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Executive Summary Report

By ARC/Corallia and Seven Sigma

Project Coordinator: Dr.-Ing. Jorge-A. Sanchez-P., Athena Research and Innovation Center/Corallia
A: Kifissias Avenue 44, Monumental Plaza, Building C, 5th Floor, 15125 Amarousion, Greece
T: +30.210.63.00.770 | F: +30.210.61.78.682 | E: info@corallia.org | W: www.corallia.org

Abstract

The Space4Maritime.gr study identified, analysed and prioritised via desk research, interviews and an online survey 118 unique needs of the maritime sector in Greece which could benefit from space infrastructure and translated them into a list of user requirements. The research conducted has drawn conclusions regarding: the Greek maritime sector activities and the assessment of their main characteristics in relation to those at the European/global level; the applicable regulatory frameworks; the existing services, assets and capacities to address the user requirements; the development needs of the emerging maritime services comprising autonomous shipping, maritime cyber-security, maritime green energy and propulsion and e-navigation. The study also analysed the Greek capabilities to develop the ground and space assets to satisfy these needs. Finally the study assessed the potential of Greece to provide and/or develop new systems for the maritime sector to address more thoroughly the identified user requirements, taking also into account industrial capabilities and budgetary constraints.

Main Contributors

Name	Organisation
Dr. Jorge Sanchez	Corallia/ARC
Dr. Nikos Vogiatzis	Corallia/ARC
Dr. Athanasios Potsis	Corallia/ARC
Mr. Orfeas Voutyras	Corallia/ARC
Ms. Nancy Liva	Corallia/ARC
Mr. Eleftherios Ioannides	Corallia/ARC
Mr. Ilias Psyroukis	Corallia/ARC
Ms. Constantina Bourouni	Corallia/ARC
Mr. Kostas Kokkinoplitis	Seven Sigma
Dr. Minos Eleftheriou	Seven Sigma
Dr. Odysseas Cartalos	Seven Sigma
Mr. Nikos Kokkinoplitis	Seven Sigma
Mr. Georgios Kalousios	Seven Sigma

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1. Introduction

ESA's Discovery Preparation and Technology Development (DPTD) activities interfaces with all of ESA's programmes, carrying out preparatory analysis and laying the groundwork for the Agency's future activities with the objective to:

- Study feasibility for selection of new mission concepts;
- Prepare/demonstrate the case for approval and funding of new optional projects/programmes;
- Implement interdisciplinary discovery project for paradigm shifts and game changers;
- Perform early "blue sky" research on topics that are recognised as being potential breakthrough ideas but not implementable in the next ten years;
- Support the evolution of ESA by analysing and testing new working methodologies.

A diversity of topics is investigated via Discovery & Preparation undertakings, running across the entire spectrum of the Agency's activities. In average, each study lasts one to two years, sufficient time for in-depth exploration of each subject. The studies undertaken by the Discovery & Preparation provide ESA and its Member States with the necessary information on which to base their decisions about the implementation of new programmes and the future direction of space activities.

In the above context, ESA has appointed Corallia Unit of RC Athena (Greece) to conduct a study on Space and Maritime analysis of requirements in Greece. The purpose of the four-month study was to collect and review requirements from the Greek maritime sector and analyse the Greek capabilities to develop the ground and space assets to satisfy these needs.

Indeed, the Maritime sector is a key economical segment in Greece and the Greek merchant fleet is the largest in the world. Space systems may substantially contribute to key activities in this sector such as ship identification and navigation, resources monitoring or maritime border surveillance. In response to a request received from Greece in January 2018 to establish a "Space and Maritime" initiative under Greek leadership, it has been decided to initiate:

- A review of the requirements from the Greek maritime sector;
- An analysis of the Greek capabilities to develop the ground and space assets to satisfy these needs.

The Space4Maritime.gr study identified, analysed and prioritised via desk research, interviews and an online survey 118 unique needs of the maritime sector in Greece which could benefit from space infrastructure and translated them into a list of user requirements. The research conducted has drawn conclusions regarding: the Greek maritime sector activities and the assessment of their main characteristics in relation to those at the European/global level; the applicable regulatory frameworks; the existing services, assets and capacities to address the user requirements; the development needs of the emerging maritime services comprising autonomous shipping, maritime cyber-security, maritime green energy and propulsion and e-navigation. The study also analysed the Greek capabilities to develop the ground and space assets to satisfy these needs. Finally the study assessed the potential of Greece to provide and/or develop new systems for the maritime sector to address more thoroughly the identified user requirements, taking also into account industrial capabilities and budgetary constraints.

Following this study, a comprehensive system study is foreseen to identify the gaps between the needs and the currently existing systems and to propose a way forward (development of space segment, ground segment and services) to cover those gaps.

2. Rationale

Greece is the prime maritime nation in the world, famous for its shipping industrial establishment. Greek shipping is, perhaps, the most important productive sector in the country, maintaining its leading position, both numerically, representing over 18% of world deadweight capacity and almost 50% of European Union fleet, as well as qualitatively, remaining a reliable partner by providing maritime services with the new ship acquisitions and technology fleet. According to recent data, shipbuilding equipment orders of more than 8b€ from Greek ship-owners are foreseen, of which 6b€ will be for newer ships, while the remaining 2b€ will serve orders for repairs and conversion of existing ships.

According to recent studies by Lloyd's and DNV-GL, as well as ESA space technology evolution reports, it is foreseen that in the coming years a significant number of modern technologies and innovations will be applied to the designs of new merchant ships, completely changing the outlook of the industry. Technologies such as automation and robotics systems, novel materials, secure and accurate navigation and shipping, as well as new communication capabilities, will characterise new ship designs as well as product and freight services worldwide.

This technological revolution is expected to lead to the creation of a new technological and commercial sector which will be able to adapt existing technologies, services and products, to shipping needs and new ship designs, eventually resulting in a new industrial base.

In this context, the deployment of Space Technologies and Applications as underlying technologies to support these new needs, is expected to have a substantial and immediate impact, given that mature, high-quality products and applications that have been tested under demanding operating conditions, can be used immediately in the field of shipping.

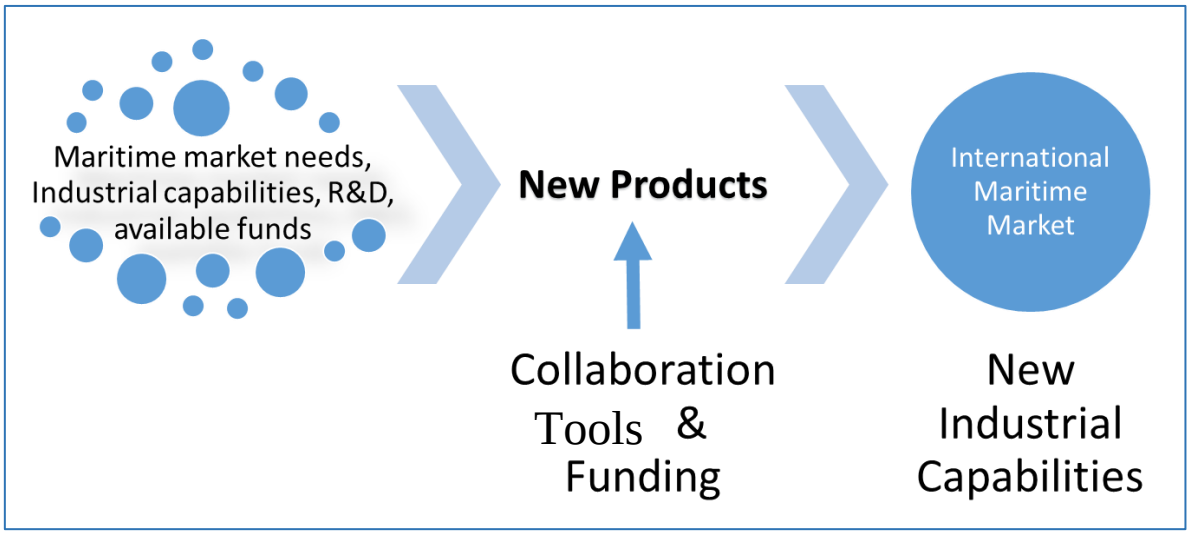

Figure 1: Development of new products for the global maritime market

In this challenging environment, the space actors, among which the Greek industry, have to adapt, evaluate the existing technological capabilities and potentials as well as any remaining liabilities arising from the recent financial crisis, and provide new solutions in the maritime market to boost it into the years to come.

3. Course of action

The implementation of the study focused on two main set of actions:

- To carry out an analysis of the needs of the Greek Maritime Sector that can benefit from the use of Space Systems and establish a list of user requirements.
- To review the Greek space and non-space industrial capabilities and how they could support the user requirements identified.

As far as the first set of actions is concerned, the main objective was to carry out an analysis of the needs of the Greek Maritime Sector that can benefit from the use of Space Systems and establish a list of user requirements. In this context, the activities of the Greek Maritime sector were reviewed and a quantitative assessment was presented for them in terms of resources involved. For each activity of the Greek Maritime sector, the legal and regulatory frameworks were identified, as well as the existing services that support the activities, together with the end users and the supplying entities and assets used for such services.

For each service that may benefit from space-based assets the user requirements were also identified especially when related to the provision of Earth Observation data, localisation data, timing data, communication link or technology re-use or transfer. For each user requirement it was eventually specified who the end-users are, the need the timeliness and the time and geographical coverage required. User requirements were finally identified related to the anticipated developments of new services or future needs in the Greek Maritime sectors which could benefit from space assets or from common technology developments between the Space and Maritime sectors.

As part of the overall study approach, the following were the maritime themes, topics and activity areas of focus:

- Management of maritime natural resources
    - Marine Life: Fishing and Aquaculture; marine animal monitoring;
    - Energy: Renewable maritime energy (Wind, waves,…); off-shore oil and gas
    - Exploration and exploitation: Technology for the safe exploration and exploitation of seas' floors (deep sea);
- Maritime monitoring for safety and security
    - Surveillance: sea borders surveillance; illegal activities detection;
    - Support to shipping: ship identification; sea and coastal traffic; monitoring of maritime transport; safety of maritime transport and ports;
    - Search & Rescue
- Maritime transport
    - Navigation: operations; autonomous shipping; automation and control; e-Navigation;
    - Communication: information transfer;
    - Logistics: management of maritime transport operations; sustainable and smart ports development
- Protecting the ocean
    - Monitoring: marine plastic litter; Eutrophication; Pollution at sea; Aggregates extraction; Ballast water exchange;
    - Protection: Protecting biodiversity; Protecting sensitive ecosystems; Protecting Natural Capital; environment protection
- Ocean science
    - Regional Climate Modelling and extreme events: Regional Climate Evolution Modelling, Projections, Natural Hazards, Extreme events

- Maritime infrastructure management and spatial planning
    - off-shore infrastructures; coastal transportation; prevention of natural disasters; sea tourism; maritime spatial planning; archaeological site protection

Key examples of future services that were explored, included Autonomous shipping, Cyber-security, Green energy and propulsion, and e-Navigation.

As far as the second set of actions are concerned, the main objective was to assess the existing and potential capabilities of the Greek industry to cover the needs identified from the study's preceding first set of actions. A detailed assessment of the capability of the Greek space and non-space industrial sector was performed (including services and applications) to cover the needs identified, through the use of existing assets or through new developments. A comprehensive list of potential companies was then provided (type of company, size, turnover, products / activities, track record for the maritime sector, track record concerning "space", projects under development) as well as a matrix that showed clearly whether and to which extent each user requirements are or can be addressed by identified asset / companies in Greece.

Finally, the potential of Greece to provide or develop new systems supporting the maritime sector and better addressing the user requirements was assessed, taking into account industrial capabilities and budgetary constraints.

4. Outcome

Three different and complementary research methods were used: a literature review, interviews with main stakeholders of the Greek maritime sector and an on-line survey covering a large number of service providers and users/consumers of services in the maritime sector.

The **desk research** aimed to gather main insights on user needs and service provision in the maritime sector. It has been organised around the following investigation topics for the maritime activity areas in question: Socioeconomic characteristics, User needs in terms of space services, Offer of space services, Legal/regulatory framework for space service provision.

The **stakeholder interviews** enabled the project team to validate main outcomes of the desk research and prepare for the questionnaire. The interviews have been designed for the main stakeholders involved in maritime activities, including final users and entities providing services from the public and private sector. An interview guide was prepared to organise discussions around: (a) background information on the maritime activities, (b) validation of findings from the desk research, and (c) specific aspects related to user needs, user requirements, service provision and the legal and regulatory framework. Due attention was paid to investigating latent needs, with reference, during the interviews, to international practices. A total of 33 interviews was conducted with a representative sample of decision makers/subject-matter experts coming from public authorities, government institutions, businesses and research teams.

The **online survey** covered the need for a more systematic investigation of a large variety of user needs. The survey was designed to cover the large majority of actual/potential users and suppliers of space services in the maritime sector. It was launched through the Survey Monkey digital platform and was organised in sections referring to: Respondent identification (name, organisation, user/provider), Maritime activity area of professional interest, Experience/involvement with emerging maritime services, Current use/provision of space services (with corresponding description of the services, assets required, degree of service availability), Needs that could be potentially covered by space/satellite services (with corresponding description as appropriate, degree of coverage of this need and technical information leading to the definition of specifica-

tions), Legal/regulatory framework and its (positive or negative) effect on the space/satellite service provision, Assessing views on the development of the space and maritime initiative. The questionnaire was distributed to 650 individuals. Furthermore, a paid digital campaign was implemented on Facebook, Instagram, Messenger, WhatsApp, Twitter, and LinkedIn, accompanying the questionnaire distribution through the Survey Monkey platform.

As a result, the study produced 33 interviews and 221 valid responses to the online questionnaire. In total, **118 needs have been consolidated** from an initial list of 466 entries. The collected needs were structured so that they could be classified according to the type of user, the Activity theme, and/or the attributes of the need (e.g. Geographical Coverage, Timeliness, Temporal Coverage). The Proposal for Needs and Requirements was then organised based on Thematic Area, Subtopic, Activity Area, Type of Service (EO, PNT, and Communication), Main End-User and Performance Parameters (Horizontal Coverage, Accuracy, etc.).

The study also produced, **a review and assessment of the activities of the Greek Maritime sector**, presented a quantitative assessment for them in terms of resources involved and compared them with the activities at global level. The review examined the different areas of maritime activities defined in the SoW. In each case, the major economic, social and environmental characteristics and trends were presented for Greece and in the broader EU/global context.

The study also studied the **legal and regulatory frameworks** for the maritime sector. The main sources used to describe the legal framework were desk research, together with answers received from the on-line survey and interviews where stakeholders of the maritime sector pointed to specific rules and regulations they have to comply with in their respective areas of activity.

The study also presented the results of the work carried out in terms of **describing the existing services, assets and capacities to address the user requirements** that have been identified. The document presents an overview of the main findings related to the identification of the existing (space) services that support specific maritime activities, as well as the corresponding providers, assets and end-users and provides an aggregated and structured view of all the information accumulated regarding four emerging maritime services: autonomous shipping, maritime cyber-security, maritime green energy and propulsion, and e-navigation. An attempt has been made to predict the future trends of the industry. The information derived from the aforementioned categories presents the shape and structure of the industry in the years to come. A series of statistical figures, including graphs, tables and charts are used to depict the degree and relevant importance of the needs to be fulfilled through the use of space-based technologies and applications in each Thematic Area.

Furthermore, more than 100 organisations from the Greek space and maritime ecosystem were contacted and a **catalogue with their capabilities and their taxonomies was produced**. As a result of the above, a list of the companies identified was produced and delivered. The list was based on the questionnaire respondents coupled with the production of a 150-page catalogue of organisations developing space technologies and applications. Furthermore, taxonomies of the actors in the catalogue were produced, as well as a coverage matric based on the ESA technology and product taxonomies. An additional coverage matrix was developed based on the maritime activities and the emerging areas.

Building upon the aforementioned work, the study provided an assessment of the potential of Greece to provide and/or develop new systems for supporting the maritime sector and addressing more thoroughly the previously identified user requirements, taking also into account industrial capabilities and budgetary constraints. A short description of these new systems is provided, together with a rough estimate of the

timeline, the budget and potential funding sources. These new space and ground assets which may be provided by the Greek industry mainly focus on four emerging maritime services: autonomous shipping; maritime cyber-security; maritime green energy and propulsion; and e-navigation.

Overall, the main target of the analysis presented is to summarise the target needs of the end users and to provide a sample of the nice technologies and products that can be provided and/or developed by the local Greek industry, supporting in parallel the new trends of the digital shipping. In this respect, the importance of this new digital shipping market and the necessary utilisation of the space assets is covered in particular. Last but not least, a set of new space and ground assets to be provided and/or developed by the Greek industry with budget and timeline, was developed.

5. Perspectives and next steps

It is important to mention that for Greece:

- The established maritime sectors employ around 347,000 people and generate close to €6 billion in GVA;
- These sectors had a significant positive impact on Greek GDP and employment. In the period between 2009 and 2017 when national GDP dropped by -24%, the established maritime sectors contribution to the GVA rose significantly by +32%, reaching 3.3% of the overall national GVA in 2017 compared to 1.9% in 2009. The share of jobs covered by the same sectors now amounts to around 9.4%, which is more than a two-fold increase from the 4.0% value in 2009;
- The key contributors to jobs in the established maritime sectors are sea tourism (77%), fishing and aquaculture (11%) and maritime transport (5%);
- Sea tourism is also the main contributor to GVA (56%). Navigation (17%) is the second highest contributor, whereas sea transport and fishing & aquaculture add slightly more than 10% to the GVA from established maritime sectors.

In the frame of this study, the needs of the maritime sector in Greece have been analytically addressed and identified. It is now apparent that space technologies can play a vital role in order to address these needs while the local industry can already provide solutions and products. A total of 118 unique user needs have been identified. This sample can provide secure results of the maturity of the local ecosystem and the current awareness of the solutions that can be provided by space related technologies.

Considering the fact that Greece has a long standing experience and know how on maritime business with large international market access, it provides an ideal working environment to develop a specific plan for space and ground related activities that could serve the emerging needs of the maritime market. A sample of niche technologies and products that could be offered by the local industry to address the expressed maritime needs have been identified. There are still requirements of high importance that need to be further mapped and analysed (e.g. needs related to Coast Guard/Border Control agencies in particular related to the refugee crisis as well as Search & Rescue missions in the Mediterranean See).

Moreover, a combination of the GALILEO and COPERNICUS emerging services as well as other ESA space missions' operational capabilities and their impact on providing solutions to maritime needs should be also addressed.

Following this study, a comprehensive system study is foreseen to identify the gaps between the needs and the currently existing systems and to propose a way forward (development of space segment, ground segment and services) to cover those gaps.