



si-cluster
a corallia initiative

“The challenges of... the blue world” – The Space Technology perspective

Insights of the Greek Space Technologies and
Applications Cluster (si-Cluster)



1. The si-Cluster & the Greek Blue World
2. Space4Maritime.gr Study
3. Autonomous Shipping
4. Satellite-based solutions
5. Space-based solutions





Our Vision

To sustain a
world class cluster
on space
technologies &
applications

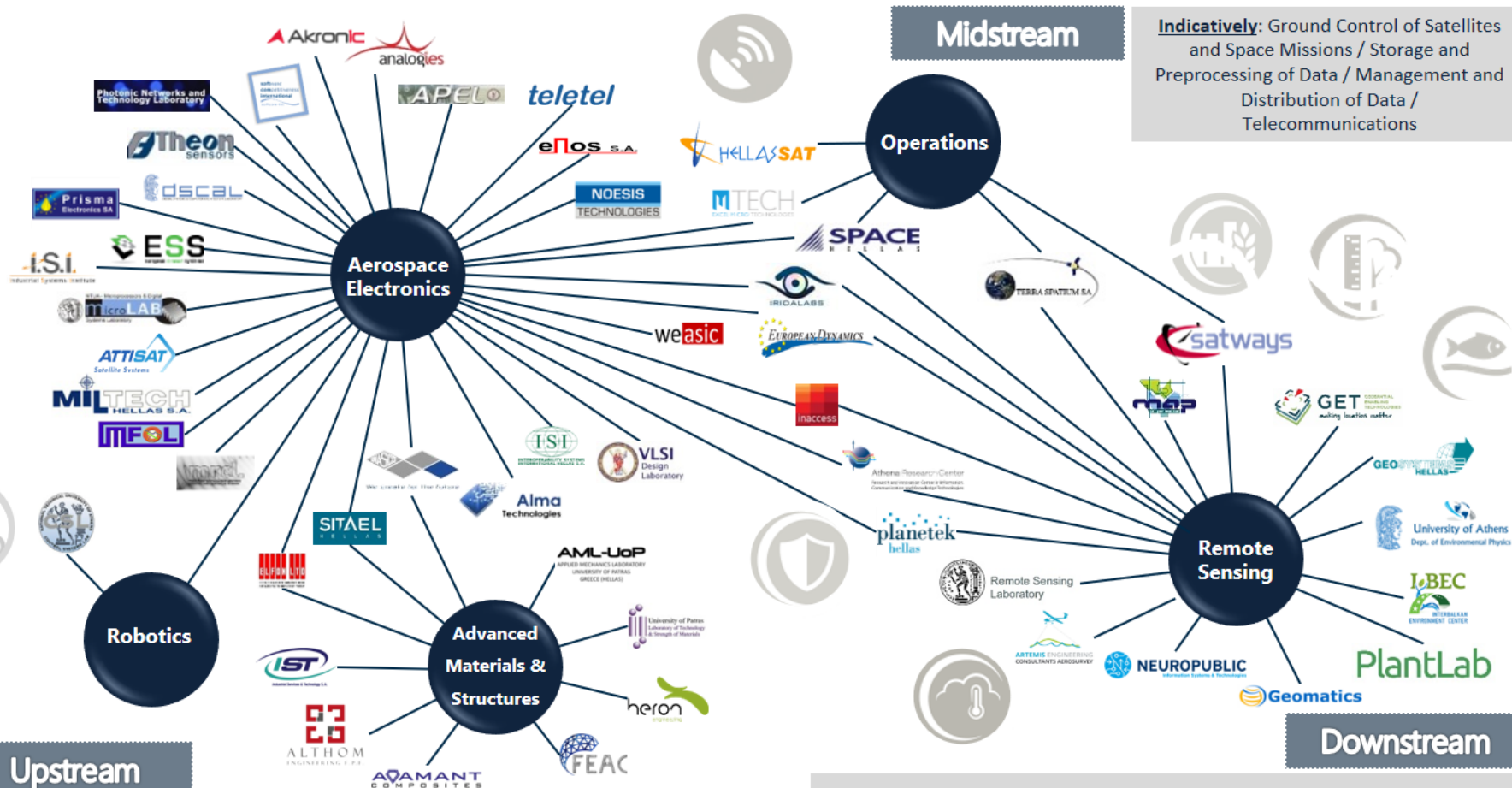
One of the 3 gold labeled clusters
worldwide in the space sector

GOLD



Cluster
Management
Excellence

PROVEN FOR CLUSTER EXCELLENCE

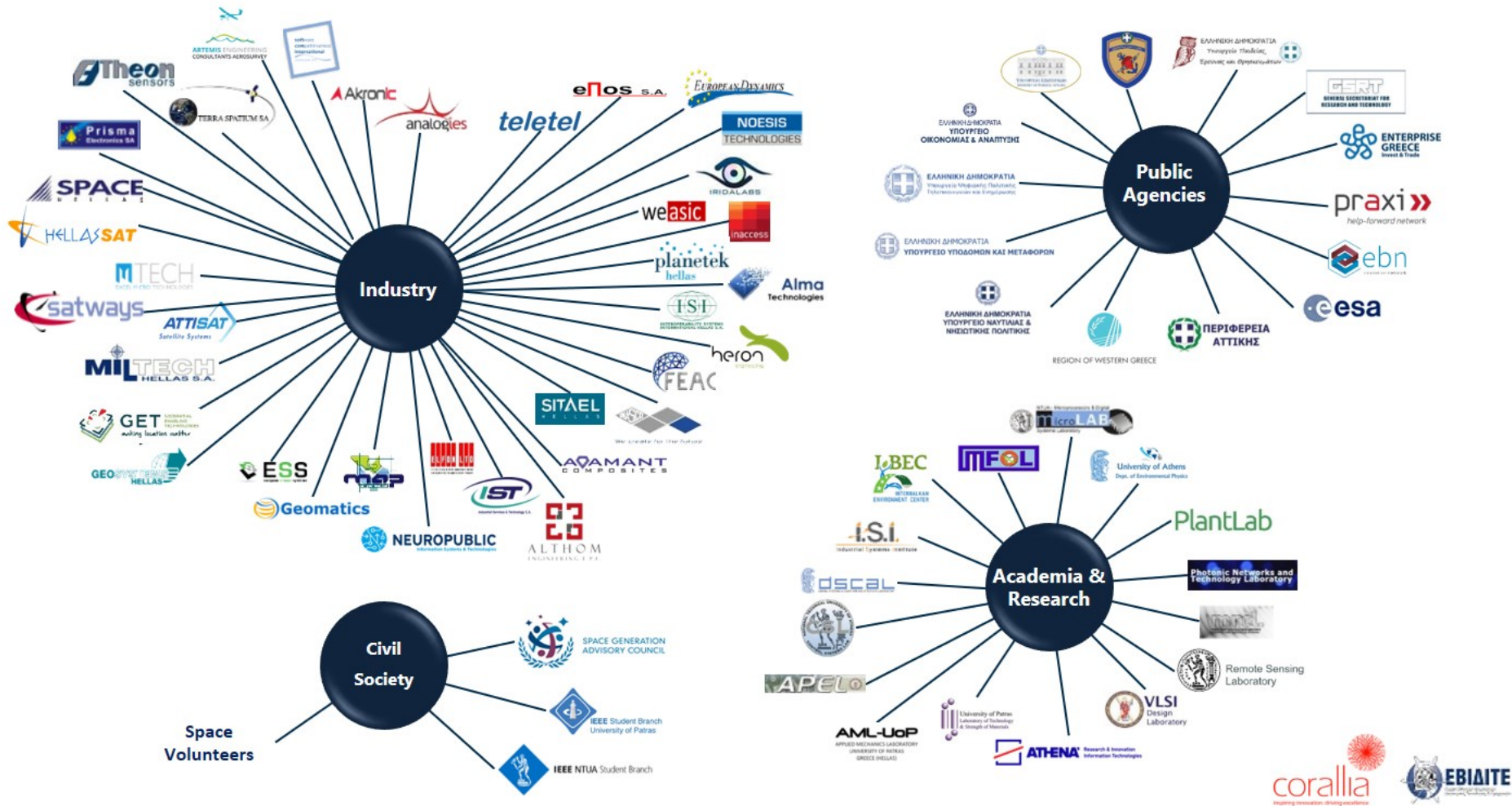


Indicatively: Ground Control of Satellites and Space Missions / Storage and Preprocessing of Data / Management and Distribution of Data / Telecommunications

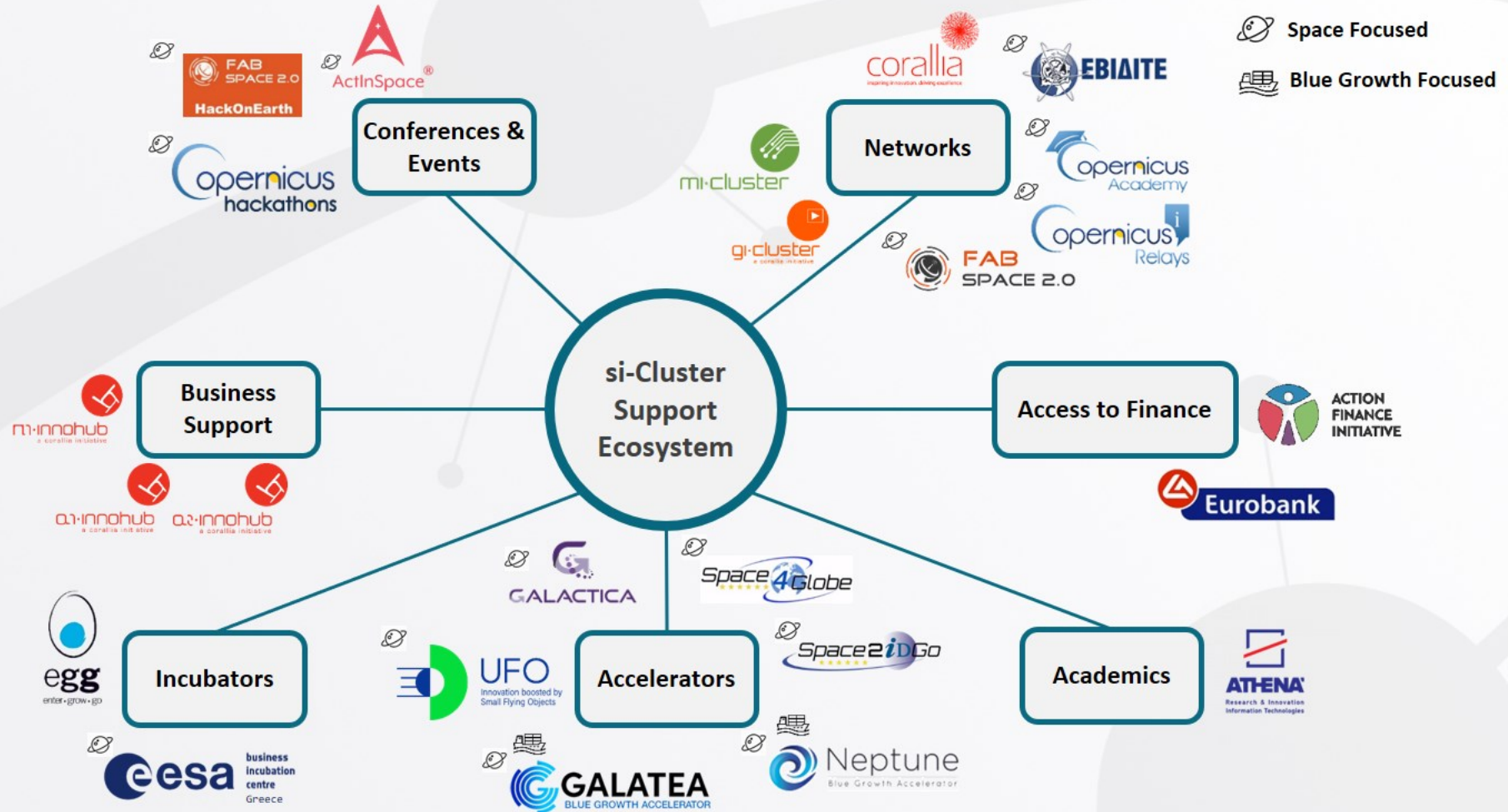
Upstream

Indicatively: Design & Development of Satellite Subsystems & Components (Structures, Mechanisms, Power Control, Telemetry Tracking & Control, Attitude & Orbital Control Systems, Communications, Thermal Control, On-Board Computers, etc.) / Payload Development (for Downstream Applications and Space Science) / Ground Control Equipment / Launchers / Life Support Equipment

Indicatively: Agriculture, Forestry & Fisheries / Biodiversity & Environmental Protection / Climate & Energy / Civil Protection & Humanitarian Aid, Security & Border Control / Public Health, Disease Control / Tourism / Transport & Safety / Urban & Regional Planning / Navigation / Air Traffic Control / Telecommunications / Space Science / Technology Transfer to Earth Applications



Ecosystem around the si-Cluster



Services Portfolio



Research & Networking



Commercial Cooperation



Cluster Expansion



Innovation & Technology



Education & Training



Policy Action



Greek Space Catalogue



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GOLD Cluster Management Excellence
PROGRAM FOR CLUSTER EXCELLENCE

The Greek Space Technologies and Applications Cluster

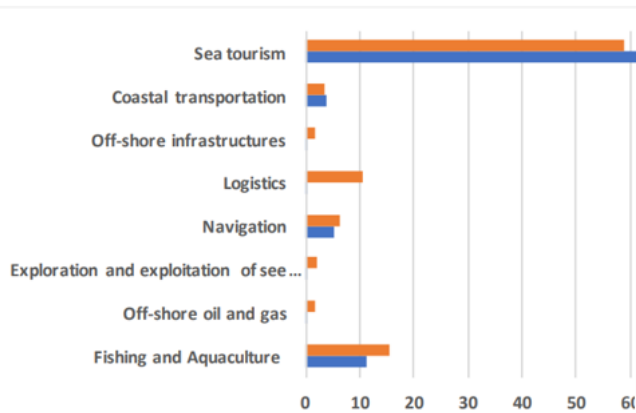
Members' Competences, Technologies, Capabilities
What they are looking for
Update July 2018



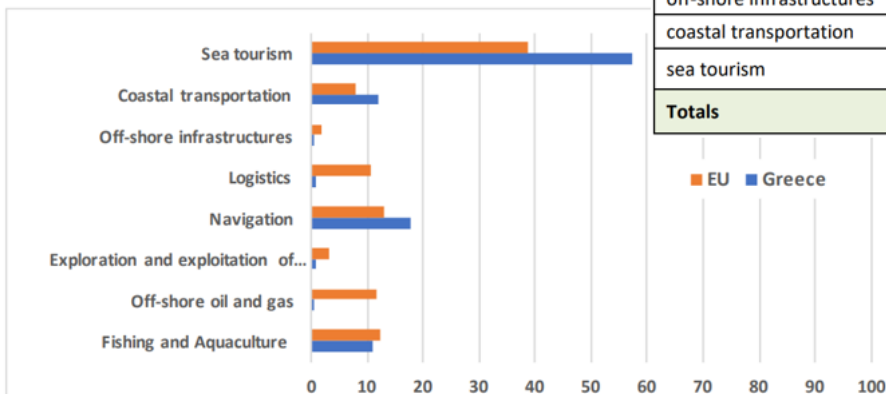
The Greek Blue World



- Greece is the **world fleet leader in dead-weight tonnage lead**, with a share of 17.3% of world total in 2017, followed by Japan (11.7%) and China (9.6%).
- In terms of **commercial value of the world fleet**, Greece ranks **third**, with a value close to 86 billion USD, behind the United States and Japan that have value close to 90 billion USD.
- The shipping industry is by far the **most extrovert sector** of the Greek economy.
- The inflows from shipping activities account for approximately **6.5% of Greek GDP** and also have a substantial indirect multiplier effect on the Greek economy.



Share of employment in established sectors of maritime activities

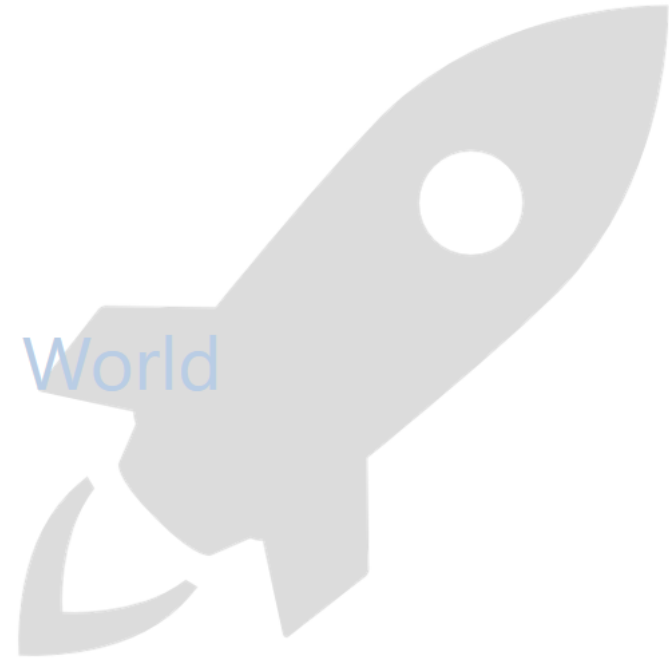


Share of GVA in established sectors of maritime activities (Greece and EU)

Maritime area / sub-sector	Greece		EU	
	Employment (thousands)	GVA (EUR million)	Employment (thousands)	GVA (EUR million)
Management of maritime natural resources				
Fishing and Aquaculture	38,10	637,00	571,48	20.681,00
Off-shore oil and gas	0,20	8,00	62,83	19.681,00
Exploration and exploitation of see floor	0,90	46,00	81,57	5.576,00
Maritime transport				
Navigation	17,70	1.025,00	232,24	21.944,00
Logistics	1,30	54,00	384,52	18.094,00
Maritime infrastructure management and spatial planning				
off-shore infrastructures	1,40	13,00	65,17	3.225,00
coastal transportation	12,80	699,00	124,38	13.121,00
sea tourism	266,30	3.342,00	2.174,73	65.116,00
Totals	338,70	5.824,00	3.696,91	167.438,00

[source: "The EU Blue Economy Report 2019"]

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Space4Maritime.gr – Objectives

1000128132/19/F/MOS Space and Maritime: Analysis of Requirements in Greece Space4Maritime.gr

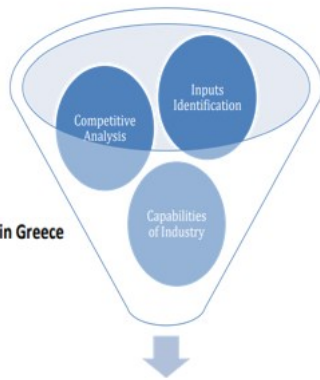
ESA Ref:
4000128132/19/F/MOS

Subject:
Space and Maritime: Analysis of Requirements in Greece

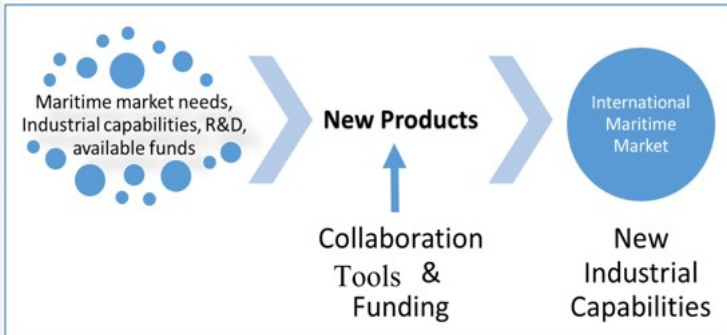
Project Title:
Space4Maritime.gr

Date:
6 March 2020

[Final Report](#)



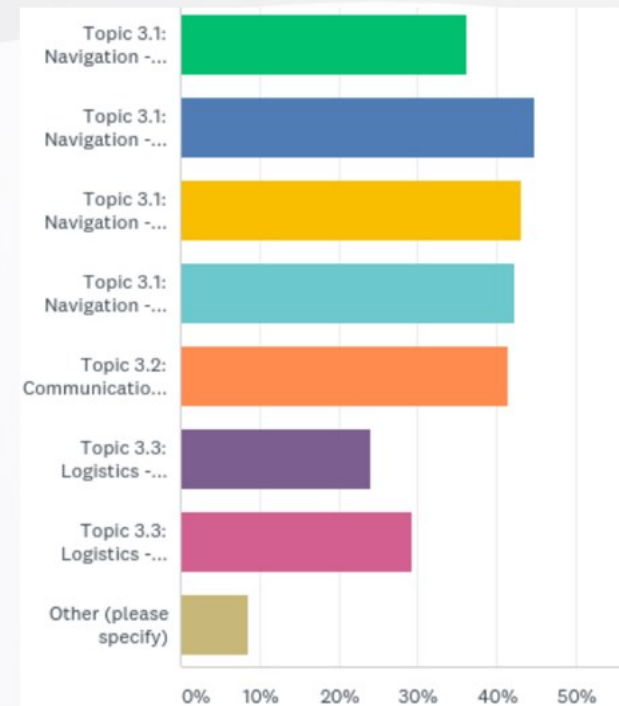
- To identify, analyse and prioritise the **needs of the maritime sector** in Greece which could benefit from space infrastructure and translate them into a list of user **requirements**
- To make an analysis of the current capacity of the Greek industry to satisfy these requirements and of the **existing solutions** (Greek, European or worldwide)



Space4Maritime.gr – Thematic Areas

- Management of maritime natural resources
- Maritime monitoring for safety and security
- **Maritime transport**
 - **Navigation**
 - **Communication**
 - **Logistics**
- Protecting the ocean
- Ocean science
- Maritime infrastructure management and spatial planning

- ✓ *"desk research"*
- ✓ *221 on-line questionnaire responses*
- ✓ *33 interviews*
- ✓ *118 needs*



ANSWER CHOICES	RESPONSES
Topic 3.1: Navigation - Activity 3.1.1: Operations	36.21% 42
Topic 3.1: Navigation - Activity 3.1.2: Autonomous Shipping	44.83% 52
Topic 3.1: Navigation - Activity 3.1.3: Automation and Control	43.10% 50
Topic 3.1: Navigation - Activity 3.1.4: e-Navigation	42.24% 49
Topic 3.2: Communication - Activity 3.2.1: Information Transfer	41.38% 48
Topic 3.3: Logistics - Activity 3.3.1: Management of Maritime Transport Operations	24.14% 28
Topic 3.3: Logistics - Activity 3.3.2: Sustainable and Smart Ports' Development	29.31% 34
Other (please specify)	8.62% 10
Total Respondents: 116	

Needs & Requirements

Table 6-3: Maritime transport

User Need ID	Reference Document	Parent Need	Need Description	Theme	Subtopic	Main Activity Area	Based on	Main End-User(s)
S4MGR-UNC-048	RD.I.018, RD.I.019	S4MGR-UNR-112, S4MGR-UNR-119	Monitor sea currents' direction	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	EO + PNT Data	Ship Master
S4MGR-UNC-049	RD.I.018, RD.I.019	S4MGR-UNR-113, S4MGR-UNR-119	Monitor sea currents' speed	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	EO + PNT Data	Ship Master
S4MGR-UNC-050	RD.I.003, RD.I.019	S4MGR-UNR-024, S4MGR-UNR-119	Monitor wave's height	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	EO + PNT Data	Ship Master
S4MGR-UNC-051	RD.I.004, RD.I.019	S4MGR-UNR-043, S4MGR-UNR-119	Monitor wavelength of sea wave	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	EO Data	Ship Master
S4MGR-UNC-052	RD.I.018, RD.I.019	S4MGR-UNR-114, S4MGR-UNR-119	Monitor wave's speed	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	EO + PNT Data	Ship Master
S4MGR-UNC-053	RD.I.018, RD.I.019	S4MGR-UNR-114, S4MGR-UNR-119	Monitor wave's direction	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	EO + PNT Data	Ship Master
S4MGR-UNC-054	RD.I.004	S4MGR-UNR-036	Verify ship's arrival notice	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	PNT Data	Port Authorities
S4MGR-UNC-055	RD.I.001, RD.I.014, RD.I.019, RD.Q.001, RD.Q.040, RD.Q.067	S4MGR-UNR-003, S4MGR-UNR-098, S4MGR-UNR-119, S4MGR-UNR-242, S4MGR-UNR-292, S4MGR-UNR-293, S4MGR-UNR-300, S4MGR-UNR-323	Accurately monitor weather conditions for route optimization purposes	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	EO + PNT Data	Ship Master
S4MGR-UNC-056	RD.I.006	S4MGR-UNR-054	Reduce ECDIS official database verification time	03. Maritime Transport	3.1. Navigation	3.1.3. Automation and Control	Communication Links	Ship Master
S4MGR-UNC-041	RD.I.018, RD.I.019	S4MGR-UNR-112, S4MGR-UNR-119	Monitor sea currents' direction	03. Maritime Transport	3.1. Navigation	3.1.4. e-Navigation	EO + PNT Data + Communication Links	Ship Operator
S4MGR-UNC-042	RD.I.018, RD.I.019	S4MGR-UNR-113, S4MGR-UNR-119	Monitor sea currents' speed	03. Maritime Transport	3.1. Navigation	3.1.4. e-Navigation	EO + PNT Data + Communication Links	Ship Operator


Table 7-3: User Requirements for Maritime transport Needs

User Requirement ID	Need Description	Theme	Subtopic	Main Activity Area	Based on	Main End-User(s)	Horizontal coverage	Vertical coverage	Horizontal resolution	Temporal resolution
S4MGR-REQ-046	Provide uninterrupted communication services	Maritime Transport	Navigation	e-Navigation	COM	Ship Operator	Global	Surface	Not relevant	Always on
S4MGR-REQ-047	Provide IoT connectivity via satellite	Maritime Transport	Navigation	e-Navigation	COM	Ship Operator	Global	Surface	Not relevant	When needed
S4MGR-REQ-056	Reduce ECDIS official database verification time	Maritime Transport	Navigation	Automation and Control	COM	Ship Master	Global	Surface	Not relevant	When needed
S4MGR-REQ-058	Improve internet connections at areas with traffic congestion (e.g. at ports)	Maritime Transport	Communication	Information Transfer	COM	Ship Master and Ship Operator	Global	Surface	Not relevant	Always on
S4MGR-REQ-059	Increase available bandwidth in communications used on-board	Maritime Transport	Communication	Information Transfer	COM	Ship Operator and Crew	Global	Surface	Not relevant	Always on
S4MGR-REQ-060	Provide next generation satellite communications on board	Maritime Transport	Communication	Information Transfer	COM	Ship Operator and Crew	Global	Surface	Not relevant	Always on
S4MGR-REQ-061	Provide remote assistance to crew with the use of augmented reality	Maritime Transport	Communication	Information Transfer	COM	Ship Operator and Crew	Global	Surface	Not relevant	Always on
S4MGR-REQ-062	Provide improved satellite communications for man-	Maritime Transport	Communication	Information Transfer	COM	Coastguard	Global	Surface	Not relevant	Always on

Solutions

Table 4-1: Space Services, providers and end-users

ID	Provider	Space Service short description	end-users
S4MGR-SS-001	Prisma Electronics	Asset and life monitoring.	organizations responsible for assets and safety at sea
S4MGR-SS-002	Prisma Electronics	Remote sensing and data fusion.	organizations
S4MGR-SS-003	Hellas Sat	Maritime satellite high throughput services.	Commercial Ships, Offshore Rigs and Support Vessels, Merchant Shipping, Naval Forces
S4MGR-SS-004	ALTUS LSA SA	Shipping air measurements.	EMSA
S4MGR-SS-005	Libre Space Foundation	AIS Cubesat Constellation, with open data policy for disruption of existing business models around AIS data.	Maritime companies, Governmental Agencies, Research Institutions
S4MGR-SS-006	University of Aegean	A test project to detect artificial plastic targets on the sea surface using UAV and satellite images technology.	-



GREEK SPACE CATALOGUE 2018

ON ORBIT 2018

Operations Center, Darmstadt, Germany Research and Technology Center, France S.A. - Torino, Italy Research, Germany

ES. Perform IDV activities on the JUICE to perform mission specific operations... stored into the Data Processing Unit... software: ALTEC S.p.A. Support the Software Re-... Architectural Design of the Spacecraft

er (ESOC) Technology for Simulation (ACT)... critical research on possibility of parallel... operational simulation. Development of a... based on REFARFA-TA. Marine... Optimization of SMAULUS infrastruc-

Simulation Environment (ACT)... equipment of a comprehensive FDES for... Prototyping, tests and procedures for... for Operational Simulation, Feasibil-... concept in SIMSAT and Operational

Prototyping for the new generation sim-... USE NO. (2018) ISSA/TEC/RES/001. Sub-... Incubation Centre Darmstadt. Design... for real-time decision support systems... hardware.

Technology Center (ESTEC)... to support Tests and Operations... The main objective of the NCCSM... of new simulation technologies... and Co-Simulators, an enabling tech-... simulation in support of Verification, Vali-... systems.

Centre Magnetic Cleanliness Approach... for Magnetic Dipole Modelling (ACT)... identification of methods to use multiple... number and type) to measure the mag-

Integration

Systems with multi payload co-... Surface Vehicle (ESV) is a... developed by ALTUS LSA. The... (size of 1.750u) and controlled... through an unmanned op-... high performance rigid inflat-... 7.2m long hull, for high endur-... reserved. It has a payload... of 730 knots, while its range can... designed in order to support... ion and thus can perform a... activities.

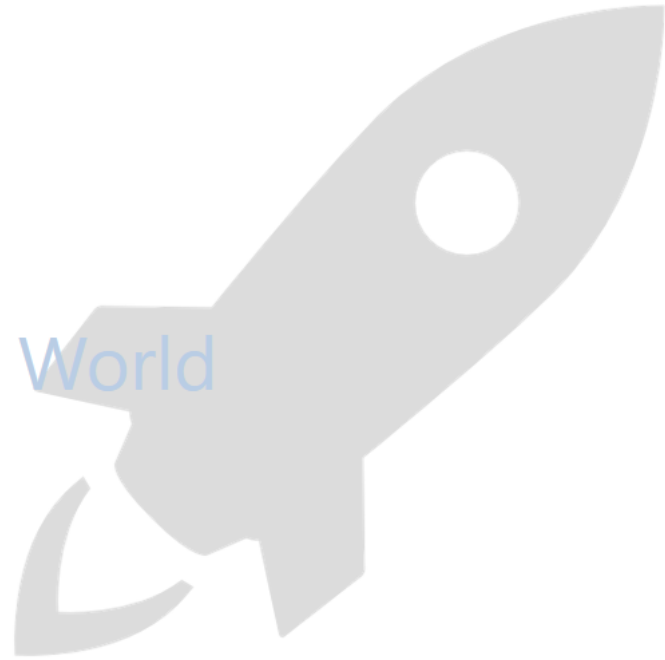
of scientific research applications... and Unmanned Surface Vehicle... (including measurement and re-... and research applications. The... inged panels. The body and... engine mounted combined with... heavy duty stainless electronic... in the speed and thrust through... (OCES).

and of... initial stabilized video/IR im-... and night missions, with its high... Resolution System (ARS) in... USSB. The ARS-IRI reads and... and is controlled by AIS Clients... AIS to Navigation.

real-time in real-time what ESOC... the Fuel Support Contract

real-time all the RPAS sensor... data. AIS signals to enhance... information between the op-... of the service during mission ex-

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3. **Autonomous Shipping**
4. Satellite-based solutions
5. Space-based solutions



4 degrees of autonomy

- 1st degree: Ship with automated processes and decision support
 - 2nd degree: Remotely controlled ship with seafarers on board
 - 3rd degree: Remotely controlled ship without seafarers on board
 - 4th degree: Fully autonomous ship



Requirements for Autonomicity

Sensing...

- IoT devices;
- magnetic sensors (e.g. for steering navigation);
- cameras and thermal cameras;
- Short-Range Radar;
- Optical and LIDAR systems;
- **EO data with higher frequency.**

... & Connectivity

- IoT systems & Connectivity;
- LoRa systems;
- data acquisition systems (DAS - on the ship and at the shore).



Requirements for Autonomicity

Digitilisation

- Digitilisation of machinery and equipment
- The Digital Twin approach is one of the main solutions to develop autonomous vessels as it provides the ability to run thousands of "what-if" scenarios and investigate the performance of the vessel, prior to construction.

Requirements for Autonomicity

Monitoring, Data Analysis, and Smart & Cognitive systems

- Computer vision (e.g. in autonomous navigation for vessels equipped with camera sensors for gathering data); data analysis on systems behaviour;
- Big Data Analytics;
- AI based situational awareness;
- AI-based decision making;
- AI based automatic maneuvering;
- AI deep learning;
- Efficient Optimal Navigation Control Algorithms;
- Proactive and Reactive cognitive systems;
- Predictive Maintenance of machinery.



Requirements for Autonomicity

Positioning-Navigation-Timing (PNT) & Communication

- GNSS; path planning and precision navigation even in the conditions of unavailability of time / positioning signals.
- Information Relay; Satellite communications; BLoS Communications; Delay Tolerant Satellite Networks; Remote operations and control (Telemetry - Telecommand) through satellite link.
- Cooperative sailing in swarms (i.e. 3 ships together) including ship to ship transfers; Inner-port autonomous operation; vessel auto-piloting and auto navigating by autonomous swarm of tugboats within port limits.

Requirements for Autonomicity

Other technologies...

- Robotic-based maintenance and repairs.
- On-board automatic 3D-printing.
- UAVs, auto-crawlers, sea drones and sub drones for e.g. inspection, cleaning, etc. (of the hull, the tank, etc.)
- Augmented Reality for enhanced monitoring.
- Cybersecurity.



Requirements for Autonomocity

... and beyond technologies

- Funding and R&D.
- Integrated applications combining space, air and ground technologies.
- Test Sites.
- National & International regulations

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Satellite-based solutions



Satellite
Communications
(SatCom)



Satellite
Navigation
(SatNav)



Satellite
Earth Observation
(SatEO)





- Marine forecasts, natural disaster prediction and early warnings.
- Accurately monitor weather conditions for route optimization purposes
- Wave's direction/speed/wavelength; Maritime thunderstorms monitoring; Monitor shape and state of icebergs above and below the sea surface and issue timely warnings.
- Identify vessels with no AIS
- Improve temporal resolution of EO data regarding illegal activities detection
- Spot and trace fallen containers



Implemented by
**MERCATOR
OCEAN
INTERNATIONAL**

TRADE & MARINE NAVIGATION

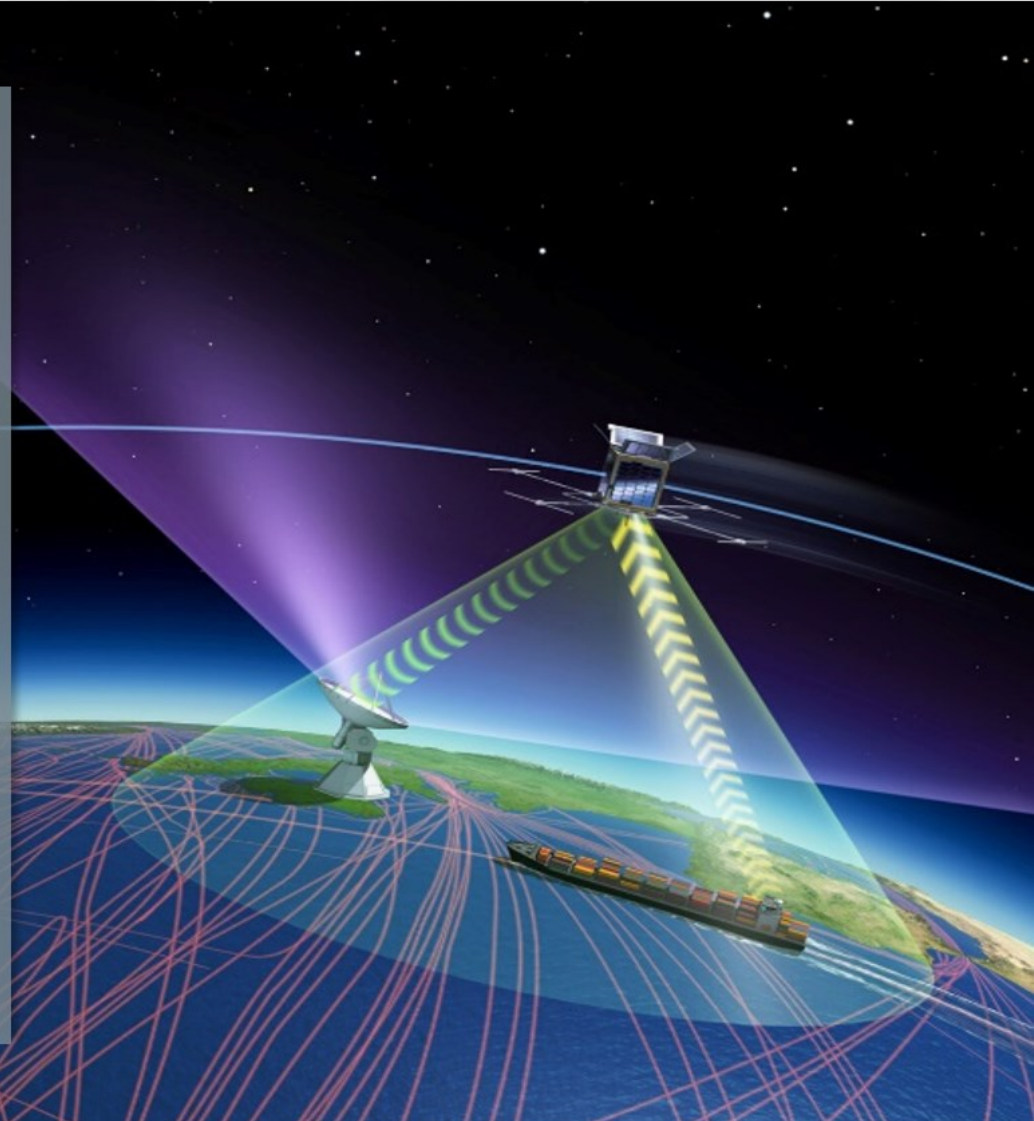


AVAILABLE
VARIABLES



OCEAN CURRENTS
SEA LEVEL
WAVES
TEMPERATURE
SALINITY
SEA ICE
SEA SURFACE HEIGHT

- Allows track and trace of vehicles, people and assets
- Allows navigation of autonomous vehicles in the open ocean and at ports.
- Enhanced Satellite Automatic Identification System (S-AIS).
- Collisions avoidance.
- Enable M2M in remote areas
- ESA's initiative Space for 5G (S45G).
- European Space Agency has initiated a new ARTES Strategic Programme Line dedicated to "Space Systems for Safety and Security (4S)"



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Space-based solutions

Space can be used to support the transition to full autonomous shipping through, not only **satellite navigation** and **telecommunications**, as well as **Earth Observation** services...

... but also through **other technologies and processes** developed for operating satellites and spacecraft in harsh environments.

Other Space Solutions

ASICS and
Electronics Design



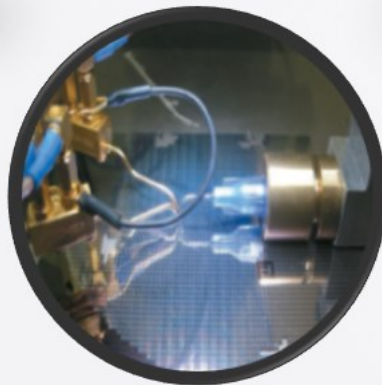
Composites Materials
and Structures



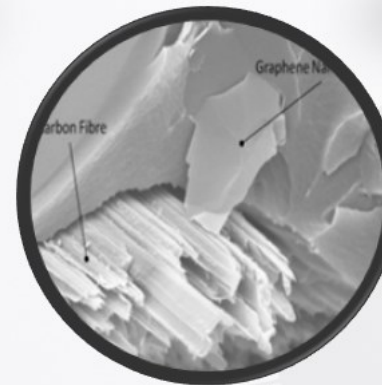
Deployable
Structures



Sensors



Novel Materials
and Processes





More information @

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