EGNOS V3 Phases C/D - Summary Statement of Work

Prepared by
EGNOS Project Office

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## APPROVAL

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## CHANGE LOG

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1 INTRODUCTION

1.1 Scope of the Document

The purpose of this Summary Statement of Work is to provide at this first stage of the procurement process an indication of the scope and complexity of the EGNOS V3 activities and responsibilities.

The contents of this document should provide the Candidate with a first understanding of the EGNOS system and its services, the challenges of implementing the new Dual Frequency (L1/L5) Multi-Constellation (GPS+Galileo) augmentation, a high level overview of the work to be undertaken, the development logic and indicative master schedule.

Detailed system requirements will be provided to the selected Candidates during the next step of the procurement process. At this stage, some key requirements considered important for the organisation of the Candidate industrial team have been included in this document.

1.2 Background – EGNOS V2 services

The European Geostationary Navigation Overlay Service (EGNOS), Europe's contribution to global navigation satellite systems, is currently in its service provision phase under the responsibility of the European GNSS Agency (GSA). EGNOS provides an augmentation service to the Global Positioning System (GPS) Standard Positioning Service (SPS). EGNOS V2 augments GPS using the L1 (1575.42 MHz) Coarse/Acquisition (C/A) civilian signal function by increasing the accuracy of existing GPS satellites while providing a crucial 'integrity message', informing users in the event of signal problems.

EGNOS V2 is providing three services, free of charge to the users:

- The EGNOS Safety of Life (SoL) Service: It is aimed at users for whom safety is essential; this service fulfils in particular the requirements of certain sectors for continuity, availability and accuracy and includes an integrity message alerting the user to any failure in, or out-of-tolerance signals from, systems augmented by the EGNOS system over the Coverage Area.

- The EGNOS Open Service (OS): It provides positioning and synchronisation information intended mainly for high-volume satellite navigation applications in the area covered by the EGNOS system.

- The EGNOS Data Access Service (EDAS): It aims at offering commercial data dissemination to promote the development of applications for professional or commercial use by means of improved performance and data with greater added value than those obtained through its open service.
EGNOS V2 message is broadcast to the users through navigation payloads on board 2 GEO satellites (for redundancy purpose) covering each an area which comprises latitudes from 20°N to 70°N and longitudes from 40°W to 40°E. Nominally, a third GEO payload is used for Test purpose (EGNOS-Test partition) and can be used in Operation (EGNOS-OP partition) in case one of the two GEO payloads used in EGNOS-OP needs to be replaced or moved to EGNOS-Test. This third GEO payload is also called “In-orbit spare”. These payloads relay the Satellite Based Augmentation System (SBAS) signals generated on ground, allowing the users to benefit from the augmented positioning accuracy and integrity.

1.3 EGNOS V3 presentation

EGNOS V3 is the second generation of the EGNOS System. The System Architecture and technologies will evolve to face major changes on the Space Segment with the new generation of GPS satellites with new frequencies in the coming decade. In particular, the arrival of a second protected frequency (L5) will allow to offer to the dual frequency safety of life users a more robust and accurate vertical guidance service (increased robustness with respect to the Ionosphere).

In addition, with the deployment of Galileo and the introduction of new capabilities in GPS, EGNOS V3 will offer improved Safety of Life (SoL) services to Civil Aviation community and potentially new applications for Maritime or Land users, thus consolidating EGNOS position as one of the leading edge GNSS Systems in the future.

The formal European Commission decision adopting the new mission objectives is the Commission Implementing Decision (EU) 2015/1183 of 17 July 2015 [RD-1], setting out the necessary technical and operational specifications for implementing version 3 of the EGNOS system.

The EGNOS V3 Implementation is also aiming at improving the overall robustness of EGNOS services against increasing security risks, in particular cyber-security risks.

The EGNOS V3 phase C/D, object of this procurement, is managed by ESA under the GSA EGNOS Exploitation Programme. It inherits from the study phases done under the ESA EGEP programme and is based on the consolidated technical specifications emanating from the PDR.
1.4 EGNOS V3 system architecture

The purpose of EGNOS V3 is to implement a system that fulfils a range of user services requirements by means of an overlay augmentation to GPS and Galileo, based on the broadcasting through GEO satellites over two channels (the first one in L1 frequency band (Legacy Service) and the second in L5 frequency band (for the new DFMC services)) of GPS-like navigation signals containing integrity and differential corrections information applicable to the navigation signals of the GPS satellites, Galileo satellites and the EGNOS GEO satellites themselves. As a result, the EGNOS V3 system can provide integrity positioning with Safety-of-Life (SoL) quality that allows it to address needs of all modes of transport, including civil-aviation. The EGNOS covers primarily the ECAC region complementarily to other augmentation systems initiatives (such as WAAS in US) but extensions are being investigated to cover other adjacent regions.

![Figure 1: EGNOS V3 Functional Architecture](image-url)
The EGNOS V3 ground segment (illustrated in Figure 1) is responsible for the computation of the integrity measurements and wide area differential corrections. To this purpose, a network of Ranging and Integrity Monitoring Stations (RIMS) will be deployed over the European Union territories (and for some of them worldwide) to collect the GPS, Galileo and EGNOS GEO raw pseudo-range measurements. The network of RIMS will be connected to two Mission Control Centres (MCCs) (of which one is master) where the integrity, differential corrections, ionospheric delays will be computed by the Central Processing Facility (CPF). This information will be sent in a message to the Navigation Land Earth Stations (NLES) to be uplinked in GPS-like signals (following the SBAS signal specification as defined in [RD-2], [RD-3], [RD-4] to the space segment (two GEO satellites). The GEO satellites will broadcast transparently the SBAS signals on the GPS L1 (1575.42 MHz) and L5 (1176.45 MHz) frequencies.

2 REFERENCE DOCUMENTS

RD-1 Commission Implementing Decision (EU) 2015/1183 of 17 July 2015, setting out the necessary technical and operational specifications for implementing version 3 of the EGNOS system

RD-2 ICAO SARPS Annex 10, including up to (up to approval of draft report to Council of amendment 90 (Item No. 20106)) (publicly available)

RD-3 MOPS for Global Positioning System/ Wide Area Augmentation System Airborne Equipment, RTCA/Do-229D, Change 1, February 2013 (publicly available)

RD-4 SBAS L5 DFMC ICD dated 13/04/2015 (will be delivered in Phase 1.b as part of the Tender Specifications)
3 OVERVIEW OF THE WORK TO BE PERFORMED

The Contractor will be asked to develop a detailed work breakdown covering as a minimum the following high level tasks:

- Project Management
- System Engineering
- Security
- Product Assurance and Safety
- Development, Deployment and System, Qualification
- System Test Platforms
- Interface & coordination with the Service Provider
- Support activities
- Optional activities

The following first level task breakdown chart is indicative.
The perimeter of the EGNOS V3 Phase C/D procurement will be to request from the Candidate the following baseline and options:

3.1 Baseline activities

1. EGNOS V3.1 design, development and qualification
   This includes all the design, development and qualification activities necessary for the delivery of the first EGNOS V3 qualified System version (V3.1), including ground communication network.

   This System release will be robust to the GPS L2P(Y) decommissioning and will provide the legacy service:
   - Over EU28 plus Norway and Switzerland based on GPS measurements
   - Over EU28 plus Norway and Switzerland, with improved robustness against disturbed ionosphere (e.g. benefitting from the additional use of Galileo measurements for the ionosphere parameters estimation)

   This System release will also include expandability capabilities.
2. **EGNOS V3.2 design, development and qualification**

This includes all the design, development and qualification activities necessary at Industry for the delivery of the second EGNOS V3 qualified System version (V3.2), including ground communication network.

This System release will replace V3.1, and will provide the legacy service over:
- EU28 plus Norway and Switzerland;
- EU28 plus Norway and Switzerland, with improved robustness against disturbed ionosphere;

and will provide, in addition, the dual frequency services consisting of GPS L1/L5 and GPS + Galileo Dual Frequency (L1/L5) services over EU28 plus Norway and Switzerland;

The V3.2 release will include design, development and qualification activities necessary for the inclusion of the Maritime requirements in the System design.

This System release will also include expandability capabilities1.

3. **EGNOS V3 System Performance Verification Platform**

It consists of the System Performance Verification Platform that will be necessary for Industry to develop, validate and qualify the V3.1 and V3.2 System releases; this platform will be used by Industry for:
- Algorithms development and testing
- Galileo-only fall-back mode algorithms modelling and testing
- System end-to-end simulations (including possibly User part)
- System performance verification and qualification

The System performance verification platform will include:
- Capability to process simulated or real data (either from V3 RIMS or from external stations)
- Initial broadcast capability either through GEO or other means (e.g. EDAS), and use of this broadcast for end-to-end testing (possibly including User receiver)
- Play and replay capabilities as well as all tools necessary for performance analysis

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1 Expandability capability means that some design provision are embedded in the baseline System design in order to limit the impacts if expandability missions would have to be implemented
4. Supporting activities

This includes support activities, on top of the V3.1 and V3.2 design, development and qualification activities, covering the following fields:

- Phase A/B study on an independent Security Management & Monitoring Concept, resulting in assessment of the impact in the design, development and validation plan for implementation in V3.2.

- Support to the V3 Service Provider, training, support to operations elaboration, support to the V2 to V3 migration.

- Assistance to ESA work packages. A provision will be made to cover industry technical assistance to ESA, e.g. for complementary studies. Dedicated work packages will be created to define precise activities when the need arises.

3.2 Optional activities

The following options will be included in the procurement:

1. Design development and qualification of the service area extension over Ukraine (SF and DF services);

2. Design, development and qualification of the service area extension over ENP South (i.e. Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine, Syria, Tunisia) (SF and DF services);

3. Delivery of additional recurrent units and (if needed) spare boards, for each sub system type;

4. Software/Hardware maintenance;

3.3 Development logic and master schedule

The EGNOS V3 development logic is depicted in the following figure with indicative dates for the mains steps.
The EGNOS V3 System development will be realised in two steps:

1. Development and Qualification of EGNOS V3 System release V3.1 that will be providing the L1 Legacy services (replacing the current EGNOS V2 system after Hand Over to the GSA of the System release V3.1 and migration to be operated and managed by the EGNOS Service Provider under GSA contract); The V3.1 QR & AR milestone should not occur later than KO date + 5 years.

2. Development and Qualification of EGNOS V3 System release V3.2 that will be providing the full set of services (after Hand Over to the GSA and entry into service operated by the EGNOS Service Provider under GSA contract):
   - L1 Legacy services;
   - Dual frequency (L1/L5), mono (GPS) and dual constellation (GPS/Galileo) services;

The V3.2 QR & AR milestone should not occur later than KO date + 6.5 years.

After the Hand Over of the V3.2 system release by ESA to the GSA, the EGNOS V3 System maintenance (HW & SW) will be performed by the EGNOS Service Provider under a dedicated GSA contract.
The IKP1 milestone shall be planned after the completion of Sub-Systems PDRs and before the Sub-systems CDRs. The main purpose is to consolidate the System Technical baseline, compared to the dossiers presented in the proposal.

The DFMC Standard Key Point is a milestone introduced between KOM + 24 months (at the earliest) and CDR-1 minus 6 months (at the latest), during the Development of EGNOS V3 to baseline some of the applicable technical requirement documents which were still including assumptions at KOM (linked to the DFMC Standard and linked to Galileo OS performance and associated failure modes). Final versions of some of the applicable technical documents will then be provided to the Contractor by this milestone.

The IKP2 main purpose is to confirm the Technical baseline for V3.2 Design and Development, compared to the dossiers presented in the proposal and at CDR-1:

In addition to the Development of these two EV3 system releases, four main platforms will be developed as part of the baseline work.

- System Performance Verification Platform (see section 3.1 above);
- System AIVP (as required by Industry for System Factory AIVQ tasks);
- Validation Chain: Val-Chain (as required by Industry for System On-Site AIVQ);
- Training Platform (as required to support Operator & Service Provider tasks).

Detailed objectives and requirements for reviews and key-points will be provided in the next phase of the procurement.

4 HIGH LEVEL REQUIREMENTS

This section specify the main high level requirements for the EGNOS V3 System development.

The detailed system requirements applicable to V3.1 and V3.2 will be provided in the next phase of the tender process. They will derive from the EGNOS V3 high level requirements on:

- Mission, based on [RD-1]
- International SBAS standards [RD-2], [RD-3], [RD-4]
- Service provision
- Safety and Certification
- Security
4.1 General requirements

**EV3.1 Development**
The Contractor shall design, develop and qualify the EGNOS V3.1 release in less than 5 years (duration between the Contract Kick Off and the EV3.1 Acceptance Review).

**EV3.2 Development**
The Contractor shall design, develop and qualify the EGNOS V3.2 release in less than 6.5 years (duration between the Contract Kick Off and the EV3.2 Acceptance Review).

**System CDR1**
The System CDR1 shall enable to review both the V3.1 and the V3.2 System design.

**System CDR2**
The System CDR2 shall enable to review the V3.2 consolidated design (considering the updated ADs provided at SBAS DFMC Standard key point).

**EV3.2 Qualification**
The V3.2 development and qualification process shall not impact V3.1 qualification credit.

**Application of ECSS standards**
In general the Contractor shall apply the ECSS standards for the execution of the project. A specific list of applicable ECSS will be provided in the next phase of the tender.

**Export control**
The deliverables from the Contractor shall be ITAR-free.

**No re-use of V2 infrastructure**
For the purpose of the EGNOS V3 development, the Contractor shall not assume any Customer Undertaking consisting of re-use nor any modification of the EGNOS V2 deployed infrastructure. It is contractor decision and responsibility to propose the re-use (with associated justification, and provided this has no impact on V2), or not, of the EGNOS V2 communication network.

**No impact on V2 services**
The EGNOS V3 development, deployment, qualification and the migration from EGNOS V2 to V3 shall not cause any impact or disruption of the EGNOS V2 services.
**MCC and System Operations Support Facilities sites**

V3 MCC and Support Facilities sites will be the following:
- MCC site in Torrejon (Spain)
- MCC site in Ciampino (Italy)
- System Operations Support Facility site in Toulouse (France)

**Mandatory RIMS sites**

The following table lists the current EGNOS V2 sites, mandatory for installation of V3 RIMS stations.

<table>
<thead>
<tr>
<th>Site</th>
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<tr>
<td>1</td>
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<td>2</td>
<td>ABU SIMBEL</td>
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<td>AZORES</td>
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<td>7</td>
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<td>8</td>
<td>CANARY ISLAND</td>
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<td>9</td>
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<td>HARTEBEESTHOEK</td>
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<td>18</td>
<td>JAN MAYEN</td>
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<td>KIRKENES</td>
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<td>20</td>
<td>KOUROU</td>
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<td>MADEIRA</td>
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<td>MALAGA</td>
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<td>26</td>
<td>MONCTON</td>
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<td>27</td>
<td>NOUAKCHOTT</td>
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<td>28</td>
<td>PALMA DE MALLORCA</td>
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</table>
Delivery of release V3.1
At final acceptance of the release V3.1 the Contractor shall deliver the qualified system consisting of all the hardware and software deployed at the final sites, all the documentation, data sets and deliverables associated to the release. A detailed list of deliverables for V3.1 will be specified in the next phase of the procurement. The Contractor shall support the hand-over of the V3.1 to a service Provider.

Delivery of release V3.2
At final acceptance of the release V3.2 the Contractor shall deliver the qualified system consisting of all the updated hardware and software, deployed at the final sites, all the documentation, data sets and deliverables associated to the release. A detailed list of deliverables for V3.2 will be specified in the next phase of the procurement. The Contractor shall support the hand-over of the V3.2 to a service Provider.

Guarantee
For both releases 3.1 and 3.2 HW and SW parts shall be guaranteed during 1 year after the system release (V3.1 and V3.2) final acceptance, including intermediate releases for correction of non-compliances. At the end of the V3.2 guarantee, all the development environments and tools necessary to exercise the maintenance shall be delivered.
4.2 Management

Detailed Management requirements will be provided in the tender specifications for the next phase, covering in particular:

- Project Management
- Risk Management
- Project Breakdown Structures
- Schedule Management
- Cost Management
- Contract Change Management
- Inventory Control
- Progress & Performance Evaluation
- Project Reviews

4.3 System Engineering

Detailed System Engineering requirements will be provided in the tender specifications for the next phase, covering in particular:

- EGNOS V3 System Engineering Requirements
- International SBAS standards
- GPS and Galileo constellations and signals definition
- GEO transponders technical specifications
- External interfaces definition

Update of Applicable Documents
As part of their baseline work, the Contractor shall take into account the AD updates provided at the pre-defined milestones (i.e. KO, DFMC Standard Key point).

4.4 Security

Detailed Security requirements will be provided in the tender specifications for the next phase, covering in particular:

- Applicable EU regulations
- Project Security Instructions (PSI)
- Security Classification Guide (SCG)
- Security Accreditation Strategy (SAS)
- EGNOS V3 System Security Requirements
- EGNOS V3 initial SECOPS
4.5 **Product Assurance and Safety**

Detailed PA & Safety requirements will be provided in the tender specifications for the next phase, covering in particular:

- Applicable EU regulations
- EGNOS V3 Software and Hardware Requirements
- EGNOS V3 PA & Safety Requirements

4.6 **Development, Deployment and System AIVQ**

Detailed Development, Deployment and System AIVQ requirements will be provided in the tender specifications for the next phase. Some dimensioning implementation requirements are highlighted here.

*RIMS deployment*

There shall be only one RIMS deployment covering both V3.1 and V3.2. Only remote SW upgrade shall be allowed between V3.1 and V3.2.

4.7 **Support to the Customer and to the Service Provider**

Detailed Support to the Customer and to the Service Provider requirements will be provided in the tender specifications for the next phase. Some dimensioning requirements are highlighted here.

*Training*

The Contractor shall foresee the training by industry of a commensurate operation team during a period of six months.

*Support to the Service Provider*

The Contractor shall support the Service Provider in the production and validation of the Operation and Maintenance procedures.

*Support to V2 to V3 migration*

The Contractor shall support the Service Provider in the migration from V2 operations to V3 operations.
5 CUSTOMER UNDERTAKINGS

Geostationary navigation payloads
The Customer intends to provide access to the following EGNOS geostationary satellites navigation payloads for the purpose of the system testing and qualification of V3.1 and V3.2:
- Inmarsat-4F2, available until end of 2021 for testing purposes
- SES-5, access limited to qualification
- Astra-5B, access limited to qualification
- GEO-3, available as of beginning of 2020 as dedicated V3 satellite

The proposed use of these GEO navigation payloads shall be justified by the Contractor. In particular, use of SES-5 and Astra-5B shall be reduced to the strict minimum, as they are EGNOS V2 operational satellites.

EGNOS V3 sites
The Customer intends to provide the RIMS, MCC, NLES and Support Facilities hosting sites (characterisation, access), for the deployment of the V3 infrastructure in the final sites.

6 MANDATORY SUB-CONTRACTORS

The mandatory sub-contractors for the provision of on-site support to the Contractor for the deployment of NLES shall be:
- SES-ASTRA for the deployment of NLES in Redu and Bedzdorf for SES-5 and ASTRA-5B
- Inmarsat for the deployment of NLES in Burum and Fucino for Inmarsat 4F2

The Contractor is free to negotiate the terms and conditions of their agreement with those mandatory sub-contractors. ESA will ensure that the mandatory Sub Contractors provide fair and non-discriminatory answers to all EGNOS V3 tenderers.
### ACRONYMS

The following table explains the meaning of the acronyms used in the text:

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>AD</td>
<td>Applicable Document</td>
</tr>
<tr>
<td>AIVQ</td>
<td>Assembly, Integration, Verification &amp; Qualification</td>
</tr>
<tr>
<td>AR</td>
<td>Acceptance Review</td>
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<tr>
<td>CCF</td>
<td>Central Control Facility</td>
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<tr>
<td>CDR</td>
<td>Critical Design Review</td>
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<tr>
<td>CFI</td>
<td>Customer Furnished Item</td>
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<tr>
<td>CPF</td>
<td>Central Processing Facility</td>
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<tr>
<td>DFMC</td>
<td>Dual Frequency Multi-Constellation</td>
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<td>ECAC</td>
<td>European Civil Aviation Conference</td>
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<td>EGEP</td>
<td>European GNSS Evolution Programme</td>
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<td>EGNOS</td>
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<td>European GNSS Agency</td>
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<td>Hosting Entity</td>
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<td>International Civil Aviation Organisation</td>
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<td>Interface Control Document</td>
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<td>Intermediate Key Point</td>
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<td>Infrastructure Requirements Document</td>
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<td>Invitation To Tender</td>
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