

EGNOS use in unmanned vehicles (EUGENE project)

Dublin, 14th March 2024

EGNOS Workshop 2024

Project Introduction

- **EUGENE:** EGNSS Service for Unmanned Aviation (DEFIS/2021/OP/0007)
- **Objective:** The aim of EUGENE is to address phase 2 “**medium risk operations**” of EC/GSA “High-Level Strategy for the introduction of an EGNSS Service for Unmanned Aviation”, which are traced to 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.

- **Consortium**



- **Stakeholders:** 5 USSP/ CIS, 2 UAS Operator, 4 CAA/NSA, Eurocontrol, ...
 - 1 official support letter from AESA (Spanish NSA)

Service Requirements Analysis (1/4)

- **Identification and justification of user needs → E-GNSS service requirements**
 - Based on the *analysis of Regulation* (initial U2 services to support BVLOS with minimal CNS)
 - EU 2019/945
 - EU 2019/947
 - EU 2021/664
 - EASA NPA 2021-14
 - EASA AMC & GM to 2019-947 amendment 1
 - Supported by other sources (future U-Space services, UAS operations, E-GNSS SiS)
 - EC Roadmap for a EGNSS service for the unmanned aviation (up to 2035)
 - EUROCAE guidelines for the use of multi-GNSS solutions for low risk operations (ED-301)
 - CORUS and CORUS-X-UAM projects (CORUS ConOps ed4)
 - Traced-back to the findings of the SUGUS Project (746/PP/GRO/RCH/19/11305)
- **Key assumptions**
 - Need of an “approved” E-GNSS receiver for UAS
 - Use of current and planned OS & SoL E-GNSS SiS (i.e. no new E-GNSS system evolution)
 - Able to provide positioning integrity in *some* degraded (e.g. obstacle rich) local conditions

Service Requirements Analysis (2/4)

- **Main findings**

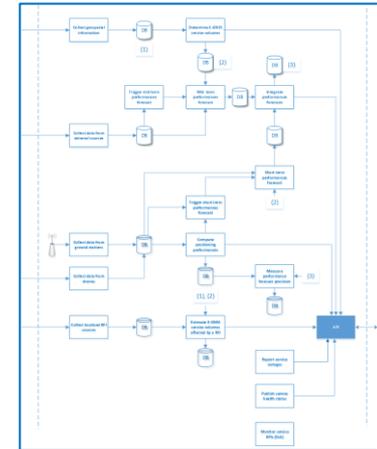
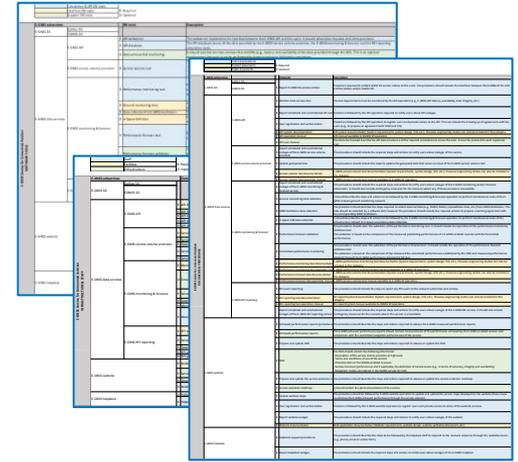
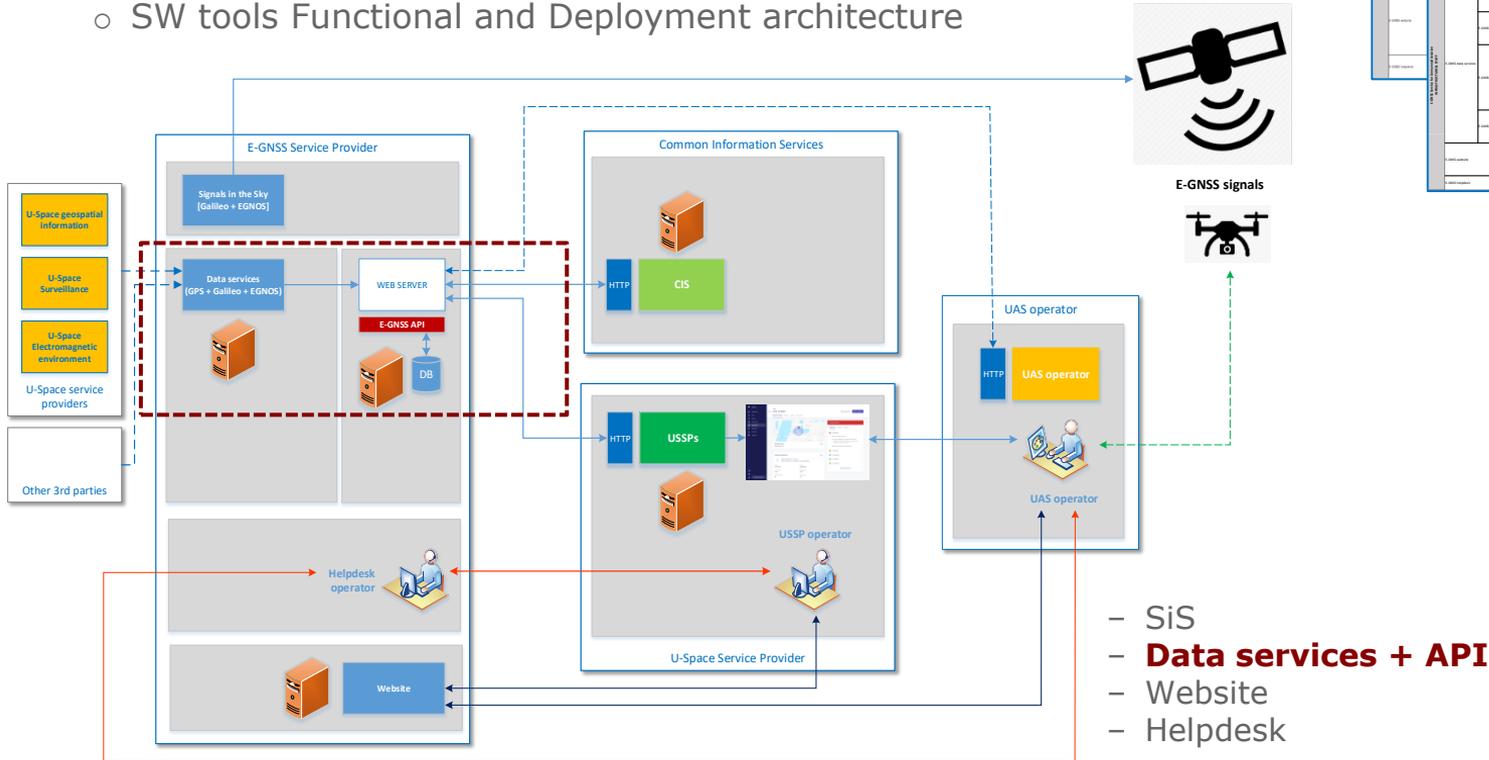
- AMC (SORA) does not address operational risk due to mid-air collisions
 - UAS trajectories de-confliction (main goal of U-Space services) has no effect on operational risk, and so
 - Low risk BVLOS operations are feasible (i.e. BVLOS \neq medium risk)
 - Need of U-Space airspace (and services) is not a must (i.e. medium risk \neq U-Space airspace)
- Need for position integrity to support medium risk operations undefined (e.g. ED-301, ED-269)
 - Direct references to accuracy (NSE (95%) and TSE (95%)) to determine separation minima
 - Indirect references to integrity (integrity risk of $1-10^{-2}/FH$) to estimate upper bounds to position accuracy
 - Qualitative rather than quantitative (e.g. FTAs) operational risk assessment in AMC (SORA)
- Minimum positioning performances service levels to support medium risk operations undefined
 - But recent UCP report (23/09/22) identifies performance requirements for SAIL III and IV operations

- **User needs (E-GNSS receiver, USSP, CIS, UAS operators, ...)**

- E-GNSS SiS providing the required positioning performances service levels
- E-GNSS “approved” receiver enabling the downlink of position reports (with current performances)
- Achievable positioning performances (to comply with OSO #13, support airspace risk assessment, ...)
 - Minimum performances (under some worst-case assumptions) in the service volume \rightarrow SDD
 - Nominal (measured statistics) and forecasted (with actual/planned conditions) performances
 - Impact of detected E-GNSS SiS vulnerabilities (RFIs) on performances

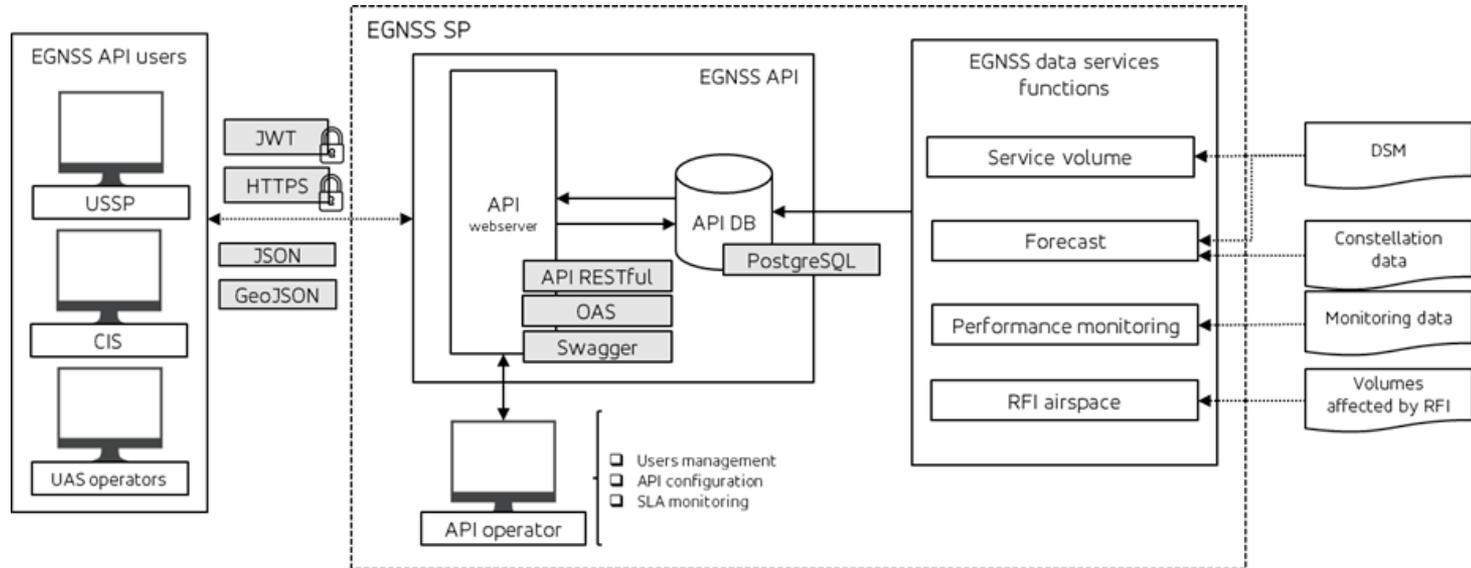
Service Requirements Analysis (3/4)

- **E-GNSS service for unmanned aviation**
 - Service Requirements (+ open issues) and Service Tree
 - SW tools Functional and Deployment architecture



Service Requirements Analysis (4/4)

- **An API will provide E-GNSS data services to end users (USSP, CIS, UAS operators)**
 - Service requirements → API use cases → API functional & non-functional requirements
 - API design consistent with standards (ED-269, data model) & regulation (AMC, data format)



User Segment Approach

Is it needed an standard (or common rules) for a E-GNSS receiver equipment?

- Ease compliance of SC L-UAS
- U-Space services and positioning requirements
- Compliance of SORA (OSO#13) & Liability scheme of E-GNSS Service for UAS

Which type of “approval” would be required for medium risk operations?

- Conformity Assessment → Open category.
- ETSO/TSO → High-risk and Certified category.
- **SC L-UAS → Medium risk operations (SAIL III & IV).**

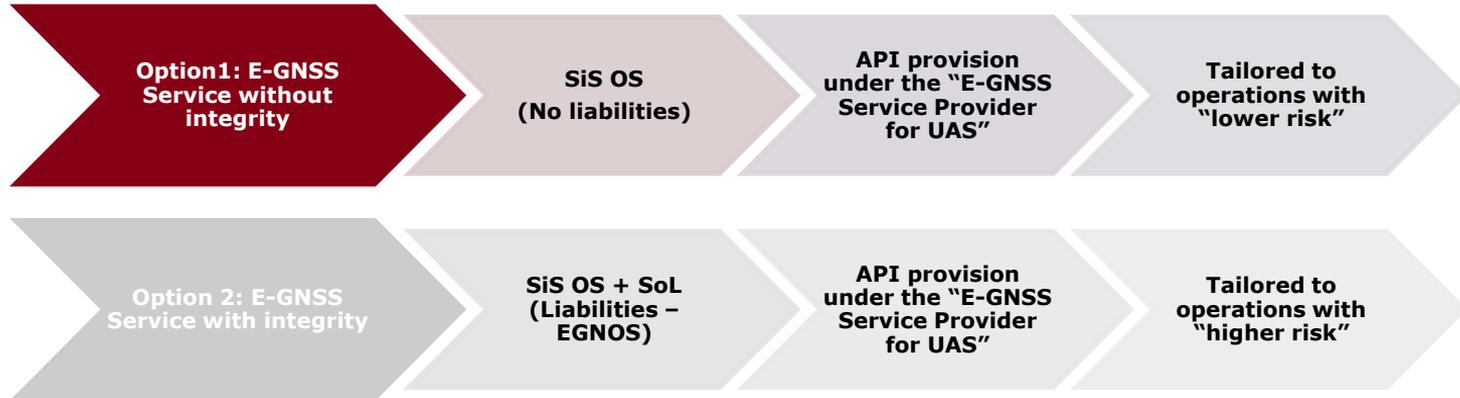
MoC for SC L-UAS:

- **MoC not based in a standard for SAIL III operations (FTB / design review) → E-GNSS Service without integrity (Option 1) → no SiS liabilities.**
- **MoC based in a standard (to be developed) for SAIL IV operations → E-GNSS Service with integrity (Option 2) → SiS liabilities.**

Service Provision Model (1/2)

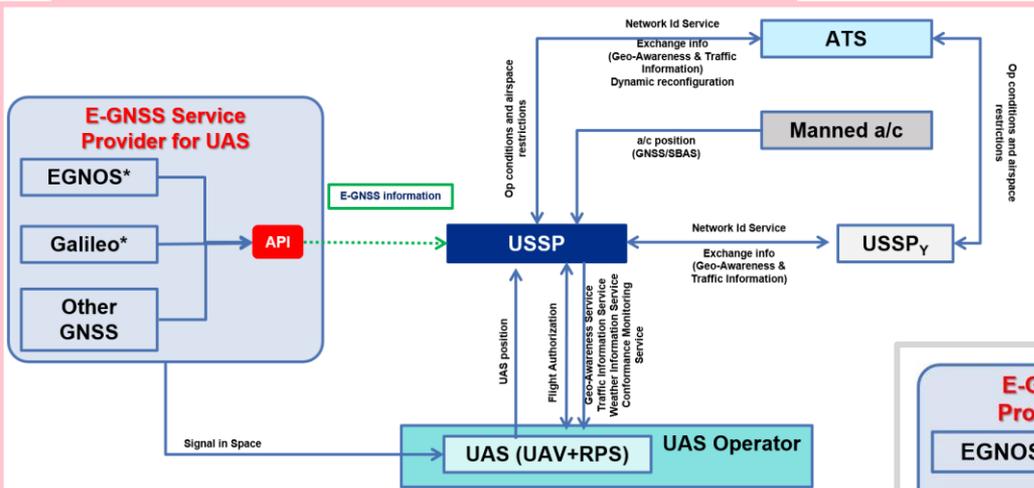
Medium risk operations (SAIL III & IV) → within/outside U-space airspace

New "E-GNSS Service for UAS" → E-GNSS SiS+E-GNSS API+(Website & Helpdesk):



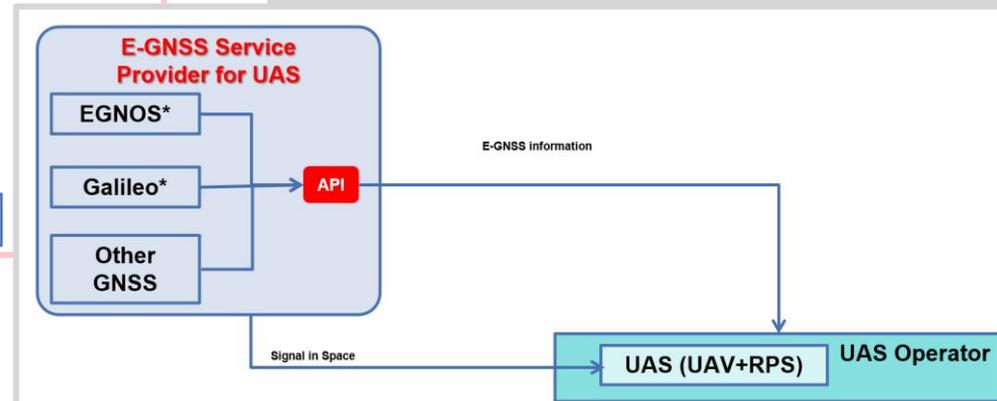
Service Provision Model (2/2)

WITHIN U-SPACE AIRSPACE



* Coordination between E-GNSS Service Provider for UAS and GNSS Service Facilitator is expected to share relevant information and ensure the provision of the service (TBD).

OUTSIDE U-SPACE AIRSPACE



* Coordination between E-GNSS Service Provider for UAS and GNSS Service Facilitator is expected to share relevant information and ensure the provision of the service (TBD).

Cost-Benefit Analysis

- **CBA for two complementary decisions**

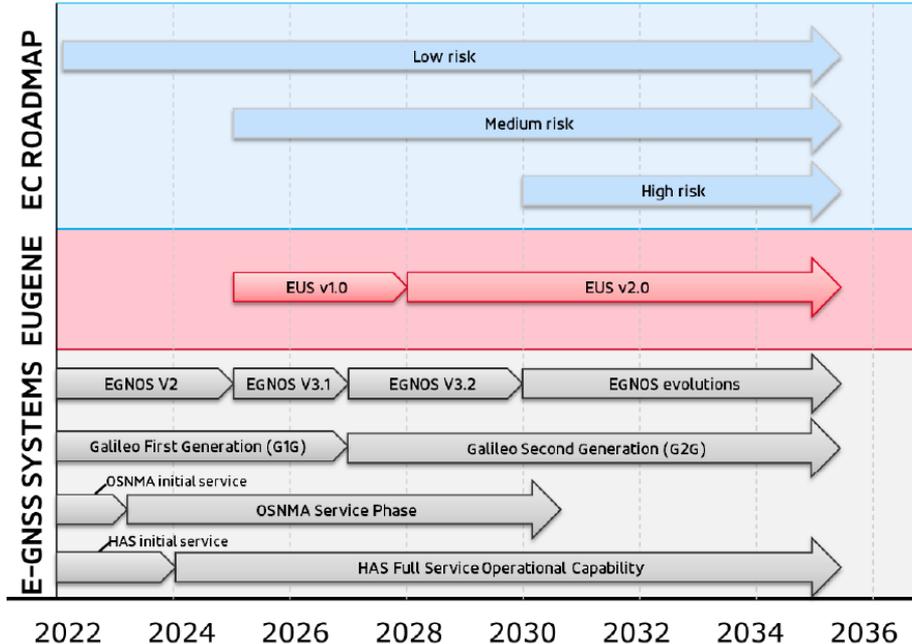
- Development of a E-GNSS service for unmaned aviation (medium risk operations)
 - Minimum required functional scope and supported navigation modes
 - Some potential costs difficult to assess are not considered (e.g. liability costs)
 - Several scenarios analysed (API deployment; OS vs SoL services, U-Space airspace)
 - Deployment of two E-GNSS service releases (in 2025 and 2028)
- Method of “Approval” of E-GNSS enabled receivers for UAS
 - 3 scenarios analysed: MoC, Conformity Assessment, TSO/ETSO

- **Main results (CBA assesed over the 2023-35 period)**

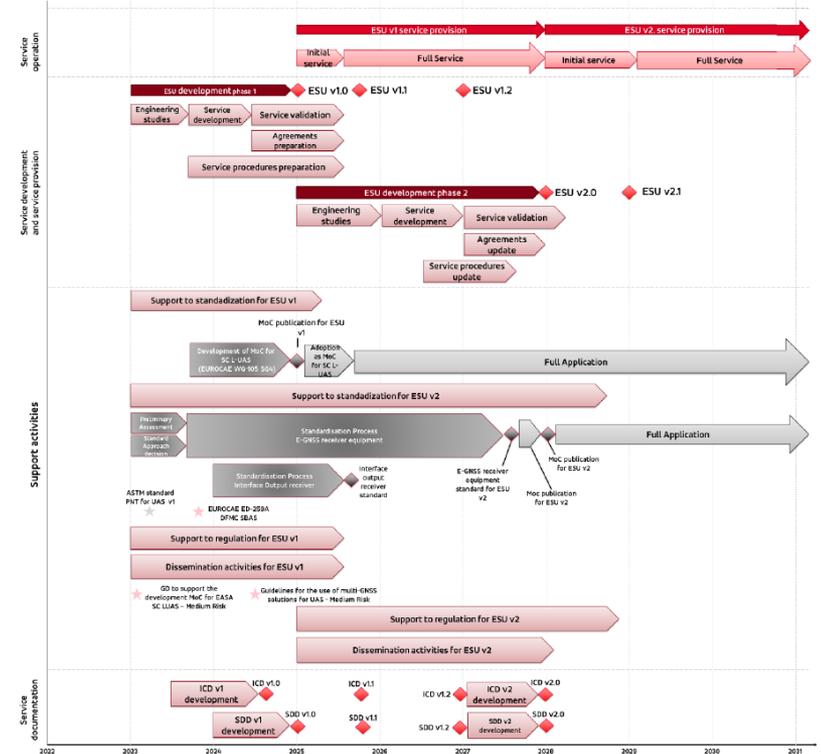
- Development of a E-GNSS service for unmaned aviation (medium risk operations)
 - Highly Positive NPV to all stakeholders
 - Centralized API deployment* minimizes total cost and provides best NPV
- Method of “Approval” of E-GNSS enabled receivers for UAS
 - Positive NPV to all stakeholders (except for *Members States and society* because benefits derived from UAS operations safety improvement have not been quantified)

Implementation Roadmap

- **High-level roadmap for ESU**
 - v1 (OS, no liabilities, SAIL III)
 - v2 (services included in v1 + SoL including EGNOS V3, liabilities, SAIL IV)



- **Implementation plan (EUS v1, v2)**



Conclusions and recommendations

- A E-GNSS service for unmanned aviation is justified to help stakeholders in meeting their needs, particularly in complying with Regulation (current and expected)
- 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

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Thank you

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