS_PM4_Action_8	to analyse JARUS cybersecurity annex	SUGUS PM4	2021-05-27	11.06.2021	A new version of D7.1 including the requested analysis was sent to the EC by email on the 11th of June.	Closed	GMV

Table 5-3: SUGUS Actions.

6. CONTRACTUAL ASPECTS

- Status of Specific contract EC signature:
 - Already signed EC+GMV (29/11/2019)
 - Amendment for project duration extension signed EC+GMV (29/06/2020)
- Status of Specific Sub-contracts:
 - Everis: Already signed GMV+Everis (06/02/2020)
 - Unify: Already signed GMV+Unify (07/07/2020)
 - CATEC: Already signed GMV+CATEC (12/02/2019)
 - ESSP: Already signed GMV+ESSP (29/01/2020)
 - VVA: Already signed GMV+VVA (14/07/2020)

7. IDENTIFIED RISKS

The following table includes the risks identified in the project (all risks raised along SUGUS development have been closed):

Risk Id	Probability	Severity	Risk / Mitigation Actions	Status
SUGUS-RISK-001	Low	Low	<p>Difficulties in selection and coordination with relevant UAS stakeholders</p> <p>As different stakeholders will be involved in the project the coordination with those actors might be difficult. On the other hand, their proper involvement in the project activities could be difficult sometimes (due to for instance unexpected unavailability for specific reviews or meeting participation).</p> <p>As a mitigation action the consortium has already contacted with some key stakeholders in order to confirm their interest in the project and in participating in the Advisory Board to be created during the project.</p>	Closed
SUGUS-RISK-002	Low	Medium	<p>Proposed EGNSS U-Space service acceptance</p> <p>It is foreseen to propose an EGNSS U-Space service that makes use of different EGNSS components. It could happen that the concept is not accepted by the stakeholders.</p> <p>As a mitigation action it is proposed to involve the stakeholders in the definition of the SUGUS proposed solutions as part of the activities of the project. Two specific workshops are foreseen.</p> <p>The consortium and the Advisory Board considers key UAS stakeholders at different levels: U-Space service providers, drones manufacturers and operators, U-Space service providers, commercial applications, etc.</p> <p>SUGUS proposed concept for the new EGNSS U-Space service was approved by the AB during the first group meeting held in October 2020</p>	Closed
SUGUS-RISK-003	Low	Medium	<p>Non availability of data for the CBAs</p> <p>The CBA needs to be fed by information from different stakeholders. It could be difficult to obtain some specific information.</p> <p>As a mitigation action, the project foresees a sound methodology for the CBAs and the great experience of VVA in this kind of analyses guarantees the mitigation of this risk. Additionally, the working group will guarantee the best conditions to mitigate this risk. The stakeholders will be consulted to overcome any potential gap of information.</p>	Closed
SUGUS-RISK-004	Low	Medium	<p>Proof of concept experimentation</p> <p>Carrying out a flight trial with a drone for the Specific category may require many limitations on the location and the timing for the test execution.</p> <p>This risk has been mitigated in SUGUS by the inclusion of CATEC as a partner, so the trial can be carried out in a segregated airspace which will facilitate the administrative permissions for the field tests.</p> <p>A draft of the proposed Experimentation Plan has been prepared and sent to the EC in advance (30/04/2021) to the expected project schedule to consolidate the trials as soon as possible.</p>	Closed
SUGUS-RISK-005	Low	Low	<p>Consortium involving several partners</p> <p>In order to fulfil the wide range of selection criteria requested in this ITT, SUGUS consortium is made up of a significant number of partners in comparison with similar EC</p>	Closed

Risk Id	Probability	Severity	Risk / Mitigation Actions	Status
			<p>projects. GMV's management procedures have been key for the long experience managing different EC projects and this will facilitate this management task. In addition, GMV has already worked in many projects with many of the partners of the SUGUS proposal, which will for sure facilitate the execution of the project.</p>	
SUGUS-RISK-006	Low	Low	<p>Project delay at MTR One of the critical milestones of the project is the MTR at T0+9M, in which the gaps for the implementation of an EGNSS U-Space service are identified. This aspect is critical for the second phase of the project. Any delay at MTR approval could compromise and impose an overlap between Tasks 3 and 4. To avoid this risk, Task3 outcomes will start to be reviewed by Task 4 partners before the MTR approval in order to avoid delays in starting Task 4 activities.</p>	Closed
SUGUS-RISK-007	Low	Low	<p>Non availability in time of CFIs SUGUS project members have been involved in many of the projects linked to EGNSS and UAS aspects carried out in the last years, which will facilitate that this information can be available for the project if there are no confidential limitations to share this information for the purposes of SUGUS.</p>	Closed

Table 7-1: SUGUS Risks.

8. CONCLUSIONS AND RECOMMENDATIONS

Generally speaking, all expected SUGUS activities have been successfully performed during the project execution, and significant outcomes have been achieved in the different developed activities.

More specifically, the following overall conclusions and recommendations can be highlighted for the most relevant SUGUS activities:

CONCLUSIONS:

- With regard to the **Application Programming Interface (API)** developed as part of the project, the following overall conclusions are provided:
 - The E-GNSS API has proved to effectively bring operational benefits to USSPs, both in the pre-flight and execution phases of their drone missions, by providing USSPs with GNSS performances forecast data collected from external GNSS prediction servers.
 - The E-GNSS API design feature that allows USSPs to retrieve the GNSS performances forecast data in the form of 4D Non Drone Zones (NDZs), tailored to the specific operational requirements of each drone mission, proved to be a more flexible approach than the retrieval of GNSS forecast outages, for a pre-defined number of GNSS service levels, over a fixed horizontal grid (as it is today the case in the GPS/RAIM and GPS/EGNOS forecast services provided by Eurocontrol and ESSP, respectively).
 - The compatibility of the E-GNSS API data model (e.g. the 4D NDZs provided on output) with the data model of the Geofencing MOPS "UAS Geographical Zone" may enable USSPs to manage the "GNSS-driven" 4D NDZs as a specific type of geofences, and so facilitate their seamless integration and management in their operational tools and procedures.
- With regard to the Service Provision Scheme proposed in the project the most important conclusions are as follows:
 - The Service Provision Scheme together with the associated liability scheme involving all the key actors has been demonstrated to be feasible.
 - There is a clear and identified impact on the existing EGNSS provision aspects and programs, which is considered bearable and manageable. Some actions have been proposed in this sense.
 - The service associated to the use of EGNSS in drones should rely on one hand on the proposed Service Provision Scheme, and on the other on a standardized receiver to put on board the UAS. This should be affordable enough to ensure both acceptance and endorsement by the industry, proposing not-too-heavy standards to be implemented together with a feasible certification scheme.
 - Moreover these two pillars would enable safer operations and would help in complying with SORA requirements for the Specific category (in particular those coming from OSO#13) in a manageable way taking into account the size of the European drone market.
- With regard to the **Flight Trials**, the following overall conclusions are provided (further details can be found in D6.2 and D6.3 deliverables):
 - Main Identified Benefits of using SUGUS API for UAS operators, pilots and U-Space service providers:
 - It has been demonstrated the operability and the high versatility of the developed API tool for the management of UAS operations and their monitoring.
 - It has been demonstrated the potential risk of the operation if GNSS performances are not taken into account at planning and flying phase.

- It should be also noted that the current API tool creates an area around the proposed flight path to take into account potential flight control and navigation errors to validate the plan, key advantage for UAS pilots in real operations.
- API tool is able to take into account also safety coming from SORA, as the compulsory buffer to take into account for forbidden areas.
- The PFMS service allows to know the area affected and an estimated timeframe by the performance degradation. This allows the operator to re-plan the flight proposing an alternative route even on real time, with minimum operational impact.
- As the API tool is able to take into account also safety coming from SORA, as the compulsory buffer to take into account for forbidden areas, UTM service provides would evaluate much easier the safety risk of these buffer definition and therefore their workload to validate them would reduce significantly.
- It is a key advantage to U-Space Service Providers that the operator observe the NDZ in order to re-plan its operation on real time to avoid it.

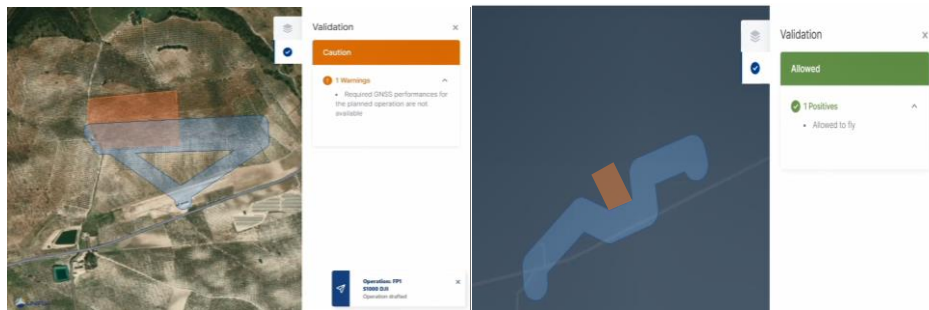


Figure 8-1: Example of rejected flight plan due to NDZ caused by GNSS performance degradation (left) and flight plan re-planning during flight phase due to presence of NDZ (right).

- EGNSS Performance Analysis:
 - In general terms the use of Galileo in dual constellation (GPS+Gal) significantly improves the performance achieved when considering only GPS satellites.
 - Generally speaking, Galileo alone is able to provide better performance than GPS alone, although Galileo constellation is partially deployed.
 - In general terms the introduction of EGNOS (SBAS) in single constellation (GPS) significantly improves the performance achieved when considering only GPS satellites or GPS+Galileo satellites.

As an example of the three aforementioned conclusions, please find below the vertical location error results for Flight Plan 1 (use case: precision agriculture) considering different GNSS combinations:

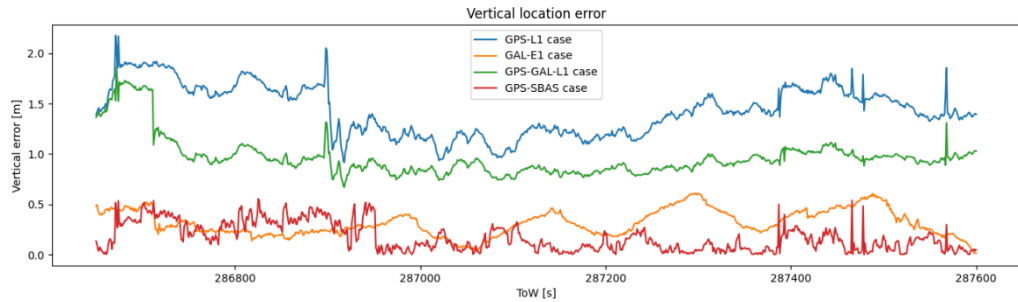


Figure 8-2: SUGUS Flight Plan 1: Vertical Error.

- No integrity events have been detected in all flights. It is also important to point out that EGNOS monitors GNSS core constellation faults and even in environments that do not comply with EGNOS assumptions it provides "system integrity", as well as the fact that the use of multiconstellation provides an additional robustness level to the achieved results. This last conclusions are very relevant for higher risk operations.

As an example of the integrity results, please find below the horizontal and vertical Protection Level results for Flight Plan 2 (use case: goods delivery), as well as the Safety Indexes for Flight Plan 1 when using GPS and EGNOS:

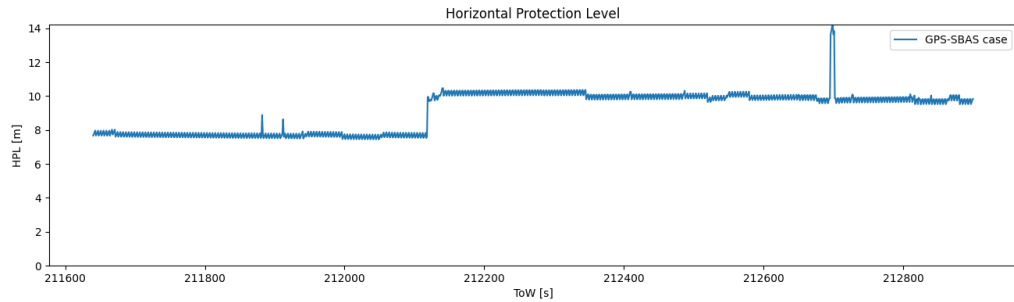


Figure 8-3: SUGUS Flight Plan 2: Horizontal Protection Levels.

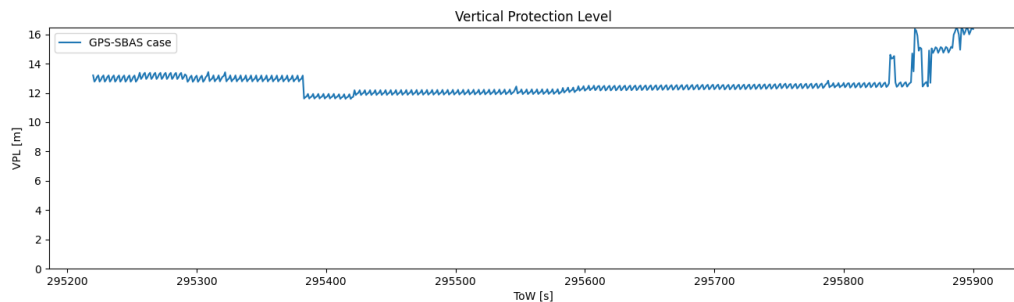


Figure 8-4: SUGUS Flight Plan 2: Vertical Protection Levels.

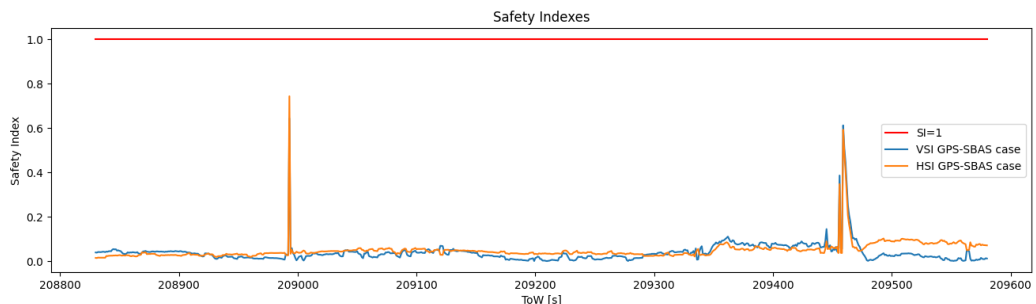


Figure 8-5: SUGUS Flight Plan 1: Safety Indexes.

- High attitude angles causes a loss of satellites visibility due to the UAS dynamics. The sudden turn of the vehicle in flight plan 1 shows that high roll angles obscure those under the antenna plane.
- With regard to the **Cost and Benefit Analysis**, the following overall conclusions are provided:
 - Total (for all the stakeholders) discounted costs for the period 2021-2035 range from less than a million to less than 36 million, depending of the API architecture.
 - Drone manufacturers and system developers, and UAS operators and pilots are net beneficiaries, since they will not bear any cost associated to the API.
 - At the time of writing, agriculture is the biggest current addressable market, while parcel delivery is expected to boom in the next decade.

RECOMMENDATIONS:

- With regard to the **Application Programming Interface (API)** developed as part of the project, the following recommendations are provided:

- The E-GNSS API design includes some features, in particular the capability to address the impact of the local environment (e.g. terrain, obstacles) on the GNSS performances that should be further explored, specifically to support BVLOS operations in urban environment. It is worth recalling that a pre-requisite for the operational use of this E-GNSS API design feature is the availability of E-GNSS forecast services (e.g. for GPS/EGNOS) that also address those local environment effects, which is not the case today. In other words, to better support BVLOS operations in urban environment, further research on E-GNSS forecast services that addresses local environment effects together with the use of the E-GNSS API should be promoted.
 - The E-GNSS API could be evolved to implement some new design features identified in the project (e.g. to identify the NANU/NAGUs causing a GNSS performances degradation, to report GNSS jamming and spoofing interferences).
 - The E-GNSS API could be used not only to support USSPs, but also to support some of the U-Space services identified in the CORUS ConOps, in particular the "Navigation Infrastructure monitoring", the "Electromagnetic interference information" and the "Navigation Coverage information", which, in turn, may support other U-Space services, such as the strategic and tactical conflict management (e.g. the Dynamic Capacity Management function of the DACUS project).
- With regard to the Service Provision Scheme proposed in the project the most important recommendations are as follows:
 - The proposal relies on the added value of EGNSS for drone operations. It must be recognized that EGNSS is not able to equally contribute to all kind of drone operations (e.g. navigation within urban canyons), but it is clear as well that EGNSS can enhance existing provisions using an improve positioning as a basis (e.g. U-space services). It is recommended to perform a deep assessment on the added value of GNSS for UAS, covering as much aspects and perspectives as possible.
 - To support the bullet above or as a complementary one, a GNSS positioning performance assessment at user level is recommended to clearly identify what can be expected from GNSS positioning and where it should be further explore how to improve GNSS to be used in more demanding applications. Moreover this would help in defining the service.
 - Finally, it is highly recommended in developing anything related to the use of GNSS in drones to keep in mind the target users (UAS operators), which normally are companies not as powerful as the manned aviation ones. This would lead to develop easy to understand documentation, oriented to users which do not have necessarily the time or available effort to manage complex concepts such as the ones related to GNSS. Making this easy for them would guarantee the service embracement.
 - With regard to the **Flight Trials**, the following recommendations are provided (further details can be found in D6.2 and D6.3 deliverables):
 - It is recommended to keep working into the API tool development, in order to introduce evolutions to enhance its operational added value.
 - It is recommended to develop some operational procedures to re-plan flights on real time, when a NDZ is unexpectedly created by any reason with the minimum impact to the UAS operation.
 - EGNSS Performance Analysis:
 - It is recommended to take into account that the UAV's dynamics obscure the satellites located below the antenna plane and could have a great impact in the satellite visibility and therefore in the GNSS performances.
 - It is recommended to keep a safety buffer that takes into account positioning performances, among other parameters such as the UAV maneuverability, local

wind, etc., to not to infringe the NDZ. This buffer size may be based on a potential Alarm Limit the operator should comply with.

- It is recommended to assess carefully the selection of double frequency solutions, since the improvement of the ionospheric error removal could be not enough to overcome the increased noise and multipath error under some environments.

END OF DOCUMENT