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Agenda item [[2]](#footnote-2) 13

Technical Domain / Task Number 2 …………………………………

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EGNOS for Off-Shore Oil & Gas Operations

# Summary

In view of the market situation, and the EGNOS features in comparison with other positioning techniques/services used in the off-shore Oil & Gas sector, the present document aims at identifying the opportunities for EGNOS introduction and the potential associated benefits.

## Purpose of the document

This is an information paper whose purpose is to provide an overview on the use of EGNOS for Off-Shore Oil & Gas operations in Europe; a market segment with promising opportunities for the utilisation and adoption of EGNOS. Committee members may be interested in the opportunities and potential use of EGNOS in a specific market segment within the off-shore Oil & Gas industry and are invited to provide comments.

# Background

Off-shore marine operations refer to all those activities which are performed in oceanic waters, beyond the coastline. Off-shore operations are in many cases associated to the Oil & Gas industry. In the context of GNSS, the Oil & Gas industry is also of interest, being one of the main users of private and public GNSS systems for the daily operations which require global coverage and high accuracy in order to avoid accidents/incidents. In this domain, avoiding accidents/incidents is especially critical due to their major economic and environmental impact.

EGNOS is the European satellite based augmentation system (SBAS) which is to be used in combination with GPS, increasing the performance in terms of accuracy and integrity. The use of EGNOS is being promoted to user communities who may need an added value due to the nature of their operations. Every sector where underperformance can derive in legal or economic consequences can take benefit of EGNOS: Maritime transport, Off-shore operations, Logistics, etc.

# References

1. IALA Guideline 1112 on Performance and Monitoring of DGNSS Services in the frequency band 283.5 – 325 kHz – Edition 1 – May 2015
2. OGP / IMCA Guidelines for GNSS Positioning within the Oil and Gas Industry. Report No. 373-19. June 2011
3. IMO Resolution A.915(22) Revised maritime policy and requirements for a future GNSS
4. Introduction to Offshore Support Vessels. By Andy Yeo and Magne Motzfeld, Pareto Securities Asia.

# Action requested of the Committee

The Committee is invited to consider the information provided in the Annex.

1. Annex 1: EGNOS for Off-Shore Oil & Gas Operations

# Methodology overview

In order to achieve the main objective of identifying the opportunities for EGNOS introduction in the off-shore Oil & Gas sector and the potential associated benefits, a well-structured methodology was defined and followed along the course of the study.

The first step was to perform a detailed analysis of the off-shore Oil & Gas applications market from the point of view of positioning.

Through this market assessment, it was provided an overview of:

* Positioning technologies: overview of the most popular positioning techniques used in the Off-Shore Oil & Gas market, including a presentation of their main principles, benefits and limitations.
* Positioning services: summary of the main commercial and public positioning services/solutions available today in the Off-Shore Oil & Gas market, focusing on their main features (performance, coverage) and high level architecture (ground/space infrastructure, etc.).
* Commercial/Public services value chain, including:
  + A general description of the value chain of positioning services, identifying the main functional elements required to provide this type of services. For each functional element, the different options that commercial/public service providers may select will be identified.
  + Actual value chain of the existing commercial/public Services: the key players and main features of each element for all commercial/public services will be identified in a synthetic way (as per available public information).

Next step was the analysis of the market status in terms of size and share of the market worldwide and at European level, including the available information of key players in relation with positioning technology. The following aspects were also covered: drivers, restraints, opportunities and challenges of the off-shore Oil & Gas market from the perspective of GNSS positioning services use.

In view of the above market situation, and the EGNOS features in comparison with the other positioning techniques/services used in the Off-Shore Oil & Gas market, the value proposition was performed by means of identifying the opportunities for EGNOS introduction and the potential associated benefits.

Finally, the market assessment, value proposition and SWOT (strengths, weaknesses, opportunities and threats) analysis led to identify the target market, as well as to outline main conclusions of the study.

# Market assessment

In order to identify opportunities for EGNOS introduction and the potential associated benefits, it is important to have a clear view of the market situation. Therefore, the EGNOS features have to be evaluated in comparison with other positioning techniques and subsequent services used in the Oil & Gas sector.

It is noted that the maritime navigation does not rely on a stand-alone GNSS system. The integrated bridge navigation system of ships requires a set of navigation sensors in order to obtain higher degrees of availability and integrity. This set of sensors may include: Gyro – heading and rate of turn, magnetic compass, GNSS, AIS, IMU, echo sounder, speed log, weather fax, sound reception, etc. This market assessment is only focussed in the GNSS sensor and the underlying positioning technique.

## GNSS Positioning techniques

The starting point was the assessment of the GNSS positioning techniques available to support off-shore Oil & Gas operations, including those which are provided free of charge to users and those requiring a subscription, typically providing the most stringent positioning performance in terms of accuracy.

The positioning techniques analysed have been the following: GNSS (Global Navigation Satellite Systems), SBAS (Satellite-Based Augmentation Systems), DGNSS (Differential GNSS), High-accuracy DGNSS and PPP (Precise Point Positioning).

Once all the techniques had been analysed, considering their main principles of functioning and the expected performance, a comparison among them was performed. The tables below compare the features of each positioning technique used in off-shore applications. Through this summary, it can be identified the differences between them in terms of accuracy, coverage, broadcast means, ground infrastructure requirements and main limitations.

It should be noted that Table 1 provides an approximation and it is susceptible to exceptions depending on the receiver hardware, algorithm, the positioning service technology, etc.

1. Comparison of positioning techniques for off-shore applications

| **Aspect** | **GNSS** | **SBAS** | **DGNSS** | **High-Accuracy DGNSS** | **PPP** |
| --- | --- | --- | --- | --- | --- |
| **Coverage** | Global | Regional | Local (<370 km) | <2000 km | Global |
| **Range limitation** | None | Service Coverage Area | Baseline | Baseline | None |
| **Typical horizontal accuracy (2σ)** | 5-10 meters | ~3 meters | <5 meters (95%)[[3]](#footnote-3) | 20 - 50 cm | 15 cm |
| **Typical vertical accuracy (2σ)** | 10 - 15 meters | ~5 meters | ~5 meters | 20 - 50 cm | 20 cm |
| **Corrections** | N/A | SBAS corrections | DGNSS corrections | Base station raw data (code and carrier phase), satellite orbit corrections | GNSS precise orbits and clocks |
| **Communications** | Satellite | Satellite | Radio | Radio & Satellite | Satellite |
| **Major limitation** | Local effects (multipath, urban canyons, etc.) | Local effects (multipath, urban canyons, etc.) | Range  Typical range is up to around 200 nautical miles (370 km) | Range  dm precision: up to 1000 km  1-2 m precision up to 2000 km | Convergence period (standard around 30 min) |

1. Availability of positioning technologies[[4]](#footnote-4) [2]

| **Aspect** | **GNSS** | **SBAS** | **DGNSS** | **High-Accuracy DGNSS** | **PPP** |
| --- | --- | --- | --- | --- | --- |
| **Land** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Inshore & Coastal**  **(4 - 20km off-shore)** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Off-shore**  **(20-350km)** | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Off-shore**  **(350-2000km)** | ✓ | ✓ | 🗶 | ✓ | ✓ |
| **Oceanic** | ✓ | (\*) | 🗶 | 🗶 | ✓ |
| **>76°N/S latitude** | ✓ | 🗶 | 🗶 | 🗶 | (\*) |

(\*) Partially

## GNSS Positioning services

Once an overview of the different GNSS positioning techniques was available, the next step was the analysis of the positioning services (specific implementations of the underlying positioning techniques) that could be selected by users from the off-shore Oil & Gas market. This analysis covered the existing services providing a detailed description of their features considering their architecture (ground and space segments), service levels, commercialisation scheme and service provision scheme.

A summary of the main features of GNSS positioning services available in the off-shore market today is provided hereafter (see Table 3). It is noted that EGNOS and IALA DGNSS transmit free-off-air GNSS corrections. However, Navcom, Veripos, Fugro and Hemisphere positioning are commercial services that require a subscription and the corresponding payment of a fee. Normally, these services are based on proprietary implementations of PPP and/or High accuracy DGNSS techniques, while free of charge services available for off-shore Oil & Gas are based on SBAS or traditional DGNSS. Positioning services based on PPP provide high accuracy, around 10-20 cm worldwide, with convergences times between 10 and 40 minutes. On the other hand, positioning services based on High accuracy DGNSS in most cases offer decimetre level accuracy, ensuring submetre accuracy up to distances of 1000 km from the reference station.

Thicker borders are used to group services which, despite having different commercial names, are based on the same (or almost the same) infrastructure and principles and hence are almost equivalent from the technical point of view (ground infrastructure, performance, algorithms).

1. Summary of GNSS positioning services for off-shore

| **Service** | **Technique** |
| --- | --- |
| EGNOS | SBAS |
| IALA DGNSS | DGNSS |
| (Navcom) C-NavC1 | PPP |
| (Navcom) C-NavC2 | PPP |
| Veripos APEX | PPP |
| Veripos APEX2 |
| Veripos Ultra | PPP |
| Veripos Ultra2 |
| Veripos Standard | High-Accuracy DGNSS |
| Veripos Standard2 |
| (Fugro) Startfix HP | High-Accuracy DGNSS |
| (Fugro) Marinestar |
| (Fugro) Startfix & Seastar L1 |
| (Fugro) Starfix & Seastar G2 | PPP |
| (Fugro) Starfix & Seastar G4 |
| (Fugro) Startfix & Seastar XP |
| (Fugro) Startfix & Seastar XP2 |
| Hemisphere ATLASTM H10 | PPP |
| Hemisphere ATLASTM H30 |
| Hemisphere ATLASTM H100 | DGNSS |

## Value chain

After the analysis of positioning techniques and services, the value chain of the high accuracy commercial services was described from a functional perspective. The main elements that all commercial services need and use include:

* Service Provision: including the operation of the infrastructure and management of the service, but also the provision of the support services to the Customer.
* Network of reference stations: GNSS measurement are to be gathered on a continuous basis and sent with low latency in order to be able to generate the corresponding high accuracy products (which may be different depending on the technique).
* Processing centre: depending on the underlying positioning technique that is applied at user level, additional processing of the GNSS measurements gathered by the reference stations is needed to compute the high accuracy products/corrections.
* Transmitting infrastructure: independently of the positioning technique to be applied at user level, the existing commercial services use a specific transmitting infrastructure to deliver their products to users.
* User equipment: dedicated/specific user equipment is normally required to take benefit of the commercial high accuracy services available in the market today. Commercial services are based on high accuracy products which are made available in proprietary formats. This has two key implications: only specific user equipment supports each commercial service and users need to pay for a subscription (in addition to the user equipment).
* Dealers: in charge of the sales, which will include in most cases the user receiver but also the subscription for the positioning service.

Thanks to this exercise some relevant common elements to the commercial services in the market, essential to understand the dynamics of the off-shore Oil & Gas market could be identified:

* All commercial service providers (PPP and/or high accuracy DGNSS based) develop their own proprietary algorithms for the generation of the products (PPP/DGNSS corrections), which are then distributed over a non-public ICD for signal access control reasons (enabling them to charge for the access).
* All commercial service providers count on a proprietary network of reference stations distributed worldwide.
* All commercial service providers use GEO satellites (6-8) as primary broadcast means for their corrections.
* As back-up solution, all commercial service providers rely on an external reference stations network provided by the same third party.
* All commercial service providers offer services based on dual-frequency multi-constellation.
* All commercial service providers rely on exclusive agreements with receiver manufacturers for the user equipment and subscription commercialisation.

# Market status

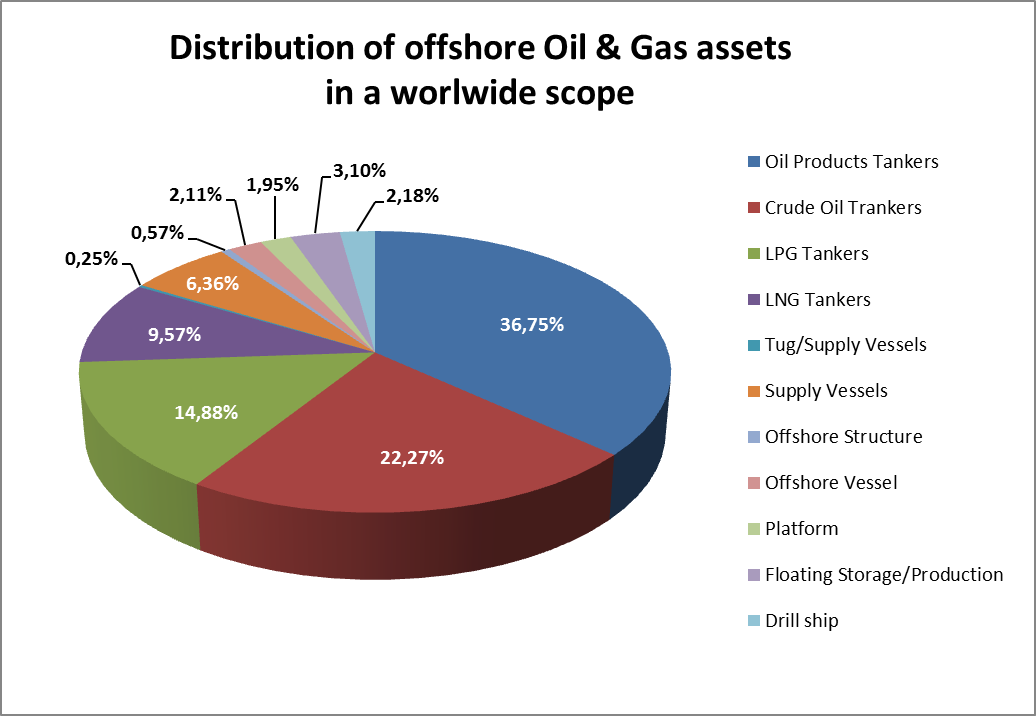
According to the analysis methodology, the next phase was devoted to the analysis of the off-shore Oil & Gas market. Such assessment began with the study of main Oil & Gas operations. The different phases of the Oil & Gas production cycle have been described, paying special attention to the identification of performance requirements for potential GNSS services to be used in this market. This exercise allowed understanding that the applications accuracy requirements are quite variable (from 10 m to 0.1 m).

The following table summarizes the position accuracy requirements [3] for the identified Oil & Gas applications (both in upstream and downstream segments):

1. Position accuracy requirements for upstream and downstream Oil & Gas applications

| **Segment** | **Phase** | **Application** | **Horizontal accuracy** |
| --- | --- | --- | --- |
| Upstream | Exploration | Survey of off-shore areas to identify prospective petroleum field | 1-2 m |
| Precise positioning of every geological structure | < 1 m |
| Seismic vehicle guidance |
| Continuous monitoring to simplify seismic takeout |
| Confirming that location is suitable |
| Development | Construction of subsea structures | 1 m |
| Installation of Drilling Rigs | 10 cm |
| Helping the asset tracking and management |
| Production | Maintenance and supervision of subsea structures and wells | 0.1–1 m |
| Management of FPSOs |
| Decommissioning | Decommission of activities performed by dive vessels | Ad-hoc per app. |
| Long-term monitoring and reporting of decommissioned production sites |
| Downstream | Transportation | Pipeline route planning | 1 m |
| Pipeline construction and maintenance |
| Bulk transport of Oil & Gas | 10 m |
| Fleet management |
| Storage | Dimensional control across storage terminals | 1 m |
| Retrofit and revamp projects |
| Tank calibration |
| Refining / Petrochemical | Dimensional control across plant facilities | < 1 m |
| Tracking and management of every asset |
| Distribution | Fleet management | 10 m |

After addressing the different operations and accuracy requirements, the market status was analysed. For this objective, the different types of vessels used in each operation phase were investigated and based on the different public sources of information the number of off-shore vessels were estimated. The approximate distribution of the different type of off-shore Oil & Gas assets in a worldwide scope is the following one:



1. Distribution of off-shore Oil & Gas assets in a worldwide scope

# Value proposition and target market

Considering the requirements of off-shore Oil & Gas operations shown in Table 4, the next step was to provide a Value Proposition of EGNOS in Off-Shore Operations, followed by the selection of a potential target market, understood as the type of vessels in this market that could benefit the most from EGNOS.

## Value proposition of EGNOS in Off-Shore Operations

The objective is to identify potential opportunities for EGNOS in the off-shore Oil & Gas operations, showing the possible associated benefits from the end user perspective, according to the market analysis already performed.

### EGNOS Open Service

EGNOS Open Service could be suitable as the primary positioning source (or as back-up, as it is currently used) for Oil & Gas applications that require around one meter accuracy levels (refer to Table 4 for full list of applications and positioning requirements).

By using EGNOS Open Service, end users would benefit from the use of a free-of-charge service with no need to modify the user equipment onboard, since EGNOS compatible receivers are widely adopted and commercialized by the main solution providers in the market.

EGNOS, apart from enhancing the GPS stand-alone solution, provides Integrity information, being suitable for safety-critical applications. This is especially important for the Oil & Gas market, in which a failure in the operation could dramatically impact the environment and have another catastrophic consequences or in case of specific cases with heavy regulatory/safety constraints. However, it is to be noted that, as of today, the commercial positioning services used in the Oil & Gas sector do not provide integrity.

### EDAS (EGNOS Data Access Service)

Another component of EGNOS which could be a suitable alternative for the applications that require around one meter accuracy levels would be EDAS; thanks to the DGNSS corrections it broadcasts taking the EGNOS RIMS stations as reference stations. In this sense, EDAS DGNSS using satellite Internet access[[5]](#footnote-5) could be a good alternative for Oil & Gas stations located in high latitudes, for instance, in Oil & Gas fields in the North Sea and in the Barent’s Sea.

Considering that the North Sea is well covered by EGNOS Open Service and that, EDAS DGNSS corrections would have to be accessed via satellite-Internet hence requiring some modifications/interfaces to the onboard user equipment, EDAS DGNSS corrections could be of higher interest for the Barents Sea area. It should be noted that, on these extreme latitudes, GEO visibility is limited (visibility problems may appear above 60N and are increased above 70N) hence impacting the availability of broadcast corrections (from SBAS systems or from commercial positioning services) at user level.

## Target market

The following step was to identify a specific application within the off-shore Oil & Gas market where EGNOS can play a role. Based on a SWOT analysis and the previous market assessment, the analysis was focused on the identification of a subset of vessels requiring positioning with an accuracy of the order of 1 meter. The use of EGNOS and their future evolutions could cover the requirements of such users. For this purpose, this analysis began with an overview of different types of off-shore vessels that are usually classified according to the operations they are involved in.

As summarised in Table 4, Exploration and Production (E&P) phase of an off-shore Oil & Gas field represents the first stage of the Oil & Gas operations value chain, usually known as the “upstream” segment of the life cycle. E&P is devoted to all the activities to search for potential locations that may allocate crude oil and/or natural gas, as well as the exploration, operation, maintenance and decommissioning of these resources. To support all these operations, a variety of specialised off-shore assets, focusing on certain tasks within the off-shore industry, are used. This kind of vessels is known as Off-shore Support Vessel (OSV).

Typically, OSVs provide support services to off-shore drilling rigs, pipe laying and oil producing assets (production platforms and FPSOs) utilised in E&P activities. It is important to note that OSVs’ specifications can differ greatly among this type of vessels and boundaries within the uses of each category are loose, i.e. one type of vessel can be used in several phases of operation and for different purposes or applications.

OSVs can be classified into different subcategories [4], the main ones are:

* Anchor Handling Tug Supply (AHTS): AHTS are designed to tow rigs from one location to another and to lift and position the rigs’ anchors. AHTS can also carry moderate amounts of supplies such as drilling fluid or drill pipe, and also support off-shore construction projects.
* Platform Supply Vessel (PSV): In addition to specialised vessels directly involved in the different phases of the E&P, there are a variety of specialised off-shore assets devoted to carry out simpler tasks such as cargo runs and supply duties.
* Construction Support Vessel (CSV): CSVs are used for subsea operations, and are typically equipped with a large crane, heli-deck, and large deck space.

Once the main OSVs were evaluated, Platform Supply Vessels were identified as the target market to promote EGNOS adoption. The following reasons supported this selection:

* PSVs are used along the whole life cycle of a platform, since the exploration, assisting the drilling ships, to the production phase and decommissioning phases.
* The number of PSVs is higher than other type of off-shore vessels with similar requirements in terms of positioning, for instance if compared with drill ships used in the exploration phase.
* Their requirements in accuracy are not so demanding: They do not require centimetre accuracy. Taking into account that these vessels are nearly 100 meter-long, they have to manoeuvre at few meters from the platform and it is required stability to load and unload the freight, with an accuracy requirement around 1 meter.

# Conclusions

Finally, based on all the information summarized above, the ability of EGNOS positioning services to support off-shore Oil & Gas operations and the potential benefits were analysed:

* Oil & Gas off-shore operations are difficult to carry on and require high levels of safety and skills. The required investment is huge and the margin of failure is really small, therefore the consequences of a minor error could be of great magnitude, both economically and environmentally. This has led to a variety of specialised off-shore assets and support vessels, focusing on certain tasks within the off-shore industry.
* EGNOS Open Service could be used as primary positioning service for a range of downstream and upstream applications requiring up to sub-meter accuracy level within the North Sea area. The EGNOS Open Service provides a free of charge alternative and would probably not require a change in the user equipment since most receivers in the market are EGNOS enabled. Platform Support Vessels are a good example of users that may benefit from EGNOS.
* EDAS could be a free of charge alternative for production fields in extreme latitudes (Bearing Sea) beyond the GEO visibility limit, although some modifications at user equipment could be required to allow the retrieval of EDAS corrections through satellite-based internet.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Input papers should be assigned to a work task as listed in the Committee work plan which is available in input papers. Leave open if uncertain but consider how the paper is to be processed if not relevant to a work task [↑](#footnote-ref-2)
3. Typical performance as per IALA guidelines 1112 [1]. To be noted that in [2] (IMCA Guidelines for GNSS Positioning within the Oil and Gas Industry], the accuracy is defined as ~3 meters. [↑](#footnote-ref-3)
4. Availability of GNSS positioning technologies dependents on installation, coverage and delivery system [↑](#footnote-ref-4)
5. Other transmission means could be used in the future if available (e.g. VDES) [↑](#footnote-ref-5)