D.9.3

MARKET ANALYSIS REPORT – INDUSTRIAL REQUIREMENTS & BUSINESS MODELS

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Abstract:

The deliverable provides a detailed market analysis identifying existing business models and competitive landscapes relevant to the technologies developed for the purposes of the ISOLA Project, market size (current and future), technology trends and regulatory frameworks relevant to the adoption of integrated novel technologies aiming to assist ship security.

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Executive Summary

The present document is a deliverable of the ISOLA project (the "**Project**"), which has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 883302.

The scope of this deliverable is to provide a detailed market analysis on the industrial requirements and business models, as well as the competitive landscape, relevant to the technologies to be developed. The deliverable will also look on the various proposed business models for the technologies and their integration and promotion to the market.

An integral part of the Project is the design and development of the ISOLA Platform, a tool that will be developed throughout the duration of the Project and will offer high-end features and specifications. The deliverable includes a SWOT analysis to consider each technology to be developed and proposed by the relevant consortium partners, including the ISOLA Platform.

It is noted that on the final version of the deliverable and subject to the progression and development of the main deliverable of the Project (the ISOLA Platform), the Report shall further address the overall ISOLA ecosystem and its competitive edge vs competitors in the market as an integrated platform.

From a regulatory perspective, an overview of the current EU legal framework and a comparison with third-country regulatory approaches is also included herein.

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List of Acronyms & Definitions

Acronym	Meaning
ACCELI	Acceligence Ltd
CENTRIC	The Sheffield Hallam University
CERTH	The Ethniko Kentro Erevnas Kai Technologikis Anaptyxis
CYBERLENS	Cyberlens BV
DBS	Dromon Bureau of Shipping
GDPR	The General Data Protection Regulation 2016/679 on the protection of natural persons concerning the processing of personal data and the free movement of such data
IBM	IBM Israel - Science and Technology Ltd
IDEMIA	IDEMIA Identity & Security France
IDMG	IDEMIA Identity & Security Germany AG
IMO	International Maritime Organization
MoD	The Cyprus Ministry of Defence
NTUA	The National Technical University of Athens
OCEANSCAN or MST	Oceanscan - Marine Systems & Technology Lda
PRISMA	Prisma Electronics ABEE
PROMETECH	Prometech BV
SIMAVI	Software Imagination & Vision S.r.l
T4i	T4i Engineering Single Member Private Company
UAS or UAV	Unmanned Aircraft System or Unmanned Aircraft Vehicle
UUV	Unmanned Underwater Vehicle
Project	The ISOLA Project.
PARTNERS OR CONSORTIUM	Partners participating in Task 9.3, per the ISOLA Grant Agreement.
IMO	The International Maritime Organisation
DVATS	Stands for Dynamic Vulnerability Assessment & Testing System

1 Introduction

For the preparation of this report the Task Leader (**ACCELI**) liaised with the partners to provide their insights and contributions from each partner's business perspective. The input was provided based on a standardised template (**See Annex I: Partner Fill-In Form**) and the individual contributions prepared by the partners have been considered, reviewed and analysed for this Report.

It is noted that on the final version of the deliverable and subject to the progression and development of the main deliverable of the Project (the ISOLA Platform), the Report shall further address the overall ISOLA ecosystem and its competitive edge vs competitors in the market as an integrated platform.

2 SWOT Analysis

SWOT analysis is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats involved in a project or a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favourable and unfavourable to achieve that objective. A consistent study of the environment in which an organisation operates helps in forecasting/ predicting the changing trends and also helps in including them in the decision-making process of the organization[1].

Due to the dynamic and increasingly competitive environments within which institutions operate, it is essential, both for the Project and for the future planning of each partner for exploitation and commercialisation of the technologies, to determine the degree to which such environments will affect them. SWOT analysis is a step that assists organisations to analyse their competitiveness whilst identifying factors within maybe a stimulus or a potential threat to their objectives.

Partners were provided with the below SWOT Table template to facilitate their analysis and responses:

	Service Name & Partner Name	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGTHS** *What do you do well?* *What unique resources can you draw on?* *What do others see as your strengths?*	**WEAKNESSES** *What could you improve?* *Where do you have fewer resources than others?* *What are others likely to see as a weakness?*

EXTERNAL FACTORS	**OPPORTUNITIES** *What opportunities are open to you?* *What trends could you take advantage of?* *How can you turn your strengths into opportunities?*	**THREATS** *What threats could harm you?* *What is your competition doing?* *What threats do your weaknesses expose you to?*

CO-Annex III lists the SWOT Analysis per partner.

3 Value Proposition

ISOLA Platform Value Proposition:

ISOLA will develop, integrate, test, deploy, demonstrate and validate a systematic and fully automated security approach by incorporating innovative technologies for sensing, monitoring, data fusion, alarming and reporting real-time during illegal incidents. This will ensure a high level of security among all the passengers of the ship and augmentation of the Ship Security Plan.

To achieve the above, the ISOLA partners will develop a set of innovative pilot technologies and will acquire data from such technologies and others, to create a high-level security environment on cruise ships.

The target customer list for the platform, including each technology segment to be created, consists of, among others:

(a) Cruise Lines, Ship manufacturers, Naval related companies;

(b) Border Authorities, Border Police, Safety and security agencies;

(c) Policymakers, EU and local agencies;

(d) Facility Managers, Maritime transport organisations;

(e) Maritime Companies & Authorities; and others.

4 ISOLA Platform SWOT

	FAVOURABLE FACTORS	ADVERSE FACTORS
INTERNAL FACTORS	**STRENGHTS** ▪ High level of interoperability in the detection mechanisms ▪ Real-time monitoring of security threats in real-time ▪ Existing Ship Infrastructure augmentation with Artificial Intelligence ▪ Intelligent Boarding System ▪ A Ship Security Plan Platform fully compliant with maritime legislation ▪ Effective and affordable combination of conventional and complex sensors ▪ Semantic representation and indexing of the collected data in a unifying framework ▪ Robust platform to cyber attacks ▪ Strong societal impact and social interaction ▪ Coverage for all passenger ships types (small ship, cruise ships) ▪ Demonstration in different ships and European Border areas ▪ Engagement of ship classification societies (Dromon) ▪ Engagement of security organisations (AVR, ZEUS, BDI, Ecole Navale) ▪ Engagement of Border Authorities (Cy-MOD, SBGS, Ecole Navale) ▪ Large European ship companies (ANEK, CSL) ▪ Effective dissemination, communication and clustering within the ship security domain ▪ Integration with existing monitoring systems in ships	**WEAKNESSES** ▪ Increased volume of data ▪ Low maturity of some technologies ▪ Ownership and liability issues
EXTERNAL FACTORS	**OPPORTUNITIES** ▪ Mass production of, at present expensive units, will lower the costs to allow ubiquitous installation of a holistic approach platform ▪ Scalability of the system to new threats that develop in the near future ▪ Insertion into the market of very expensive equipment at low interoperability levels ▪ Break the fragmentation and isolation of European agencies in the maritime domain ▪ Potential extension to other types of ship (cargo)	**THREATS** ▪ The ISOLA concept is copied by an organisation with more financial leverage ▪ Local legislation barriers

5 Market Analysis

5.1 Business Environment

Through the ISOLA project, partners aim to develop novel solutions to enhance the situational awareness and support to the assigned Ship Security Officer & Crew on board commercial and industrial ships to the execution of their duties; especially with regards to the implementation of the Ship Security Plan.

The ISOLA consortium will develop, integrate, test, deploy, demonstrate and validate a systematic and fully automated security approach and will be incorporating innovative technologies for sensing, monitoring, data fusion, alarming and reporting real-time during illegal incidents.

Part of the main objectives of the ISOLA project is the adoption of innovative sensors and visual technology components to support security safety.

Potential customers of ISOLA products are companies with the highest innovation potential, investment capabilities and needs correlated to the technologies to be developed.

5.2 Benefits to the industry and market players

The development of the pilot technologies will have a significant impact on the shipping industry and can influence market players to adopt new practices incorporating innovation and technology in various sections of their everyday activities.
The utilization of the proposed technologies can significantly improve safety, reduce costs and speed up activities, while it can also speed up the process for granting access to authorized personnel on and off-board.

Some of the key benefits that have been identified include:

(1) Replacing the need for human inspections, routine maintenance can be monitored remotely in real-time by surveyors, providing instant feedback to the vessel or offshore Superintendent. This, in turn, reduces costs, increases efficiency and significantly reduces the risk to human life during essential maintenance.

(2) Dealing with the task of hazard avoidance has become far easier for commercial shipping companies where drones can be utilized to inspect and address hazards before to human intervention.

(3) Drones can be typically operated by one person without any extensive safety equipment, meaning the costs associated can be significantly reduced.

(4) UAVs are quick to deploy in comparison to traditional methods, reducing downtime.

5.3 Benefits to the economy

Partners were asked to provide their input on what they would consider the potential benefits to the economy could be from the adoption of their innovation and/or technology development. The main points that were recurrently put forward by partners, irrespective of their technical specifications, include:

(1) the ability to enhance and automate operations and enrich user experience from the utilization of Artificial Intelligence (AI) technology;

(2) the reduced costs from the adoption of such technologies, which is a significant factor for market players in this industry due to the budget cuts they have to address;

(3) safety and security, including passenger and personnel protection and welfare;

(4) operational efficiency and performance and minimization of human errors.

The contributions of the partners are included in **CO Annex III** based on the technology to which each partner is contributing.

5.4 Policy Plans & Regulatory Framework

For the purposes of the Project, it is important to consider the applicable legal and regulatory framework which may have an impact on the technology innovations developed.

Based on the specifics of the ISOLA Project, the below legal frameworks have been identified which govern the use and deployment of the technologies to be used for the Project.

A. Unmanned Aircraft Vehicles ("UAVs") / Unmanned Aircraft Systems ("UAS")

EU Regulations 2019/945 of 12 March 2019 on unarmed aircraft systems and on third country operations of unmanned aircraft systems and 2019/947 of 24 May 2019 on the rules and procedures for the operation of unmanned aircraft (the "**Regulations**") set the framework for the safe operation of drones in European skies (EU and EASA Member States; a list of which is provided hereto https://www.easa.europa.eu/country-category/easa-member-states).

The Regulations are enforceable in all EU Member States as of 31 December 2020 and all UAS manufacturers and operators must ensure they comply with their provisions. The Regulations do not distinguish between leisure or commercial activities for operations or UASs; a risk-based approach is followed taking into account the weight and other specifications of the UAS as well as the type of operation it is intended to complete.

There are three (3) UAS categories in accordance with the Regulations:

a) Open Category

The Open Category is a category of UAS operation that, considering the risks involved, does not require prior authorization by the competent authority nor a declaration by the UAS operator before the operation takes place.

b) Specific Category

The Specific Category is a category of UAS operation that, considering the risks involved, requires a prior authorization by the competent authority before the operation takes place, taking into account the mitigation measures identified in an operational risk assessment, except for certain standard scenarios where a declaration by the operator is sufficient or when the operator holds a light UAS operator certificate (LUC) with the appropriate privileges.

c) Certified Category

The Certified Category is a category of UAS operation that, considering the risks involved, requires the certification of the UAS, a licensed remote pilot and an operator approved by the competent authority, in order to ensure an appropriate level of safety.

B. Edge Solution and Mobile Application

There are two relevant legal frameworks for the development of the edge solution in ISOLA, namely the (i) the General Data Protection Regulation (the "**GDPR"**) on a European level and (ii) the adoption of the GDPR on a national level and/or any additional local directives or guidelines issued to that extent.

The GDPR was formally adopted by the European Parliament in May 2016, and replaced the 1995 General Data Protection Directive, applying to all 28 EU member states, effective from May 2018. Entities are subject to the GDPR as far as they process personal data of EU data subjects for their goods or service offerings in the EU and/or for the monitoring of the behaviour of EU data subjects taking place within the EU.

The GDPR is a game-changer for organizations. It has introduced new requirements and more stringent data protection challenges, backed by extremely high fines of up to 4% of total annual worldwide turnover or €20,000,000 for non-compliance. GDPR is not just a compliance exercise. There are major strategic implications that could bring market opportunities and competitive advantage for those who plan as appropriate, or potential revenue loss for those who fail to react.

The GDPR is highly relevant for the development and use of the edge service as this solution processes personal data from individuals in video streams. The same regulation is relevant for the development of the mobile application for the purposes of the Project, in which personal data of individuals will be collected (such as registration details) as well as reading and collection of individual's Twitter accounts.

C. Detection of illicit drugs

The applicable EU framework for the detection of illicit drugs is Regulation (EC) No 273/2004 of the European Parliament and of the Council of 11 February 2004 on drug precursors (the "**Regulation 273**"), establishing harmonised measures in the EU for the control and monitoring of certain substances frequently used for the illicit manufacture of narcotic drugs or psychotropic substances with a view to preventing the diversion of such substances. Regulation 273 provides the legal framework on the prevention of illegal use of narcotic drugs, as this is to be implemented across the different EU Member States focus on detection of illicit drugs.

The competent authorities for the enforcement of the Regulation include, among others, the different law enforcement agencies in each Member State (on a national level) and the EUROPOL (on a European level).

The Regulation 273 is relevant for the purposes of the project as the consortium will develop a monitoring system of air facilities and handheld chemical detector (**Partner: T4i**) for the detection of illicit drugs on cruise ships.

D. Cyber Security

Vessels worldwide are facing compliance with various cyber security regulations whose goal is to support secure shipping, which is operationally resilient to cyber risks. The maritime cyber security legislative and regulatory frameworks that govern ISOLA's Service 7.3.1 include the following.

Resolution MSC.428(98)[2] **- Maritime Cyber Risk Management in Safety Management Systems**. This Regulation was adopted by the International Maritime Organization (IMO) in June 2017 as part of the mandatory regulatory framework for the shipping industry. The resolution encourages administrations to ensure that cyber risks are appropriately addressed in existing safety management systems, as defined in the International Safety Management

(ISM) Code. Ship owners and operators will need to comply with the Resolution from 1 January 2021, and no later than the first annual verification of the company's Document of Compliance (DOC).

The IMO Regulation is supplemented by the **IMO Guidelines on Maritime Cyber Risk Management - MSC-FAL.1/Circ.3**[3]. With MSC-FAL 1/Circ 3, IMO provides guidelines and high-level recommendations on maritime cyber risk management to safeguard shipping from current and emerging cyber threats and vulnerabilities. The recommendations can be incorporated into existing risk management processes and are complementary to the safety and security management practices already established by IMO.

Additional guidance is available from publications including the "**Guidelines on cyber security onboard ships**"[4] issued by BIMCO, CLIA, ICS, INTERCARGO, INTERTANKO, OCIMF and IUMI and the World Shipping Council. BIMCO has also issued a "**Cyber Security Workbook for On Board Ship Use**"[5] which uses checklists, providing a ship's crew with the practical skills to identify cyber risks and to protect vulnerable onboard systems. Recently, DNV GL also published a relevant **Recommendation on ISM and Cyber Security**[6]. This recommendation aims to support DOC holders handling the cyber challenge through their safety management system (SMS), as mandated by the ISM Code.

Other best practices recognized for the implementation of cyber risk management include the following:

- **ISO/IEC 27001:2013**[7] standard on Information Security Management Systems published jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC), and the

- United States National Institute of Standards and Technology's Cyber Security Framework (the **NIST Framework**)[8].

Both ISO/IEC 27001 and NIST CSF involve establishing a risk management framework and implementing information security controls. The Maritime and EU regulatory framework together with the emerging industry standards for cyber risks protection recommend maritime companies to implement management systems that conform to the above-mentioned international standards and frameworks.

6 Technology Trends

Technology and market trend analysis is important to assist the consortium of the Project to predict the success of their innovations in the sector. It provides valuable evidence to help entities take informed decisions around long-term strategies for the promotion and exploitation of the technologies going forward.

Market trends can further signal shifts in the industry which can present Partners with a tremendous opportunity to "move" along with the trends and not against them, leading to potentially profitable opportunities.

This section addresses the current technology trends relevant to the innovations being developed for the ISOLA project. Accompanied by the Competitive Analysis it enables to locate business rivalry and assess their strengths so that partners can adjust to offer a competitive advantage versus existing and/or similar technologies.

6.1 UAVs

The commercial application of UAVs in various industries highlights the rapidly growing need for efficiency, reliability, and cost-effectiveness that UAVs provide to large-scale businesses. The industries that have thus far benefitted the most from utilizing UAV and AI technologies are agriculture, energy, construction, media, maritime, security and surveillance.

This growing trend exemplifies the endless commercial possibilities of UAVs in the supply chains across industries in the primary and secondary economies. Market reports have estimated that the drone market industry could grow to $63.3 billion by 2025, with Goldman Sachs forecasting that the total drone market size to be worth $100 billion[9].

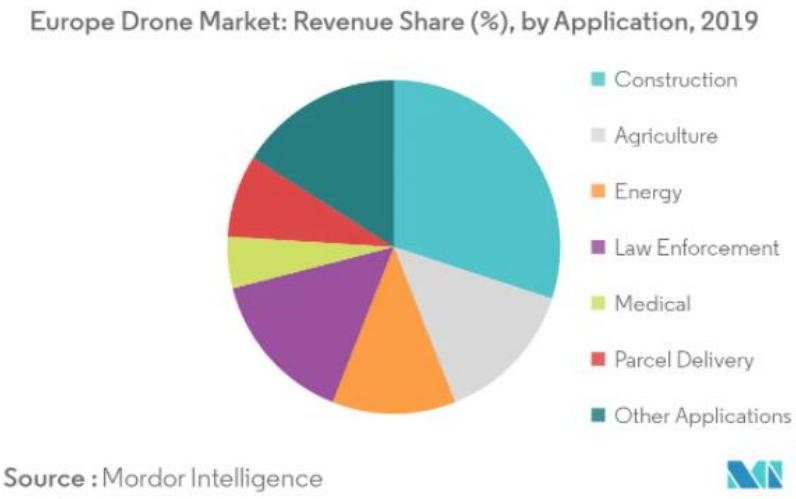

Figure 1: Europe Drone Market Revenue Share (2019).

Currently, UAVs are used as monitoring and mapping tools, providing a bird's-eye view of any situation. This allows for faster, more efficient, and less costly evaluation of a project or work site. For example, in the Maritime industry, UAVs are utilized primarily to perform monitoring tasks, such as enabling a ship's maintenance officer to survey the hull of the ship for potential leaks and damages without having to physically send a boat to investigate[10]. In mere minutes,

a drone equipped with advanced camera sensors sends a crystal-clear image to the officer who is then able to inspect the site and evaluate the need for maintenance.

Furthermore, the European Union Airspace Safety Agency had recently approved Nordic Unmanned as the first European Light UAS Operator Certificate (LUC)[11]. Following the certification, Nordic Unmanned was able to perform drone operations beyond the visual line of sight (BVLOS) within all EASA member countries. In turn, this allowed Nordic Unmanned to deploy their UAVs on behalf of Lithuanian authorities in maritime pollution patrolling operations. Following the application of UAV maritime pollution patrols, the Lithuanian authorities reported that the percentages of inspected ships rose from 25% to 70-80% of the ships entering Lithuanian waters. Among these ships, the Lithuanian authorities identified more than 10 cases of non-compliant vessels and have handed out a 10,000 EUR fine to a shipping company for Sulphur pollution.

6.2 Visual Content Analysis

Governments are focusing on increasing their AI capabilities to revolutionize various sectors, from healthcare and security to transport. EU has committed to invest EUR 1.5 billion in AI to catch up with the United States and Asia. With AI becoming the core of many technology-based applications, investments in the sector are growing. For example, image recognition stands as one of the standard features for many AI-related industrial or not applications. Thus, the market is expected to leverage the fast-growing technology and expand in the coming years.

Furthermore, the AI Image Recognition Market estimated value was USD 1695.93 million in 2020[12] and is expected to reach a value of USD 5161.04 million by 2026[13], registering a CAGR of 24.82% during the forecast period (2021 - 2026)[14], evidently a massively growing and upcoming industry.

Numerous industries could benefit from the utilisation of visual content analysis technology including automotive, banking, financial services and insurance, healthcare, retail and security.

Additionally, visual content analysis technology components are used and will continue to be utilised in the future across various fields, such as vehicular safety, advertising, security and surveillance, biometric scanning machines, pedestrian recognition, and e-commerce, with various applications in multiple domains, the market is expected to witness strong growth during the forecast period.

6.3 Semantic & Multimodal Indexing

During the last decade, Internet has become one of the most common things that people worldwide use every day. In specific projects and applications, the number of sensors that are utilized can produce gigabytes or terabytes of data. Semantic and multimodal indexing plays a crucial role in organizing, fusing and translate all those data into useful and exploitable information.

Semantic and multimodal indexing could further benefit all industries that produce a lot of data and need to fuse and translate those data into information with increased exploitability and in human-friendly form. Examples include, but are not limited to, the automotive, healthcare, banking, financial and security industries.

6.4 Mobile Application

Mobile marketing nowadays has become the easiest and best way for exploring or expanding any business, assisting organisations to expand their customer base and make an online profit.

With such an advanced and fast way of marketing in play, the mobile app plays an important role in major announcements to the market[15].

6.5 3D-visualisation module

With regards to the 3D visualisation module to be presented, the benefits of such a model are that the learner cues on visual, auditory and spatial elements of a 3D environment which leads to better recall and application of learning[16]. It further enables the learner to rehearse on a virtual on-the-job behaviour, in an environment as close to the job environment as possible (also referred to as a real learning environment). Furthermore, a 3D visualisation model allows learners at a distance to be in the same place to practice behaviours (not just online at the same time) and to become emotionally involved in the learning due to the realistic features offered. For experienced learners, the opportunities to explore more possibilities of dialogue than in a scripted simulation are enhanced and provide an ultimate sense of "being there", making real-life reaction responses and preparedness levels rise.

The current market growth of mobile application installations has increased by 50% from 2019 to 2020 across all verticals, with installs up again by 31% in the first quarter of 2021 compared to the same time frame last year[17].

The future uses for mobile applications are immense; over 1 billion smartphones and 179 billion mobile applications are downloaded per year, making mobile development certainly one of the most innovative and actively growing sectors. Mobile application development is driven by advancements in technology which requires businesses to have a vision for the next few years.

Some of the trends which will determine the future of mobile application development are indicatively included herein below:

- Wearable Devices: Wearable devices connected with smartphones will influence the next generation of mobile application development strategies.
- Internet of Things and Mobile-Connected Smart Objects: Domestic smart objects will be a part of the Internet of Things and will communicate through an App on a smartphone or tablet.
- Motion And Location Sensing: Precise indoor location sensing, combined with mobile applications, will enable a new generation of extremely personalized services and information.

6.6 Field Analysis / Monitoring Systems and Detectors

There is a strong trend for field analysis, i.e., instead of bringing samples to the lab, to develop technologies that can analyse them onsite. With the advent of miniaturization and power autonomy, this is possible nowadays and safety and security, in general, is strongly focusing on developing hand portable instrumentation. This technology is characterized by weights less than 5kg, power autonomy between two (2) to five (5) hours, with the possibility of battery swapping and expanding operation time, highly ergonomic design that allows for versatility.

Advent in communications has resulted in connecting these technologies with the operational centre that receives the onsite measurements, either as raw data or processed alarm messages, for further processing, visualization and reporting.

The current uses of such technologies are mostly found in environmental monitoring, industrial safety and security. Future uses include cruise business and smart cities, with an emphasis on multi-store buildings. The industries that can benefit the most from the use of this technology include, among others, Original Equipment Manufacturers ("OEM"s) of chemical detectors as

well as many industries that are part of the supply chain, e.g., miniature pumps, valves, plastic tubes. However, the main benefits will be on the cruise business by increasing the safety and security of customers and personnel.

Due to their expanding usage, geo-political actors have taken steps in utilising and/or developing and/or regulating this technology by defining specifications for using this technology in the field, including NATO which introduced Standard 810G known for defining many different specifications (e.g., IP protection) of similar field-deployable equipment.

The current market growth for such detectors is indicatively presented in the table below:

Global Market Trends in USD billions in DOVER relevant market segments (2015-2020*)

Global Market Sectors	$	2020 $	CAGR	Comments
Forensic Market	2012: 8.3	17.7	11.43%	Airborne chemical detectors do not exist.
UAV	2015: 9.0	14.0	9.24%	More than 20% for civil sector
Gas and VOCs detectors	2014: 2.5	3.35	5.0%	PIDs are included
Spectrometers (Total)	2013: 12	20.0	7.57%	IMS and MS are included

6.7 Edge Computing

Edge computing has several advantages over centralized computation, as it avoids the transmission of data from a data source to a centralized system and is beneficial in application fields that require short reaction times. This helps to improve operational efficiency, performance and security as it reduces the amount of data that has to travel over a network.

Core application fields of edge-based video processing are automatic self-driving[18], traffic control[19], or surveillance applications[20] for the protection of critical infrastructures[21]. Respective applicants of edge solutions include car manufactures and especially suppliers, public authorities managing public camera surveillance systems, private organizations of critical infrastructures like energy providers, airports, ports, railway stations etc. Besides that, also hardware and software providers, integrators, distributors and more will profit from this development.

According to Expert Market Research[22], the global edge computing market will rise from USD 3.1 billion in 2020 to USD 11.6 billion by 2026, at a CAGR of 24.48% in the 2021-2026 forecast period.

A compliant figure[23] from a different source shows the expected market growth of edge computing separated into different geographical regions:

Solutions for video-based edge computing are still at the beginning of development and market penetration.

Figure 2: Edge Computing Market by Region.

Besides the above-mentioned core applications fields, future edge-based applications may also include for example the health sector (surveillance of patients) or the area of mobile robotics/ automation.

The most relevant industrial organizations in the field of video-based edge computing are camera manufacturers that integrate video processing in their camera chips. The key top providers from the western hemisphere include BOSCH and AXIS[24].

6.8 Secure Boarding System

According to NEC Corporation COVID-19, COVID is a" catalyst" that contributes to transforming travel habits. In many airports, contact checkpoints are being eliminated and streamlined with biometric verification with the objective of better security and better hygiene. Airlines and airports around the world are implementing technology that enables travellers to check in with face recognition, enabling contactless passage through multiple touchpoints in the airport.

The industries that could benefit the most by utilizing this technology include, among others, border control, passenger flowmanagement in airports, harbours or public transport in general, popular events such as Olympic Games or World Championships.

As a brief showcase of the market growth for such technologies, it is worth noting that Mordor Intelligence the Biometrics Market was valued at USD 27.92 billion in 2020, and it is projected to be worth USD 62.9 billion by 2026 while registering a CAGR of 14.59% during the period of 2021-2026.

6.9 Crisis Classification

Maritime transport plays a crucial role in the global economy, allowing world trade to prosper through the openness of the sea. However, this unique essence of the maritime industry exposes maritime operations to an increased security risk, especially when operating in certain high-risk areas[25]. Such threats can be financially damaging and life-threatening for passengers and crew alike, as well as dangerous for the broader security of a specific area or country. Thus, considering the consequences of inaction, industry stakeholders are increasingly taking steps to increase onboard security[26]. This, in turn, reduces the negative economic impact due

to security incidents and attracts passengers that would otherwise avoid, e.g., cruises due to security concerns.

The primary beneficiaries of the crisis classification service are the cruise and passenger line operators. Secondary beneficiaries of the technology are the port operators, coast guards, and security personnel, which are directly involved in case of a security incident.

Three (3) main factors that are related to the market growth of this technology are identified. First, the increasing security threats; as piracy and terrorist attacks, illegal boarding, etc.; and the relevant regulatory framework urge stakeholders to seek measures to enhance security onboard. Then, the ongoing market growth for the cruise industry will increase the demand for security-related systems to be installed. Finally, the increasing user acceptance for similar solutions due to recent technological advancements makes cruise ship owners more likely to install such solutions to enhance onboard security.

The crisis classification service conducts risk assessments based on the received inputs from other ISOLA components and services. Given additional input data, future use of the service could include additional security threats to be assessed and considered in the estimation of security level.

Security incidents are a major concern for all governments globally (most notably, the USA) and organizations (such as the IMO) that have set in place a series of actions aimed at reducing the risk from the security gaps in the maritime network.

6.10 UUV System

Advancements in technology that reduced the costs of ocean exploration technologies, paired with increased concerns over climate change and environmental impact created large interest in ocean exploration and monitoring. The UUV system used in ISOLA provides a very accessible platform with reduced operational cost and high flexibility.

Some of the industries that could benefit the most from adopting the UVV system include:

(i) Military & Defence: used for border security and surveillance, antisubmarine warfare, monitoring smuggling of illegal goods, environmental assessment, mining countermeasures.

(ii) Oil & Gas: used to conduct pipeline surveys, geophysical surveys, debris/ clearance surveys, baseline environmental assessments.

(iii) Environmental Protection & Monitoring: for habitat research, water sampling, fishery study, emergency response.

(iv) Oceanography

(v) Archaeology & Exploration

(vi) Search & Salvage Operations

According to Markets and Markets, the autonomous underwater vehicle (AUV) market (without payload) is projected to grow from USD 638 million in 2020 to USD 1,638 million by 2025; it is expected to grow at a CAGR of 20.8% from 2020 to 2025.

The use and demand for autonomous systems are growing worldwide. Autonomous underwater vehicles are used to collect various types of data. In the future, such vehicles can be used to collect data and take actions autonomously based on the data collected.

The increased need to monitor the ocean and the reduced operational costs of the autonomous systems is probably why the need is growing for such systems.

6.11 Drones Platform

Platforms for automatically piloting drones are safer and can save time and costs across many sectors. Tasks, such as inspections, which are performed today manually or semi-manually can be automated and digitized, while integrating with AI models and asset management systems to achieve an end-to-end drone based solution. The technology can be operated in otherwise hard to reach areas as well.

Some of the industries that could benefit the most from adopting the drones platform technology include:

(i) Civil infrastructure for inspecting ageing structures.

(ii) Maritime scenarios – ship inspection, cargo loading, search and rescue at sea

(iii) Agriculture – for precision agriculture

(iv) Cell towers and electricity lines inspection

The market is currently growing significantly in the automatic piloting sector. For example: "The overall drone inspection & monitoring market is projected to grow from USD 9.1 billion in 2021 to USD 33.6 billion by 2030, at a CAGR of 15.7% from 2021 to 2030. North America is estimated to account for the largest share of the drone inspection & monitoring market from 2021 to 2030[27].

Drone platforms are currently used, among others, in civil infrastructure for inspecting ageing structures, maritime scenarios for ship inspection, cargo loading, search and rescue at sea. They are also widely utilised in agriculture for precision agriculture and cell towers and electricity lines inspection. Potential uses could be introduced for aeroplane and solar panel inspection as well as power cables inspection.

It is worth noting however that there are currently ongoing regulation efforts on automatic drone piloting. There is interest from various sectors as to the use of this technology (civil infrastructure, agriculture, etc.). As the use of drones is wide-spreading, for inspection, security, news and media and delivery, more countries are allowing automated flights pilots to be held[28].

6.12 Dynamic Vulnerability Assessment & Testing System

Undoubtedly, the growing utilization of advanced Information and Communication Technology (ICT) and Operational Technology (OT) systems onboard ships has increased the efficacy of their operations both onboard and ashore, yet it opened the otherwise isolated and protected systems of the ship to cyberspace making them vulnerable to cyber security threats. To address the cyber security challenge, the major stakeholders of the maritime industry have started moving towards the utilisation of maritime risk management systems. The utilisation of such technologies greatly benefits the maritime industry, however, this may be expanded to other industries as well, such as the oil and gas, chemicals, petrochemicals, pharmaceutical, and steel industries.

According to a new report entitled "Global Maritime Risk-Management Software Market Growth (Status and Outlook) 2021-2026", the maritime risk-management software market will register an 11.9% CAGR in terms of revenue, and the global market size will reach US$ 400 million by 2026.

Both current and future uses of such technology concern the maritime cyber risk management teams whose purpose is to safeguard the shipping industry from current and emerging cyber threats and vulnerabilities.

Understanding the importance of security and the advantages of introducing such technologies onboard ships and vessels, the IMO, the global standard-setting authority for the safety, security and environmental performance of international shipping has taken important steps towards regulating our technology through the Resolution MSC.428(98) – Maritime Cyber Risk Management in Safety Management Systems.

7 Key Innovative Technologies

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
ACCELI	Service 3.2.1 ISOLA UAV	• Open Source: Software with source code that anyone can inspect, modify, and enhance. • Algorithms utilised • GPU support: Embedded AI-driven operation for enhanced decision support capabilities. • UAV neutralization: Automation of the overall procedure with no "time to react" delays. • Perform image/video processing Threat detection and forecasting: using advanced anomaly-based detection models to indicate deviations to normal system activity w.r.t. the application and signify potential threats before they cause critical damage.	• Detection, Recognition, Alarm for any approaching threat. • Mission UAV can approach the object and identify the situation. • Onboard sensors and cameras for ship surveillance and nearby areas.	• User-friendly: easy to be used by anyone with minimal training. • Ecosystem friendly • Continued technical support and updates
CENTRIC	Service 5.4.1: Decision Support	• Text generation algorithms used • Predictive analysis of threats using risk modelling	• Support the early identification of risks and emerging threats before they manifest	• Configuration and customisation for particular uses cases and adapting to

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
	Service 6.1.1: Risk Management Modelling Service 6.2.1: Warning message	• Active decision support reacts to threats to give advice promptly.	• Provision standard operating procedures using an interactive platform to ensure ease of compliance	operational constrains and requirements.
CERTH	Service 3.5.1: Drones Platform/UAV Path Planning	• Coverage Path Planning (CPP) operations: capable of deploying a team of UAVs to cover areas to support situational awareness overview of the ship using UAV-onboard sensors. • Single/Multi-UAV support. • Support of No-fly zones/Obstacles inside the operational area. • Supported shape of Region of Interests: Convex & Concave polygons. • Autonomous and cooperative design: using advanced algorithms for allocating sub-tasks to each member of member of the swarm, taking into account each UAV's sensing and operational capabilities. • Integrated into an end-to-end platform that eases and automate the utilization of the UAVs.	• Single/Multi-UAV mission planner for monitoring. • High percentage of coverage. • Increase situational awareness.	• User friendly interface: create, perform and manage UAV missions. • Easy-to-use and compatible with any commercial UAV. • Assisting non-expert users in proper UAV operations.

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
	Semantic & Multimodal Indexing	• The objective of semantic representation service is to develop semantic knowledge structures (ISOLA ontology) to capture information pertinent to the project, develop the mechanism for populating the ISOLA ontology for further interlinking and enrichment of data. • The objective of multimodal indexing service is to collect and index all ISOLA data and metadata for effective storage and information retrieval. The effective and efficient search in data collections require multimodal representation mechanisms and early fusion of heterogeneous data.	• Translate incoming data from heterogeneous sensors into exploitable and user-friendly information.	• Easy sharing, reusing and configuring of the incoming data and implemented framework.
CYBERLENS	Service 7.3.1 DVATS (Dynamic Vulnerability Assessment & Testing System)	• Ability to conduct vulnerability assessment of the ships' IT and OT systems using automated threat analytics and detection methods. • Ability to generate messages concerning the identified vulnerabilities, including the type of vulnerability identified, the	• Ability to conduct vulnerability assessment of the ships' IT and OT systems using automated threat analytics and detection methods.	• User friendliness: easy to be used by anyone with minimum training. • Continuous technical support and software updates

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
		specific ICT component affected, the vulnerability signals that led to its identification and a brief description of the recommended actions to be performed by the ship's crew.		
IBM	Drones Platform	• Drone agnostic architecture • Automatic piloting • Swarm control • Dynamic routing • Control on-board equipment • AI models agnostic • Repeatable flights	• Gather quality images and metadata based on mission requirement	• Flexibility in mission creation • Web dashboard for configuring and monitoring missions • Mobile app for automatically controlling drones.
IDEMIA	Service 3.1.1: Secure Mobile app Service 3.1.2: Boarding Kiosk	• Biometric Face Recognition • Passenger Flow Facilitation • Privacy enforcement	• Contactless control	• Usage of smartphones of the market
IDMG	Service 4.1.2: AV Edge Device	• Usage of standard processing hardware • Support of GPU processing • Implementation of state-of the art of video analytics on the device • Connection via IP to a centralized solution • Alarming capabilities	• Face and person detection • Identification by means of face recognition • Management of multiple edge devices via a centralized solution	• One central solution to manage all edge devices • Each edge device can be configured individually

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
NTUA	Service 5.5.1: Crisis Classification	• Classifies in real-time the crisis – security incident. • Algorithm develop in Python which is a widely used programming language. • Enhances situational awareness by combining input for several sources.	• Crisis level classification	• Does not require human input to estimate the crisis level. • Provides the parameters that are considered for the assessment to operators for informed decision making.
PRISMA	Service 3.6.1: Connection with the ship's legacy systems	• NMEA (Radar, GPS) - AIS (Type1, 5) sentences acquisition • Decoding AIS-NMEA data to export the information required	• Suspicious Vessel Detection	• Continued technical support and updates
OCEANSCAN	Service 3.2.2: Data acquisition from UUV	• Open Source: Software with source code that anyone can inspect, modify, and enhance. • Modular design that allows for a wide range of sensors and equipment • Capable of onboard decision making	• Set of template manoeuvres that cover a wide range of survey types • Capable of operating in different types of water bodies (oceans, rivers, lakes) • No infrastructure required for deployment or retrieval	• Complete software suite for mission planning and review • User friendly mission planning with a set of configurable survey manoeuvres and payload parameters • Lightweight and portable format that allows for 1-2 person deployment • Open Source communication protocol for easier integration with other platforms

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
PROMETECH	Service 4.4.1: Passenger and crew monitoring system • Service 4.5.1 • Hazard Dispersion prediction	S4.4.1: • Secure data transfer of personal information • Tracking of embarked tags S4.5.1: • Continuous dispersion modelling of the complete vessel layout • Predictive hazard dispersion analysis inform appropriate next steps • Create dispersion models quickly to provide adequate reactionary time	S4.4.1: Passenger and crew tracking S4.5.1: • Room airflow and dispersion models • Ventilation airflow and dispersion models	S4.4.1: • Increases the safety of the vessel and the people on board • Has benefit to the user experience of the guests on board • Centralise crew management system S4.5.1: • Low resource dispersion modelling • Toxic agent dispersion warning • Identifying quarantine zones
SIVECO	Service 3.3.1: Crowdsourcing and mobile apps monitoring Service 5.3.1: 3D visualization module for the network	• Platform supported • Minimum technical requirements • Number of FPS (frames per second)	• How fast the emergency messages are generated • 3D environment respects the real plans	• User friendly: easy to use by anyone with a mobile device • Continued technical support and updates • Usability, 3D environment

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
	Service 7.5.1: Interactive User Interface			
T4i	Service 3.4.1: Monitoring system of air facilities Service 3.1.3: Handheld chemical detector	• Valve-less periodic gas sampling, dynamic inlet • Smart sampling procedures • Probe/stick for directed sampling	• Hazardous chemicals detection	• Reliability, versatility, • Automation • Web-based software, adaptable for mobile app • Technology made simple (minimum training required)

8 Competitive Landscape

For this Report, partners to identify possible competitors in their respective fields and the related advantages of the ISOLA technologies and solutions vs the competitor's solutions. Responses were gathered in a standardised format and template as part of the Partner Fill-In Form, as is presented in **Annex 2** herein "**Competitive Landscape Section**".

In brief, partners were asked to provide answers to the below indicative set of questions to enable them to identify accurately the competition landscape relevant to their innovation.

What is the competition intensity (relevant to your innovation)?

Three competitor names – where applicable.

- *Does this competitor have the same solution / customers as you?*
- *What are the limitations of this company compared to your solution?*
- *Describe the performance of this company compared to your solution.*
- *Can you point out how you are better or different (e.g. price, product size, market experience, innovation & new product, value, branding?*

We include herein below the analysis provided by the Partners, all addressing the above questions.

8.1 CERTH

Competitors:

Visual Content Analysis: Google, Qualcomm, NEC, LTU Technologies, Honeywell, IBM etc.

Semantic & multimodal indexing: IBM, Linguamatics, AppZen, Senseye.

The competition does not provide the same solutions as CERTH, however, they do service a similar customer base as they are developing and/or providing solutions on visual content analysis such as object detection, detection of abnormal behaviour and crowd monitoring or semantic and multimodal indexing.

The limitations faced by CERTH in comparison to the competitors include the fact that CERTH is a research centre and not an industrial company with a specific product for specific needs. This means that CERTH exploits highly educated employees to provide customized solutions for every need and always at a state-of-the-art level.

The competitive advantages of CERTH and especially M4D/MKLab versus competition include the fact that they both have immense experience in security projects, specifically in those which use computer vision technologies. Since 2017 the organisations have participated, and are still currently working on more than 12 projects, including beAWARE, ROBORDER, ARESIBO, 7SHIELD that have an emphasis on the development of visual content analysis tools and semantic and multimodal indexing. This provides an advantage as the organisations are constantly improving and upgrading their existing techniques while at the same time we keep track of the market trends of the industry.

8.2 ACCELI

Service 3.2.1. Data Collection from UAV and process to the edge

The European drones market is highly fragmented, with several players accounting for significant shares in the market. Some of the prominent companies in the European drones market are Azure Drones SAS, Parrot Drones, Terra Drone, Onyx Scan Advanced LiDAR Systems, and AltiGator Unmanned Solutions. The companies are spending heavily on improving technology and introducing new features in drones to support various commercial applications. For instance, in September 2019, Parrot Drones introduced a drone with a smartphone-powered first-person view.

The camera is powered with a 4K HDR 21 megapixel sensor and comes with long-lasting battery life, which can be used for shooting advertisements and other entertainment applications.

The launch of such advanced drones for various applications is anticipated to help companies expand their presence in the region. Furthermore, with the ease in drone regulations, many companies are entering the drones industry of Europe, which is expected to further increase the competition among the players in the future.

1. Competitor: ELISTAIR

Competitor Technology: ORION 2 Tethered UAV - Advanced Tethered UAV for military and public order agencies

Competitor Description *(Nationality, main activities, turnover, main customers):*

USA – EU (FRA), tethered UAV manufacturers.

Main customers include private and public security organisations.

Elistair designs and manufactures tethered drone systems, offering extended flight times, increased safety and secured high-speed data transfer, for persistent surveillance and communications. The company's products are deployed by police forces, public safety departments, private security companies and government in over 30 countries. Elistair has received up to 9.5M EUR in funding (Grant, Seed, Series A & B) at the time of this Report to further develop its technology offering.

Competitor solution:

ORION 2 is capable of operating for 24 hours continuously at 100 meters (330 feet) height with 2 kg of payload and extended detection ranges up to 10 kilometres. Gimbal stabilization and crystal-clear imagery with low latencies. Optical Zoom x30 - EO Channel Specs 1080p Full HD - IR Channel Specs 640×480 - IR Digital Zoom x4. Automated Deployment, Smart Parachute, Secure Data Link – transfer speed up to 200 mb/s. Weather-resistant with an IP54 rating. Mission Operation Software "T-Planner": digital stabilization, a map overlay of the drone's location and camera POV. EO and IR images are streamed simultaneously. IP based video stream allows external sharing of the video feeds such as streaming, processing, integration into third party software and VMS.

Competitor solution comparison:

	Technical Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
#1	Algorithm / Software Source	"T-Planner": competitor's own software
#2	GPU AI Decision Support	Detect and track capabilities
#3	UAV Neutralization / Automation	Yes. Automatic take-off / landing, altitude
#4	Image / Video Processing, Threat Detection and Forecasting	Image / Video Processing, Yes. Threat Detection and Forecasting, No.

	Functional Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
#1	Human detection	Yes. Detect and track
#2	Object Detection	Yes. Detect and track
#3		
	Commercial Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
#1	User friendly	Yes. Operation Setup in minutes. Single operator, Automated take-off, climb and land procedures
#2	Ecosystem friendly	Modular, hot-swappable arms/legs
#3	Continued technical support and updates	Dependent on Competitor software update frequency

2. Competitor: DronesLab B.V. VERTICAL Technologies (https://www.deltaquad.com/)

Competitor Technology: DeltaQuad Pro VTOL #VIEW – Long Range Surveillance UAV

Competitor Description *(Nationality, main activities, turnover, main customers)*:

DronesLab B.V. VERTICAL Technologies is a UAV manufacturer, specialised in long-range Mapping and Surveillance UAVs. Based in Badhoevedorp, Netherlands ANNUAL REVENUE 2018 USD $1.87 million

Competitor solution:

Fully autonomous from take-off to landing. Automatic object tracking & object following. Simple manual control using the DeltaQuad Controller. Tool-less 1 minute field assembly. No pre-flight calibrations are required. Covering up to 100KM / 150KM in a single flight. Redundant flight system. Online mission validation & log analysis tools. Automatic object following. DeltaQuad Pro #VIEW with surveillance package 3 can automatically follow a moving object. Proprietary control software allows the system to safely and intelligently follow a human, car, vessel, or even another UAV. Transmission range of up to 50KM, HD quality video from a hand-held remote controller. Unlimited range by streaming both HD video and UAV control over a VPN secured mobile connection (4G, 5G).

Surveillance package 3: Dual Thermal (IR) and RGB (EO) controllable turret gimbal

Industrial-grade thermal & RGB (EO/IR) surveillance package, Nighthawk2-V computer-controlled retractable gimbal. 360-degree control, 40x zoom. Stabilization, automatic object tracking and object following by touch-screen tapping on an object, and HD recording. The camera is controlled using the DeltaQuad Controller or from an additional Camera Control Laptop. Instant switching between RGB and Thermal vision. Thermal & RGB live video Pan, Tilt & 40x zoom control, Touch screen object tracking & stabilization, Automatic object following, Target coordinates & altitude, GPS controlled camera position holding, Onboard recording.

Competitor solution comparison:

	Technical Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
#1	Algorithm / Software Source	Competitor Proprietary Software

#2	GPU AI Decision Support	Detect, track, follow capabilities. Identify and distinguish human, car, boat, other UAV
#3	UAV Neutralization / Automation	Tool-less operation setup. Minimized setup time. Airborne in 2 minutes. Automatic take-off/ landing
#4	Image / Video Processing, Threat Detection and Forecasting	Image / Video Processing, Yes. Detect and follow. Threat Detection and Forecasting, No.
	Functional Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
#1	Human detection	Yes. Detect, track, and follow autonomously
#2	Object Detection	Yes. Detect, track, and follow autonomously
	Commercial Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
#1	User friendly	Medium. Single operator, continuous monitoring. Automated take-off/ landing.
#2	Ecosystem friendly	
#3	Continued technical support and updates	Dependent on Competitor software update frequency

3. Competitor: HEIGHT TECHNOLOGIES

Competitor Technology:
G3 Tactical Drone VTOL (https://heighttech.nl/wp-content/uploads/2020/02/Techspecs_G3.pdf)

Competitor Description *(Nationality, main activities, turnover, main customers)*:

HEIGHT TECHNOLOGIES manufactures technologically highly developed drones equipped with cameras, sensors and measurement equipment, in Meerbusch, Nordrhein-Westfalen, Germany. Military and Security oriented UAVs. Geldermalsen, The Netherlands.

Competitor solution:

Simple, compact, lightweight & modular design Ruggedized, dust and rain proof 1 man required for rapid deployment and operation Designed for ISTAR missions. The G3 is equipped with a gimbaled, stabilized high-performance EO & IR camera.

Payloads are interchangeable with other sensors such as communication jammers, electronic warfare etc. can be configured to hold any kind of sensor up to 3 kg. Transportable with a standard Jeep and designed for longer, more complicated missions. Less than 5-minute assembly, swappable batteries, and sensors. Up to 90 minutes flight time, 5km range, 30-300m AGL, -10 to +50 C operating temperature, Data uplink, telemetry, and video downlink, day & night real-time HQ video.

Competitor solution comparison:

	Technical Criteria

Technical Comparison Criteria		Competitor Solution Performances
#1	Algorithm / Software Source	Proprietary Competitor's Software
#2	GPU AI Decision Support	Up to 3kg sensor, no built-in detect & tracking
#3	UAV Neutralization / Automation	Automated take-off/ landing. Simple controls.
#4	Image / Video Processing, Threat Detection and Forecasting	EO/IR camera system up to 3kg. No AI Threat Detection and Forecasting
	Functional Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
#1	Human detection	Not built-in.
#2	Object Detection	Not built-in.
	Commercial Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
#1	User friendly	5-minute setup. Easy manual/ control.
#2	Ecosystem friendly	
#3	Continued technical support and updates	Dependent on Competitor software update frequency

4. Competitor: HEIGHT TECHNOLOGIES

Competitor Technology: PD1 VTOL Unmanned Aerial System

Competitor Description *(Nationality, main activities, turnover, main customers)*:

HEIGHT TECHNOLOGIES manufactures technologically highly developed drones equipped with cameras, sensors and measurement equipment, in Meerbusch, Nordrhein-Westfalen, Germany. Military and Security oriented UAVs. Geldermalsen, The Netherlands.

Competitor solution:

The PD1 is a hybrid-powered VTOL fixed-wing ready-to-fly solution UAV, standard equipped with an EO/IR camera system, encrypted LR data link and ground control station. 10+ hours flight time, 3km service ceiling, 10kg payload, 100km live full HD video, 500+ km operational range. 4m wingspan, 2.5m length, 4-stroke propulsion with runway/catapult/VTOL take-off methods. PD–1 VTOL CONVERSION KIT: fully automatic take-off and landing, can be operated on the ship, can hover for a limited time, less space for take-off/ landing. Target tracking, scene lock.

COAST GUARD AND MARITIME OPERATIONS Use PD–1 VTOL system for fast deployment and response time. Upgraded with movement detection system—specially adjusted for maritime operation–USG–212 gimbal allows you to automatically detect small targets, such as people in the water, fishing boats, jet skies and so on. The PD–1 VTOL conversion kit will allow you to operate the drone from the vessel for a rapid response while the command-and-control centre will give an advantage of a single environment for all your units to get real-time information on the go and to record all videos and events. Additionally, the package delivery system will allow you to drop a lifesaving buoy.

Competitor solution comparison:

	Technical Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
#1	Algorithm / Software Source	Proprietary Competitor's Software

#2	GPU AI Decision Support	Detect, Track, Follow
#3	UAV Neutralization / Automation	VTOL autonomous take-off & landing with VTOL KIT, pre-programmed autonomous flight path
#4	Image / Video Processing, Threat Detection and Forecasting	Night / Day live stream full HD video. No built-in Threat Detection and Forecasting.
	Functional Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
#1	Human detection	Yes. Can detect humans in the water, on boats, land, etc.
#2	Object Detection	Yes. Can detect small boats, jet skis, etc.
	Commercial Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
#1	User friendly	Medium. Autonomous take-off/ landing, easy-use controller
#2	Ecosystem friendly	
#3	Continued technical support and updates	Dependent on Competitor software update frequency

8.3 Prisma

Service 3.6 – Connection with the ship's legacy systems

Prisma invested in research to build its own product suite for Knowledge Management from Sensors and Humans, focus in maritime mainly due to the easy access to more than 20% of Shipping industry through Athens hub. As one of the outcomes, Prisma developed an advanced Internet of Ships Platform for a smarter, safer, and greener Ship and Fleet Performance Management. LAROS, our system, is the only integrated system based on a powerful platform that provides real time data analytics for fleet and vessel efficiency, honoured with the prestigious Lloyd's Award for Technical Excellence.

1. **Competitor Name: Trelleborg** (https://trelleborg.com)

The competitor offers a standard solution for the condition monitoring of the assets. While not focusing only in maritime sector this competitor has a great portfolio in this industrial area.

The main disadvantage is the high cost of the solution as well as the limited scalability. In addition, there is a need for extended cabling installation onboard as the solution is mainly wired (not wireless).

2. **Competitor Name:** Kongsberg (IMSA) (https://kongsberg.com/)

Kongsberg is one of the main vendors for navigational equipment onboard focusing mainly in Bridge and Alarm Monitoring Systems. The vendor has already installed its systems in a vast majority of vessels globally. Last years Kongsberg is investing in data collection and fusion of different sensors and systems and also provides the capability to transmit the data to the shore for further analysis through its dedicated software.

While the solution is robust it provides two main disadvantages that are the high cost of the solution and the restriction on acquisition only through dedicated interfaces (hardware and software).in addition the system requires extensive system modifications onboard.

8.4 SIMAVI

Service 6.1 - Augmented reality headsets

There are many augmented reality headsets on the market. Microsoft HoloLens 2 is one of the well-designed mixed reality headsets. The first HoloLens was released in 2016 and was an innovative tool. In November 2019, Microsoft released the HoloLens 2 with many improvements.

One of the most important improvements from the previous version of HoloLens is the design. HoloLens 2 is smaller and lighter, becoming more comfortable and easier to use for a longer period.

Another improvement is the display resolution (2048 × 1080 px per eye vs 1280×720 per eye).

HoloLens 2 has a new generation of a Holographic Processing Unit, a more powerful RAM card (up to 8 GB vs. 2GB in HoloLens 1) and a different USB port, a more modern Bluetooth connection (5.0 vs 4.1).

Below is a detailed comparison between the 2 models:

Specs	HoloLens 2	HoloLens 1
Display resolution	2048 × 1080 pixels (per eye)	1280×720 pixels (per eye)
Holographic density	>2.5K radiants (light points per radian)	>2.5K radiants (light points per radian)
Field of view (FOV)	52°	34°
Weight	566 grams	579 grams
IPD adjustment	yes	yes
Eye-based rendering	Display optimization for 3D eye position	Automatic pupillary distance calibration
Eye-tracking	yes	no
Processor	QC Snapdragon 850	Intel Atom x5-Z8100P
CPU Cores	8	4
Memory	4GB	1GB
HPU	2nd generation custom-built holographic processing unit	1st generation custom-built holographic processing unit
Camera	8MP stills, 1080p video	2.4 MP, HD video
Audio	Built-in spatial sound; 3.5mm jack	Built-in speakers 3.5mm jack;
Built-in microphone	five-microphone array	four-microphone array
Flip-up visor	yes	no
Voice command	yes	yes
Biometric Security (Iris Scanning)	yes	no
Hand tracking	both hands full tracking	one hand
Gestures: Bloom, Air Tap, Tap and Hold	yes	yes

Gestures: Press, Grab, Direct manipulation, Touch interaction, Scroll with a wave	yes	no
USB	USB Type-C	micro USB 2.0

In the last years, several companies have invested in AR technology, and some of the most important competitors of our solution are:

1. Competitor's name: Magic Leap

Competitor Technology: The Magic Leap One's display technology is based on waveguide technology.

A waveguide is an intermediary device between the user`s eyes and the hardware that creates a digital image. It guides light waves based on their frequency.

Competitor Description:

The Magic Leap was founded in 2011 by President & CEO Rony Abovitz. It has headquartered in Florida, with additional offices in California, Texas, Washington, Colorado, Israel, New Zealand and Switzerland.

Total funding to-date: ~ $2.44B.

Latest funding round: ~ $1.06B.

The most important investors are Alibaba Group, Andreessen Horowitz, AT&T, Axel Springer SE, EDBI, Fidelity Management and Research Company, Google, Grupo Globo, Janus Henderson Investors, J.P. Morgan Investment Management, KKR, Kleiner Perkins Caufield & Byers, Morgan Stanley Investment Management, Qualcomm Ventures, T. Rowe Price Associates, Temasek, The Public Investment Fund, Vulcan Capital, Wellington Management Company.

Competitor Solution:

Magic Leap One is a lightweight, wearable computer that enriches user`s experience in the real world with digital content, in everything from commerce and entertainment to communications and productivity.

Competitor Solution Comparison:

	Hardware Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	Display resolution	1280 x 960 pixels per eye
2.	Field of view (FOV)	76.9 degrees diagonal field of view
3.	Weight	316g
4.	Processor	NVIDIA Parker SOC CPU: 2 Denver 2.0 64-bit cores + 4 ARM Cortex A57 64-bit cores
5.	Memory	8GB (4 gigabytes of memory available to applications)
6.	Graphics	NVIDIA Pascal, 256 CUDA cores Graphic APIs: OpenGL 4.5, Vulkan, OpenGL ES 3.1+AEP
7.	Camera	2 Megapixel colour sensor, f/2.0 aperture, Fixed focus

8.	Audio	built-in Stereo Speakers
9.	Built-in microphone	yes
10.	Hand tracking	6DoF controller
11.	WiFi	IEEE 802.11a/g/b/n/ac, dual-band
	Functional Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
1.	OS	Lumin OS
2.	Voice command	yes
3.	Gesture commands	yes
4.	Eye-tracking	yes
5.	Hand tracking	yes
	Usability Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
1.	User experience	Magic Leap 1 hardware includes the Glasses, Lightpack, and Control; - The Lightpack is a small and portable processing powerhouse that clips onto the user's pocket for total freedom of movement; - Effortless navigation in the palm of your hand, Control provides six degrees of freedom (6DoF) and haptic feedback for an intuitive, sensory experience.
2.	Continued technical support and updates	Dependent on Competitor software update frequency

Competitor Limitations:

There is a significant limit to the user`s field of view. The user cannot look to the side or upwards without turning the head.

The device's design doesn't allow for wearing prescription glasses.

The controller interaction has a downside: the user will not always have both hands free.

There is support for voice input and hand gestures and hand tracking, but nearly all of the available apps and the entire OS are built around the controller.

The glasses are connected with the light pack by a trailing cable that can cause discomfort.

2. Competitor Name: Lenovo

Competitor Technology: The display technology of ThinkReality A6 is based on waveguide technology.

Competitor Description:

Lenovo is one of the world's leading personal technology companies, producing innovative PCs and mobile internet devices.

Competitor Solution:

Lenovo introduced a new solution they are calling ThinkReality, which is a platform that provides all the software development tools needed to create advanced AR/VR applications. It incorporates prebuilt functions and program logic, which enables engineers to quickly build sophisticated applications that would normally take much longer.

The ThinkReality platform is described as both cloud and device agnostic, meaning it can be used with many products.

Competitor Solution Comparison:

	Hardware Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	Display resolution	1920×1080 pixels (per eye)
2.	Field of view (FOV)	40 degrees diagonal field of view
3.	Weight	380g
4.	Processor	Qualcomm Snapdragon 845
5.	Memory	4 GB
6.	Graphics	Intel Movidius
7.	Camera	13MP RGB camera
8.	Audio	Yes, surround sound (Audio codec)
9.	Built-in microphone	Two noise cancelling mics
10.	Hand tracking	3DoF controller
11.	WiFi	802.11ac 2x2 (2.4/5 GHz)
	Functional Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	OS	Android
2.	Voice command	yes
3.	Gesture commands	yes
4.	Eye-tracking	yes
5.	Hand tracking	no
	Usability Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	User experience	Interacting with the ThinkReality A6 can be done via voice, gesture, and gaze control, or with a 3DoF hand controller, offering users an intuitive experience; ThinkReality A6 is lightweight and comfortable, its weight being less than 380g.

2.	Continued technical support and updates	Dependent on Competitor software update frequency

3. Competitor name: Vuzix

Competitor Technology: The Vuzix M4000`s display technology is based on waveguide technology.

Compared to other technologies that display an opaque image Waveguides are transparent, so the smart glasses do not need to be removed while working in the real world.

Competitor Description:

Founded in 1997, Vuzix is an optical company with speciality manufacturing skills. It is a public company (NASDAQ: VUZI) with offices in Rochester, NY; Oxford, UK; and Tokyo, Japan.

The main activity is the design, manufacturing, marketing, and sale of Waveguides and Smart Glasses.

Vuzix origins are in R&D for next-generation military display solutions.

Competitor solution:

The Vuzix smart glasses are designed to enhance the connected worker experience. They are designed around user comfort.

Vuzix presents solutions in areas such as Manufacturing, Field Service and Remote Assist, Warehouse Logistics and Tele-Medicine.

Competitor Solution Comparison:

	Hardware Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	Display resolution	854x480 pixels
2.	Field of view (FOV)	28 degrees
3.	Weight	100 g (Smart Viewer); 86 g (Battery); 60 g (USB-C cable, and frame over glasses).
4.	Processor	Qualcomm XR1, 2.52Ghz.
5.	Memory	6 GB
7.	Camera	12.8 Megapixel; Improved Auto Focus (PDAF); Flash/Scene illumination; Improved Optical Image Stabilization.
8.	Audio	Integrated Speaker
9.	Built-in microphone	Triple noise-cancelling microphones
10.	Hand tracking	no
11.	WiFi	2.4/5Ghz 802.11 a/b/g/n/ac
	Functional Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	OS	Android
2.	Voice command	yes
3.	Gesture commands	yes
4.	Eye-tracking	no
5.	Hand tracking	no
	Usability Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	User experience	
2.	Continued technical support and updates	Dependent on Competitor software update frequency.

Competitor Limitations:

The Vuzix M4000 has a full colour transparent optical display with a resolution of 854× 480- and 28-degree field of view which may be too small to cover all requirements.

The device's design doesn't allow for wearing prescription glasses.

There is support for gestures but only using the controller, the user will not always have both hands free.

Service 6.2 - Virtual reality headset

1. Competitor Name: High Tech Computer Corporation (HTC)

Competitor Technology:

The Vive Focus 3 uses dual 2.88 inch LCD panels with a 2448 x 2448 pixels per eye resolution and a refresh rate of 90Hz powered by Qualcomm's Snapdragon XR2 platform built specifically for XR.

Competitor Description:

The High Tech Computer Corporation (HTC) was founded in Taiwan in 1997. The company originally focused on PDA and MDA devices and later on smartphones.

After initially making smartphones based mostly on Windows Mobile, HTC became a co-founding member of the Open Handset Alliance, a group of handset manufacturers and mobile network operators dedicated to the development of the Android operating system.

Competitor Solution:

- The LCD panels and the Qualcomm Snapdragon XR2 offer an impressive visual experience.
- The FOV is 120-degree that allow working comfortably in VR for a long time.
- The dual-driver speakers create 3D spatial sound.
- Directional speaker design, with sound leakage reduction.
- Up to 2 hours of continuous use.
- The VIVE Focus Controller offers easy input and navigation.
- The 6DoF support, ergonomically placed buttons and triggers, and touch sensors further deliver intuitive and precision controls.

Competitor Solution Comparison:

	Hardware Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	Display Technology	2x 2.88-inch (73.15-mm) LCD panels
2.	Display resolution	2448 x 2448 pixels per eye
3.	Field of view (FOV)	120 degrees
4.	Refresh rate	90 Hz
5.	Weight	785g with battery
6.	Processor	Qualcomm Snapdragon XR2 (Snapdragon 865)
7.	Memory	8 GB
8.	Graphics	NVIDIA GeForce GTX 1060 or AMD Radeon RX 480
10.	Audio	2x microphones with echo cancellation; 2x directional drivers2x microphones with echo cancellation; 2x directional drivers.

12.	Sensors	4x Tracking cameras; G-sensor; Gyroscope; Proximity sensor.
13.	Connectivity	2x USB 3.2 Gen-1 Type-C peripheral ports, external USB-C port supporting USB OTG, Bluetooth 5.2, Bluetooth Low Energy, Wi-Fi 6
	Functional Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
1.	OS	Android
2.	Voice command	no
3.	Gesture commands	yes
4.	Tracking Technology	HTC Vive inside-out tracking
5.	Hand tracking	yes
	Usability Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
1.	User experience	The HTC Vive Focus 3 has good image quality and a good refresh rate that gives a more natural movement representation. Is a standalone headset and doesn't need a PC connection; Comfortable, user-friendly headset;
2.	Continued technical support and updates	Dependent on Competitor software update frequency

2. Competitor Name: Valve

Competitor Technology:

- IPS LCD panel with 1440×1600 resolution for each eye. The panels are full RGB with 80 Hz, 90 Hz, 120 Hz, or 144 Hz (experimental) mode;
- Support for Valve's Lighthouse 2.0 tracking system;
- Valve Index supports both the Windows and Linux operating systems.

Competitor Description:

Valve Corporation is an American video game development and digital distribution company based in the United States.

Valve created the Half-Life and Portal series, as well as the software distribution platform Steam.

Competitor Solution:

The Valve Index offers an optimized pixel layout, with dual 1440x1600 RGB LCDs. It runs at 120Hz with full backwards compatibility to 90Hz, as well as an experimental 144Hz mode. Higher framerates improve realism and optical comfort, allowing longer and more comfortable use sessions.

The Valve Index displays have a reduced illumination period of 0.330ms to 0.530ms (framerate dependent), allowing imagery to remain just as sharp when your head is in motion as when you're standing still.

The Valve Index HMD includes stereo, global-shutter RGB cameras made for computer vision.

Competitor Solution Comparison:

	Hardware Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	Display Technology	Dual LCD, canted lenses
2.	Display resolution	1440 x 1600 pixels per eye (2880 x 1600 combined)
3.	Field of view (FOV)	Adjustable up to 130 degrees
4.	Refresh rate	80, 90, 120 or 144 Hz
5.	Weight	809g
6.	Recommended Processor	Quad Core+
7.	Recommended Memory	8 GB RAM or more
8.	Recommended Graphics	Nvidia GeForce GTX 1070 or better
10.	Audio	Built-in: 37.5mm off-ear Balanced Mode Radiators (BMR), Frequency Response: 40Hz - 24KHz, Impedance: 6 Ohm, SPL: 98.96 dBSPL at 1cm; Aux Headphone Out 3.5mm.
12.	Sensors	SteamVR 2.0 sensors, compatible with SteamVR 1.0 and 2.0 base stations
13.	Connectivity	5m tether, 1m breakaway trident connector, USB 3.0, DisplayPort 1.2, 12V power
	Functional Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	Recommended OS	Windows 10, SteamOS, Linux
2.	Voice command	no
3.	Gesture commands	yes
4.	Tracking Technology	SteamVR 2.0 sensors, compatible with SteamVR 1.0 and 2.0 base stations
5.	Hand tracking	yes
	Usability Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	User experience	Good resolution and field of view; Comfortable, user-friendly headset; Awesome controllers.

2.	Continued technical support and updates	Dependent on Competitor software update frequency

Competitor Limitations:

- The Valve Index is tethered to a PC and depends on its performance.
- These headphones are more expensive than the others presented.
- Index does not support HDMI, and will not work with DisplayPort to HDMI adapters.

3. Competitor Name: Hewlett-Packard Company (HP)

Competitor Technology:

- Dual LCD 2.89'' diagonal with Pulse Backlight technology and a resolution: 2160 x 2160 pixels per eye (4320 x 2160 pixels combined);
- 2 front-facing cameras and 2 side-facing cameras;
- HP Reverb G2 inside/out 6 DOF motion tracking, gyroscope, accelerometer, and magnetometer
- One 6m 2-in-1 cables (DisplayPort 1.3 + USB 3.0 Type C).

Competitor Description: Hewlett-Packard Company is specialized in developing and manufacturing computing, storage, networking hardware and software. The company is headquartered in Palo Alto, California, United States.

Competitor Solution: HP's Reverb G2 is developed in collaboration with Valve and Microsoft. The headset provides an immersive virtual reality experience and is compatible with Windows Mixed Reality and SteamVR. It has a very good visual fidelity and powerful built-in audio in a form-factor that doesn't touch the user`s years

The controllers are comfortable to hold, thanks to their smaller, ergonomic design. They also provide optimal tracking performance via Bluetooth.

Competitor Solution Comparison:

	Hardware Criteria	
	Technical Comparison Criteria	**Competitor Solution Performances**
1.	Display Technology	2 x 2.89" LCD
2.	Display resolution	2160x2160 pixels per eye
3.	Field of view (FOV)	About 114 degrees Fresnel-Aspherical
4.	Refresh rate	90 Hz
5.	Weight	550 g
6.	Recommended Processor	Intel Core i5, i7, Intel Xeon E3-1240 v5, equivalent or higher; AMD Ryzen 5 equivalent or higher.
7.	Recommended Memory	8 GB RAM or more
8.	Recommended Graphics	DX12 capable graphics
10.	Audio	Integrated

12.	Sensors	HP Reverb G2 inside/out (Six Degrees of Freedom); Gyroscope, Accelerometer, and magnetometer.
13.	Connectivity	DisplayPort 1.3 port; USB 3.0 Type-C port; Power adapter connector.
	Functional Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
1.	Recommended OS	Windows 10 May 2019 update or later
2.	Voice command	no
3.	Gesture commands	no
4.	Tracking Technology	Two front-facing cameras; Two side-facing cameras.
5.	Hand tracking	no
	Usability Criteria	
Technical Comparison Criteria		**Competitor Solution Performances**
1.	User experience	The HP Reverb G2 VR headset has an ultra-high resolution and a good refresh rate that gives a more natural movement representation.
2.	Continued technical support and updates	Dependent on Competitor software update frequency

Competitor Limitations:

The HP Reverb G2 needs a PC capable of running VR applications without slowing down the frame rates.

The Reverb G2 depends on visible light tracking that requires a well-lit room to work properly.

8.5 T4i

Service 3.1.3 - Handheld chemical detector

Competitor Name: Qmicro by Sensirion

Competitor Technology: micro-GC systems that are based on MEMS technology.

Competitor Limitations:

All known calculations from established theory on chromatography are not 'credible' for "square columns" (MEMS-based). T4i DOVER GC uses high-performance exchangeable columns that follow the established theory of high-performance chromatography. All surfaces are clearly defined, whilst having no sample interaction with valves. Currently, 3 different PID lamps can be used for additional separation. The core module, the Sampling Modulation and Separation Unit (SMS) can be also be combined with Ion Mobility Spectrometers to enhance detection capabilities.

Qmicro has been adopted by a large technology provider in the market. They have advanced MEMS GC with 'square' columns, based on stereo-lithography. Although being quite innovative, this technology still demonstrates poor performance when compared to traditional GC capillary columns.

8.6 IDM

Service 4.1.2 - AV Edge Device

1. **Competitor Name:** Bosch (https://www.boschsecurity.com/de/de/)

Bosch provides solutions with video analytics capabilities that are part of their own cameras and running on the camera chip. This approach is different to the one of an external computational edge device that primary is independent of a camera device as long as it provides an IP stream. The analytics capabilities of Bosch are focused on classical VMS solutions providing analytics for intrusion detection, indoor people counting or asset protection[xxix]..

Bosch focuses on the surveillance market with related customers and has a long history in this field which differentiates it from IDEMIAs analytics capabilities which are more driven by law enforcement applications.

IDEMIA's approach of an external edge device is independent of a specific camera provider with related camera technology and processing capabilities. Furthermore, IDEMIA's innovation can process video streams on one device from multiple cameras at the same time.

2. **Competitor Name:** AXIS (https://www.axis.com/)

Like Bosch, AXIS provides video analytics capabilities on the camera device. These are more comprehensive than in the case of Bosch and include for example face and person detection or license plate recognition[xxx].

Like Bosch, Axis focuses on the surveillance market with related customers and has a long history in this field. They have a long history of experience in this market segment while IDEMIAs analytics capabilities were more driven by law enforcement applications.

IDEMIA's approach of an external edge device is independent of a specific camera provider with related camera technology and processing capabilities. Furthermore, we can process video streams on one device from multiple cameras at the same time.

3. **Competitor Name:** Milestone (https://www.milestonesys.com/)

A different class of competitors are providers of Video Management Systems (VMS). Instead of analysing the video streams at the data source (like Bosch or AXIS), VMS solutions execute video analytics mostly centrally on servers.

Milestone covers a broader spectrum of applications fields also beyond critical infrastructure protection, including for example smart cities, stadiums or access control.

Milestone has a strong international position in the field of VMS solutions and has beyond that a long history of experience in this market segment. As Milestone, IDEMIA is also a globally operating company with a world-wide distribution network. Its analytics capabilities were more driven by law enforcement applications.

IDEMIA's approach of an edge device provides advantages to centralized processing as the data is analysed near the data source and only events need to be transferred to a central station.

8.7 NTUA

Service 5.5.1 - Crisis Classification

1. Competitive Rivalry

As the module does not operate independently from other ISOLA components, it cannot comprise a standalone solution that is ready for market, and, thus, does not have any direct competitors. However, there are a few similar solutions available which are presented in this table. It is important to note that, as a service that runs calculations in the background to provide estimations of the crisis level, it is impossible to directly compare to other solutions without access to the code and methodologies they incorporate.

2. Buyer Power

The pool of potential buyers of the service is cruise and passenger line operators, despite the geographic area of operations. It is worth noticing that the global cruise fleet size consists of more than 420 units[xxxi].

3. Threat of Substitution

By employing state-of-the-art methodologies for security risk assessment and by combining the input data from several ISOLA components and services they need for substitution is eliminated, especially considering the negligible maintenance and installation costs of the crisis classification service per se.

4. The threat of New Entry

The main cost of the service lies in the development phase which requires a high level of collaboration with experts from multiple expertise backgrounds. This obstacle is eliminated through the ISOLA project.

1. **Competitor Name:** Maritime Anti-Piracy System (MAPS)

MAPS is designed to protect seafarers and merchant ships against heightened crimes like piracy, hijacking and terrorism. It employs round-the-clock smart mobility tracking and in-depth behavioural analysis to provide early warning against suspicious vessels. The powerful software engine automatically detects, monitors and tracks small targets, even in noisy and heavily cluttered environments[xxxii].

The technology of Competitor:
This product provides only early warning for piracy attacks, theft and illegal boarding but not for chemical substance threats, as the crisis classification module.

As a more specialized product, the customers of these competitors are narrowed down to those who need increased security against pirate threats, thefts, and illegal boarding.

The main limitation of this company is that they do not consider dangerous and illegal substances as security incidents in their assessment.

The crisis classification module considers dangerous and illegal substances which are not included in the competitor's solution. In addition, the crisis classification service provides a security level range that goes beyond the three (3) levels described in the ISPS for enhanced decision support.

2. Competitor Name: NEPTUNE P2P GROUP – Cruise ships security

"We provide a seamless, discreet solution for our cruise ship clients. Our services to support your voyage can start at your planning stages, where we can work to identify and share intelligence on specific potential risks. In addition to providing on-board trained security guards, our services extend to training crew to recognise the characteristics and behavioural patterns of those who are likely to threaten the security of the vessel[xxxiii]".

The competitor performs security risk assessment, alas, not in real-time. Thus, the competitor does not consider the changes in the security incident as the situation evolves. It services the same customer base as NTUA's innovation, however, it provides services during the planning of the customer's voyage, while the crisis classification performs real-time threat and vulnerability assessment.

The NTUA crisis classification service seems to require more resources due to the need for the installation of collaborating components and services but with lower operating costs since the solution does not require specialised personnel to operate.

8.8 IBM

Service 3.5.1 - Drones Platform

1. Competitor Name: Skydio

Skydio is a private company founded in 2014 in the USA and by 2018 it has launched R1, a widely regarded breakthrough in autonomous drones for consumers and as a platform for commercial development. Skydio prides itself as Americas leading drone manufacturer incorporating AI and computer vision.

Competitor Technology: Skydio Autonomy™

Skydio Autonomy offers the below features, which are considered as leading components and high-end in the industry:

- 360° obstacle avoidance
- 360 Superzoom
- Visual Return-to-Home
- Point-of-Interest Orbit
- Track-in-Place
- Offline Maps
- Motion Planning
- Fly near and around obstacles in a GPS-denied environment
- Search and Rescue Overwatch
- BVLOS Operations

8.9 IDEMIA

Service 3.1.1 - Secure Mobile app & Service 3.1.2 - Boarding Kiosk

There are approximately four direct competitors able to provide a similar and equally complete solution for passenger facilitation such as the Boarding Kiosk provided by IBM. However, the competitor offering is fragmented as key modules such as Biometrics, kiosk, Passengers Information management are provided on an individual basis rather than as a whole service offering.

1. Competitor Name: NEC

NEC offers a comprehensive passenger flow management solution that provides real-time insights throughout the airport journey for efficient movement of passengers. As the passenger moves through the checkpoints, various cameras and sensors at different locations collect the necessary data. Through advanced ICT solutions, NEC can analyse this data to give operators vital knowledge about the smooth running of the airport and how to increase revenue and enhance security.

The main customers of NEC include airports, police force, casino houses and world-class events such as the Champions League, as the use of such technology has been observed in the South Wales and Met Police, the 2017 Champions' League Games in Wales and Casinos in Cyprus.

NEC's solution is perceived as expensive, although they are currently in the process of launching a more low-cost version with a new algorithm. It has also been observed that NEC lacks a clear strategy in promoting their technologies with an opportunistic move to the retail market. It is also understood that NEC's technology is currently lacking efficient video investigation offering (post-event), and follows a strong focus on face recognition, without incorporating other modalities (such as silhouette recognition).

NEC benefits from a strong brand image for face recognition however IDEMIA has adopted an aggressive approach against it through strong investment in R&D that can provide high-end features such as FRVT benchmark and video analysis.

2. **Competitor 2:** Thales DIS

Thales IDS provides end-to-end identity solutions such as enrolment, documents & personalization, digital ID, management system and maintenance services supported by large integration capabilities.

Thales mainly addressed border control at the governmental level and does not offer the functionality of passenger facilitation. It is currently ranked as the number 1 provider and holds a strong position and extensive footprint in the market, leading by market share and shipments.

Thales is up-selling its E2E solutions as a large-scale system integrator however, it appears that no modular vending approach is followed.

The advantages that IDEMIA's solution may have against Thales' technology include the fact that Thales does not have an in-house offer of biometric face matching scanners, an equivalent of IDEMIA's MFace solution. Their current biometric scanners offer is focused only on Fingerprint, Iris and Palm biometrics.

8.10CYBERLENS

Service 7.3.1 - DVATS (Dynamic Vulnerability Assessment & Testing System)

Every business and every individual can be subject to cyber threats. in the last couple of years, cyber security has become a significant challenge for the maritime industry as well. Since then, the maritime risk-management software market has gained a lot of traction. A newly published report entitled "**Global Maritime Risk-Management Software Market Growth (Status and Outlook) 2021-2026**"[xxiv] thoroughly presents the market competition landscape and provides a detailed analysis of the major players in the market. Three of the key players covered in the report, namely DNV GL, Global Maritime, and IMSA Global, are referenced below as part of our competitor analysis.

3. **Competitor Name: DNV GL** (https://www.dnv.com/)

Software Tool: Synergi Life Risk Management (https://www.dnv.com/software/services/qhse/synergi-life-risk-management-index.html)

The competitor offers the same solution as CLS and serves customers in multiple industries including the maritime industry targeted by CLS's solution. In comparison, DNV's solution that applies to the maritime industry, DNV's risk analysis tools have been adopted globally in the oil and gas, chemicals, insurance, steel, and other industries for understanding and managing risk. In terms of pricing, CLS's solution wishes to be affordable to small- and medium-sized shipping companies.

4. **Competitor Name:** International Maritime Security Associates (IMSA) (https://imsa.global/)

Software tool: ARMS (https://arms.imsa.global/)

IMSA offers a similar solution and has a broader list of clients ranging from port facilities to vessels, cargos, large yachts, and marine facilities. IMSA is a maritime-oriented security company focused on protecting not only vessels and cargo, but also marine facilities and ports.

On the innovation side CL's solution succeeds IMSA's solution since most shipping companies won't have their security analyst onboard, our solution has codified and automated the workflows an analyst would use, eliminating the need for highly experienced personnel.

5. **Company name:** Wilhelmsen (https://www.wilhelmsen.com/)

Software tool: Risk Management & Systems (https://www.wilhelmsen.com/ship-management/risk-management-systems/) HIS

Wilhelmsen offers a similar solution to CLS and serves a global customer base, as a global service provider focusing on marine products, marine chemicals, maritime logistics and ships agencies.

CLS anticipates being competitive versus Wilhelmsen's solutions on the pricing.

9

References

- [1] L. Bell, "Strategic planning and school management: Full of sound and fury," Journal of Educational Administration, vol. 40, no. 4, pp. 407-424, 2002

ANNEX I: Partner Fill-In Form (Template)

ISOLA Market Analysis Report

Partner Fill-in Form

This document serves as a guide for all partners participating in **Task 9.3** on the preparation of **Deliverable 9.3: Market Analysis Report.**

All partners are required to fill-in all the relevant information below for the purposes of the deliverable.

The scope of this deliverable is to provide a detailed market analysis including the competitive landscape relevant to the technologies to be developed under the project and the proposed business models to be followed for the promotion of the technologies.

Please follow the guidelines and use the template hereinbelow to fill in any information.

To edit the document, please SAVE AS NEW DOCUMENT and follow the below naming convention:

[*NAME OF PARTNER]_Task9.3_version[1]*

Name of Partner:	

Name of technology you lead:	
Date:	

Table of Contents

1. SWOT Analysis

Description: The SWOT (Strengths, Weaknesses, Opportunities, Threats) matrix is a tool to support strategic decision-making and help build a successful market access strategy for your product/service.

How to fill-in your SWOT matrix:

- ➔ Always keep in mind your objective, i.e. to commercialise your product/service. The template must be filled from this point of view:
  - ◆ What are the strengths for your product/service commercialisation? What are the opportunities for your product/service commercialisation? Etc.;
  - ◆ Distinguish between internal factors (that come from your company, your products, your know-how etc.) and external factors (that come from your environment, competitors, laws & regulation, market trends etc.).

To work out if something is an internal or external factor, ask yourself if it would exist even if your business didn't.

- ➔ Rely on facts, not intuitions;
- ➔ Provide figures each time it is possible;
- ➔ Prioritise.

Remain synthetic in the matrix and bring explanations below it if necessary (An external reviewer should be able to understand the foundation of your statements).

For more information on how to perform a SWOT analysis, please look at: https://www.mindtools.com/pages/article/newTMC_05.htm

Please use this template to fill in the SWOT analysis for each ISOLA innovative technology.

	Service [XXXX]	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGTHS** *What do you do well?* *What unique resources can you draw on?* *What do others see as your strengths?*	**WEAKNESSES** *What could you improve?* *Where do you have fewer resources than others?* *What are others likely to see as a weakness?*
EXTERNAL FACTORS	**OPPORTUNITIES** *What opportunities are open to you?* *What trends could you take advantage of?* *How can you turn your strengths into opportunities?*	**THREATS** *What threats could harm you?* *What is your competition doing?* *What threats do your weaknesses expose you to?*

2. Benefits to the Economy

Please provide us with information on what benefits to the economy your innovation/technology bring about. [100 words, in paragraphs]

You can focus on questions such as:

- *Why investing in such technologies will benefit the economy?*
- *Who will gain from utilising this technology? How will this benefit manifest?*
- *How will these technologies bring about substantial - beneficial changes to their respective markets/industries?*

3. Policy Plans & Regulatory Framework

In this Section, we ask you to provide information on any applicable laws that govern your technology in question. Laws governing the technology could be focused on matters such as: (i) technical specifications, (ii) limitations on utilisation and use of the technology, (iii) registration and/or licensing required for the technology, etc.

We are focused on 2 legal frameworks, namely:

1) *National/EU policy plans supporting/promoting utilization of such technologies*
    a) *EU regulations/directives:*
    b) *National law different from EU law? If yes, how?*
2) *Third countries/beyond Europe:*
    a) *USA*
    b) *Russia*
    c) *China*

Please provide the following information for each legal framework:

[100-500 words in each legal framework section, in paragraphs, with different subsections for Points 1 and 2 as above]

- *Name of applicable law*
- *Brief description of law*
- *Impact of law on ISOLA technology*
- *Web link access to law*

4. Technological Trends

Please provide the information with references (web links to publications/articles). [100-500 words, in paragraphs]

Why is there a move towards utilization of this technology?

Which industries would benefit the most from the use of this technology?
What is the current market growth for this technology?
What are the current uses and what could be future uses of the technology?
Have major economic/financial/industrial and/or geo-political actors taken any steps towards utilising/developing/regulating the technology?

5. Key Innovative Technology - Comparison Criteria

It is essential to properly identify your solution comparison criteria, as they will allow you to benchmark your solution against competing ones, to highlight your competitive advantages and to help you define your unique value proposition to the prospective owners/operators.

How to identify your solution comparison criteria:

- ➔ *Your solution comparison criteria must be as common as possible to all competing solutions.*
- ➔ *They should reflect the main technical and/or functional characteristics of the solution and the main investment and exploitation issues at stake.*
- ➔ *They should be customer-oriented i.e. they should be defined regarding customers' use cases, their needs and their constraints (financial, technical, skills related etc.).*
- ➔ *They should be adapted to your customers' profiles. If your customers are very technical, you should foster technical criteria. If not, you should foster functional ones.*

The template table provided below will assist you in structuring your comparison criteria. Fill in the relevant fields accordingly.

Fill in only the fields that are dedicated to you as a Partner - Pilot Technology. Delete All other irrelevant fields dedicated to the other partners.

Lead Partner	Pilot Technology	Technical Criteria	Functional Criteria	Commercial Criteria
ACCELI	Service 3.2.1 ISOLA UAV			
CENTRIC	Service 5.4.1 Decision Support Service 6.1.1 Risk Management Modelling Service 6.2.1 Warning message			
CERTH	Service 4.2.1 Visual Object detection Service 4.3.1 Crowd counting			

	Service 4.3.2 Abnormal behaviour detection Service 5.1.1 Semantic indexing Service 5.2.1 Multimodal indexing			
CYBERLENS	Service 7.3.1 DVATS (Dynamic Vulnerability Assessment & Testing System)			
IBM	Service 3.5.1 Drones Platform			
IDEMIA	Service 3.1.1 Secure Mobile app Service 3.1.2 Boarding Kiosk			

IDMG	Service 4.1.2 AV Edge Device			
NTUA	Service 5.5.1 Crisis Classification			
PRISMA	Service 3.6.1 Connection with the ship's legacy systems			
OCEANS CAN	Service 3.2.2 Data acquisition from UUV			
PROMETECH	Service 4.4.1 Passenger and crew monitoring system Service 4.5.1 Hazard Dispersion prediction			

SIVECO	Service 3.3.1 Crowdsourcing and mobile apps monitoring Service 5.3.1 3D visualization module for the network Service 7.5.1 Interactive User Interface			
T4i	Service 3.4.1 Monitoring system of air facilities Service 3.1.3 Handheld chemical detector			

6. Competitive Landscape

In the Competitive Landscape Section, you are asked to compile a list of relevant competitive technologies.

The first question on competition intensity is aimed at creating a general image of the competition within the industry. It is based upon Michael Porter's "Five Forces" strategy tool.

1. **Competitive Rivalry**
   How many rivals do you have? Who are they, and how does the quality of their products and services compare with yours?
2. **Supplier Power**
   How many potential suppliers do you have? How unique is the product or service that they provide, and how expensive would it be to switch from one supplier to another?
3. **Buyer Power**
   How many buyers are there, and how big are their orders? How much would it cost them to switch from your products and services to those of a rival? Are your buyers strong enough to dictate terms to you?
4. **Threat of Substitution**
   A substitution that is easy and cheap to make can weaken your position and threaten your profitability.
5. **Threat of New Entry**
   How easy is it to get a foothold in your industry or market? How much would it cost, and how tightly is your sector regulated?

For more information on Porter's "Five Forces", please follow this link: https://www.mindtools.com/pages/article/newTMC_08.htm

For each pilot technology, the competitive landscape should be assessed and drafted and 3 relevant competitors should be included, as per the template herein below:

WHAT IS THE COMPETITION INTENSITY?
1. *Competitive Rivalry* 2. *Supplier Power* 3. *Buyer Power* 4. *Threat of Substitution* 5. *Threat of New Entry*
COMPETITOR 1 / COMPETITOR 2 / COMPETITOR 3
DOES THIS COMPETITOR HAVE THE SAME SOLUTION AS YOU?
DOES THIS COMPETITOR HAVE THE SAME CUSTOMERS AS YOU?

WHAT ARE THE LIMITATIONS OF THIS COMPANY COMPARED TO YOUR SOLUTION?
DESCRIBE THE PERFORMANCE OF THIS COMPANY COMPARED TO YOUR SOLUTION?
CAN YOU POINT OUT HOW YOU ARE BETTER OR DIFFERENT (E.G. PRICE, PRODUCT SIZE, MARKET EXPERIENCE, INNOVATION & NEW PRODUCT, VALUE, BRANDING?

ANNEX II: Competitive Landscape Section

The below sections formed part of the Partner Fill-In form focusing specifically on the competitive landscape applicable to each of the technologies being developed as part of the Project.

Partners were asked to provide their input based on the below template:

What is the competition intensity?

1. *Competitive rivalry*
2. *Supplier power*
3. *Buyer power*
4. *Threat of substitution*
5. *Threat of new entry*

Competitor Names (x3) – where applicable.

- Does this competitor have the same solution as you?
- Does this competitor have the same customers as you?
- What are the limitations of this company compared to your solution?
- Describe the performance of this company compared to your solution?

- Can you point out how you are better or different (e.g. price, product size, market experience, innovation & new product, value, branding?

CO-ANNEX III: Market Analysis & SWOT Analysis per Partner

1 Market Analysis

1.1 Benefits to the economy

A description of the technologies to which each partner is contributing is included in **Section 4: Key Innovative Technologies**.

	Comments
IBM	In the maritime domain, various opportunities emerge including (i) the inspection of the ship structure, (ii) monitoring the loading of cargo, (iii) sea-based search, (iv) rescue operations and (v) sea-based oil monitoring. Civil infrastructure deals with old constructions requiring expensive, dangerous and time-consuming inspections. Using new technologies can save a lot of money, time, and people's lives, enabling better and more frequent inspections.
ACCELI	Unmanned aerial vehicles (UAVs) have become an increasingly attractive area of research in recent years[1,1,1,1]. Many researchers have been studying UAVs to utilize them as an ideal platform for civilian tasks or military tasks, such as inspection, delivery, reconnaissance, or surveillance, like the mobile robots based on autonomous navigation, real-time path planning, and object recognition[1,1,1,1]. Yet, UAVs still face challenges for autonomous flight, such as control strategy including parameter tuning, adaptive control, real-time path planning, and object recognition under uncertain environments. Various approaches on negation, heuristics and graph theory have been previously proposed for addressing these challenges, but they remain inadequate due to difficulties with sensors, system dynamics and qualities[1,1,1]. Artificial intelligence (AI) and specifically the area of machine learning (ML) offer an attractive alternative to overcome the challenges in UAVs for autonomous flight enabling UAVs to recognize patterns or make predictions from data without explicit programming designs for autonomous flight. Despite the promising results provided by the AI-enabled systems, UAV constraints, such as endurance, weight, and payload, require the development of specific hardware and software solutions for being embedded on board of a UAV. Taking these limitations into account, only few systems in the literature have embedded feature extraction algorithms using deep learning processed by GPU technology on board a UAV. A wide array of potential applications exists for robots that have the level of mobility offered by flight. The security applications of aerial robotics have been recognized ever since the beginnings of powered flight, and they have already been realized to sometimes spectacular effect in surveillance, targeting, and even strike missions. On the other hand, a wide range of civilian applications are also identified and includes remote sensing, disaster response, image acquisition, surveillance, transportation, and delivery of goods.

CERTH	*Visual Content Analysis:* The AI Image Recognition Market estimated value was USD 1695.93 million in 2020 and is expected to reach a value of USD 5161.04 million by 2026, registering a CAGR of 24.82% during the forecast period (2021 - 2026). The adoption of artificial intelligence (AI) technology is rising, owing to its ability to enhance and automate operations and enrich the user experience. The algorithms for visual content analysis provided by CERTH can provide solutions for different types of industries and specifically for the shipping industry in the case of the ISOLA project. The visual object detection algorithm, the detection of abnormal behaviour and crowd monitoring solutions can increase the levels of the ship's security and situational awareness, which will lead to faster response times from the ship's security personnel. This results in safer travels of passengers, with reduced impact of the security incidents, which of course increases the reliability of the shipping company and has a huge impact on its economy. *Semantic and Multimodal Indexing:* Nowadays the growing importance of the Internet and the World Wide Web has made indexing one of the most important research fields. Many different index structures, compression techniques and retrieval algorithms have been proposed in the last few years. More importantly, these proposals have been widely used in the implementation of document databases, digital libraries, and web search engines. Indexing can be defined as a process that collects, parses and stores data to facilitate fast and accurate information retrieval. Semantic Indexing tries to beat the problems of lexical matching by using statistically derived conceptual indices instead of individual words for retrieval. Semantic Indexing assumes that there's some underlying or context structure in word usage that's partially obscured by variability in word selection. For browsing, searching, and manipulating video documents, an index describing the video content is required. The complex nature of this work makes manual indexing of video documents an expensive and time-consuming task. Therefore, automatic classification of video content is necessary. This mechanism is referred to as multimodal indexing and is defined as the process of automatically assigning content-based labels to video/image or social media documents. CERTH's algorithms will introduce the shipping industry to these technologies, which will increase the situational awareness of the security personnel by collecting, fusing and indexing the incoming data from heterogeneous sensors.
CENTRIC	Using a decision support system in the aid of disaster mitigation can: Preventing supply chain disruption from ships that have taken on incidents, affecting all global industries. Possible insurance savings from securer ships, that are less at risk from threats. Reduction in military assistance as there are cost savings in using onboard drone equipment for monitoring rather than using military patrols, including the benefit of additional fuel savings. Negate the negative economic effects of tourism and fishing disruption from regions deemed unsafe for travel, through secure boarding and piracy mitigation. Fuel savings from safe direct routing and speed reductions (when safety is ensured and managed through the support system), decreasing the costs of shipping goods, benefiting small exporters.
SIMAVI	Some of the key benefits that have been identified include:

	• The mobile application will be used to better understand the presence and quantity of passengers onboard, inform them of imminent threats, locate them in case of an emergency. • 3D-visualisation of early warnings, will not only offer a 3D environment but will also show early warning signals in case of emergency. • Interactive user interfaces - The goal of user interface design is to make digital interaction as simple, fluid, intuitive and efficient as possible. It must anticipate needs and ensure ease of access, comprehension and use, maximising the user experience. The interface must always have a user-centred design.
T4i	Aiming at commercialization in a stagnated economic environment against major budget cuts. Public opinion and, consequently, cruise firms are drivers that support budget allocation for tackling the use of toxic chemicals onboard ships. Terrorist events have made clear that the use of hazardous materials within cruise vessels may be linked with terrorist or criminal activity. Cruise businesses facing the threat of HazMat and personnel exposure, as well as customers risks, are ready to allocate more resources for personnel protection, safety and welfare. The DOVER chemical detector is designed as a dual-use product, namely as a fixed and handheld detector (with a probe/ stick). The dual concept of operation of DOVER balances between forward-looking and traditional use.
PRISMA	The project will have a profound impact on the adoption of several innovative technologies in the maritime sector. These include sensing, monitoring, data fusion, distributed computing. Prisma aims to pave the way towards a more sophisticated policy-making process and standardization. Furthermore, the project will benefit ship owners and operators to increase efficiency, reduce downtime and costs, and ensure the safe operation of their assets. Moreover, the connection with legacy aims to highlight new areas for socio-economic research and demonstrate the benefits of the adoption of Big data technologies and extreme scale data processing solutions in the shipping industry.
IDEMIA/ IDMG	The computing paradigm of edge computing shifts data processing to or near the data source that is regarded as the edge of a network. In contrast to centralized cloud or data centre applications, a key feature of edge computing is therefore de-centralized data processing. *Edge Computing:* Edge computing has several advantages over centralized computation, as it avoids the transmission of data from a data source to a centralized system and is beneficial in application fields that require short reaction times. This helps to improve operational efficiency, performance and security as it reduces the amount of data that has to travel over a network. Real-time video analytics is therefore regarded as the killer application for edge computing (https://www.microsoft.com/en-us/research/publication/demo-video-analytics-killer-app-for-edge-computing/), especially as the transmission of HD video streams and beyond like 4k videos require high bandwidths and thus expensive network infrastructures.

	Core application fields of edge-based video processing are automatic self-driving, smart cities and the surveillance/ protection of critical infrastructures. *Secure Boarding System:* Our economy requests a strong restart of travels for business or tourism. It is crucial for many sectors depending of visits for leisure or in professional circumstances. This restart should be compatible with social distance and limiting contact operations. Our secure boarding system favours a complete hand-free procedure for the traveller at boarding time while creating a trustable relationship with him at enrolment time. It is an opportunity to create in a situation where an important flow of persons needs to be managed to introduce what IDEMIA named "smart path", provided contactless biometrics.
NTUA	The cruise industry is an integral part of the tourism industry and, although being significantly disrupted by the Covid-19 pandemic, the market is once again rising. However, it is a market vulnerable to security incidents which can severely impact consumer confidence and, consequently, inhibit the market's growth. Hence, it is in the best interest of industry stakeholders (ship owners, crew, port operators, passengers, etc.) to invest in security solutions that enhance the security of their customers and operations. To this end, the crisis classification service supports decision making, enhancing the onboard security without the need for additional security personnel onboard.
MST	The use of UUVs for underwater data acquisition is a low cost and safe alternative to manned ship surveys or underwater divers. As the areas to be surveyed are usually very large, automation of the entire survey will increase the quality of the results and decrease human costs. As opposed to ship surveys, UUVs can travel close to the bottom which increases the resolution of the acquired data. Moreover, as opposed to divers, UUVs are fit for travelling long linear transects while estimating their position accurately. In conclusion, UUV results are of better quality and at a fraction of the cost (monetary and labour-wise) of manned ship surveys or divers. In the case of ISOLA, the UUV will make the job of divers much easier by quickly sweeping large areas and allowing for easy and precise identification of features.
DBS	The security personnel onboard will be significantly reduced and consequently decreasing the overall cost. The use of technology can enhance security and assist in minimizing human error; therefore, the reliability of the security system will be increased which will have a consequent positive impact on the industry. By utilizing UAVs, the security inspections can be conducted more safely and efficiently while surveyors can be appointed live through the digital system. Connecting through satellite the availability of the vessels is increasing and therefore the vessels are not retained in ports for inspections. This revealed a continuity of trade, and the global economy is increased.
MINISTRY OF DEFENSE, CYPRUS	Increasing productivity and bringing to companies and citizens new and better goods and services regarding specifically the domain of shipping safety and security. Furthermore, standalone technologies to be implemented throughout the project could be potentially adopted and utilized in various other industries, such as military applications. The ISOLA innovations could be catalysts in adopting technologies to fill in the gaps present in the market and can lead the way for multiple adoption opportunities in other industries as well.

CYBERLENS	Advancing digital cybersecurity technologies, such as those proposed by ISOLA's DVATS service, bring about several economic benefits to the shipping industry, including reduced economic losses as potential cybersecurity attacks are less probable to occur with these technologies in place. At the same time, medium- and long-term economic repercussions will also be reduced as less costly cybersecurity measures will need to be implemented onboard the ship. The gains that these technologies bring to their respective markets/industries also go beyond the mitigating impacts of cyber terrorism and result mostly from the better asset (inventory) control, the decreased payroll (due to IT improvements) as well as the decreased insurance costs (premiums).

2 SWOT Analysis

SWOT Analysis presented per partner, in the following order:

1. ACCELI
2. PROMETECH
3. CERTH
4. SIMAVI
5. T4i
6. IDM
7. NTUA
8. CENTRIC
9. MST
10. IBM
11. CYBERLENS

	Service 3.2.1 ISOLA UAV ACCELI	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNA	**STRENGHTS**	**WEAKNESSES**

	• Real time monitoring of security threats • Constant evaluation of threat levels and decision-making models/ choices ▪ Enhancement of security monitoring capabilities and threat response times ▪ Effective and affordable combination of conventional and complex sensors ▪ Coverage of all passenger ship types (small ship, cruise ships) ▪ Integration with existing monitoring systems in ships	▪ Increased volume of data ▪ Low maturity of some technologies ▪ Ownership and liability issues ▪ Staffing, Training, operation, and maintenance costs
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Mass production of, at present expensive units, will lower the costs to allow ubiquitous installation of a holistic approach platform • Scalability of the system to new threats that develop in the near future • Insertion into the market of very expensive equipment at low interoperability levels • Break the fragmentation and isolation of European agencies in maritime domain • Potential extension to other types of ship (cargo)	▪ The ISOLA UAV concept is copied by an organisation with more financial and/or technological leverage ▪ Local legislation barriers

	Service 4.4.1 & Service 4.5.1. PROMETECH	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Modelling based on the latest scientific information • Flexible software • No competition	▪ Small team ▪ No customers at the moment
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Endless market • Possible government legislation • Custom made overviews	▪ New market, with no current relationships ▪ Time intensive to build a 3D map of a building/ ship, so expensive solution

	Service 4.2.1 - Visual Content Analysis CERTH	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Development of custom state of the art solutions to detect objects by efficiently exploiting hardware with high or low computational resources • We develop state of the art algorithms based on convolutional neural networks that offer near-real time object detection for embedded systems with limited computational capabilities. The advantages of those algorithms are that they can process frames at high rates without sacrificing much of the precision. • We develop custom state of the art algorithms based on convolutional neural networks that offer near-real time object detection with higher precision results. These solutions aim for powerful computational systems. The advantages of those algorithms are that they present excellent performance in terms of precision and robustness on multiple datasets. Development of a state of the art solution to	▪ The performance of our model is depended on the size, the quality and heterogeneity of annotated datasets that will be used for the training process. This in some cases can be considered as a drawback, if the datasets for detecting specific objects are not available. ▪ There is not one algorithm that can produce high precision results and simultaneously process frames at high rates when using either embedded or high performance computational systems. Each solution has to be selected according to the specific use case and requirements.

	detect abnormal behaviors from visual content, that can be considered as potential threats to ship's security. • The model based on convolutional neural networks is capable of representing more complex functions, yielding in practice both a lower training loss and a lower testing loss and achieving state of the art performance on challenging public action recognition datasets. • Development of a state-of-the-art solution to detect abnormal behaviours from visual content, that can be considered as potential threats to ship's security. • The model based on convolutional neural networks is capable of representing more complex functions, yielding in practice both a lower training loss and a lower testing loss and achieving state of the art performance on challenging public action recognition datasets. • The majority of our employees is highly educated staff, which can design and produce novel technologies.	
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Our model is based on algorithms that can be adapted to different use cases and can be optimized easily according to their needs. Assuming that the datasets are available our solutions can adapt and provide state-of-the-art results in many different cases.	▪ A potential delay of the competence of the algorithm could make it outdated and not competitive ▪ Lack of equipment or delays due to long term supply chain intermissions during the pandemic.

	Service 5.1.1 Semantic indexing Service 5.2.1 Multimodal indexing CERTH	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Ontologies will be used which translates to less effort and solid base commencement for the decision support module. • Easy sharing, reusing and configuring of implemented framework. • The general procedure's concept is understandable by both humans and machines. • Inference might lead to assumptions the human mind would have missed. • The majority of our employees is highly educated staff, which can design and produce novel technologies.	▪ There is no standard way to generate ontologies ▪ Ontology and reasoning rules generation might consume a lot of time until finalization ▪ Erroneous initial data might lead to erroneous assumptions as general pipeline's results.
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Opportunity to test the semantic indexing in such a project with many heterogeneous sensors. It will prove that it can be capable to support very complex design and applications.	▪ Possible denial of service or delays in responding to queries due to high traffic from heterogeneous sensors.

	Service 3.6.1 - Connection with the ship's legacy systems Prisma	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Scalable solution • Shareable data • Low cost compared to competition • High level of experience	▪ Time to the market (development) ▪ Long sales cycle ▪ Sales and RD continuous financing
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Large existing market in need • Further Health & Safety legislation • Expansion to new fields	▪ Market resistance to Change ▪ Management authority limitations ▪ Disruptive technology ▪ Inconspicuous competition

	Service 3.3.1 Crowdsourcing and mobile apps monitoring SIMAVI	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Collect data from passengers on board the ship • Inform them of imminent threats • Locate them in an emergency • May collect additional information from social media feeds • Coverage of all passenger ship types • Communication with existing monitoring systems from ships	▪ The application may not work so well on older devices ▪ In case of weak signal or low battery, the application may not be very responsive
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Mass production of the application • Adapt the application for new threats that may appear • Could be adapted to other types of ships • Could read data from more data sources	▪ The concept of the application is copied by other organisation ▪ Local legislations

	Service 5.3.1 3D visualization module for the network SIMAVI	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• 3D visualisation mode • Display the exact location of the root cause or event • Display warning messages • The environment of the ship is based on real plans	▪ The application may not work so well on older devices ▪ In case of weak signal or low battery, the application may not be very responsive
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Mass production of the application • Adapt the application for new events that may appear • Could be adapted to other types of ships • Could read data from more data sources	▪ The concept of the application is copied by other organisation ▪ Local legislations

	Service 7.5.1 Interactive User Interface SIMAVI	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• 3D visualisation mode • The environment of the ship is based on real plans • Very good user interface • Display immediate action in case of emergency	▪ The application may not work so well on older devices ▪ In case of weak signal or low battery, the application may not be very responsive
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Mass production of the application • Adapt the application for new events that may appear • Could be adapted to other types of ships • Could read data from more data sources	▪ The concept of the application is copied by another organisation ▪ Local legislations

	Service 3.4.1 - Monitoring system of air facilities & Service 3.1.3 - Handheld chemical detector T4i	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Innovative, dual use detector (either as fixed or handheld), real-time chemical monitoring, scalable solution (potentiality to combine it with analytical technologies, such as IMS), remote diagnostics and early maintenance. • Handheld: versatility to carry and use at different locations within a vessel. • Fixed: integration with the ventilation system.	▪ Difficulties in getting European and International exposure, low experience in pricing and after-sales service.
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Gap in the market for autonomous detection of toxic chemicals onboard passenger ships, increased needs globally for passengers and personnel safety and security in cruise vessels, needs for cost-efficient solutions in services for surveillance and inspection. Potential applications in detection and monitoring of critical infrastructures, such as multi-store buildings with controlled air ventilation. Advent of smart city market.	▪ Delays in economic recovery due to global health crisis, delays in establishing relevant regulations, delays in the supply chain, mostly on hardware (e.g., micro-electronics and pneumatics).

	Service 4.1.2 – AV Edge Device IDM	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	Organization • Globally operating organization including a world-wide distribution network • Technical • GDPR compliant solution: advantage in the Western hemisphere • Processing unit independent of camera providers and thus customer-specific dependencies • Provision of latest state of the art video analytics; e.g. ranked first in comparative NIST FR vender evaluation • Configurable selection of video analytics on an edge device • Central management of multiple edge devices	Organization ▪ Minimal market share today ▪ No references so far Technical ▪ Individual management of edge devices may become complex in case of huge number of edge devices. ▪ Dependence on single source hardware provider ▪ Hardware footprint large
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Exponential growth rate for edge computing, especially in case of video analytics • Expected continued increase of GPU power • Advancements in camera technology • Ubiquitous camera usages	▪ Upcoming restrictions of usage of video analytics in public spaces ▪ Additional regulations through the upcoming 'AI Act' ▪ Trend of making video analysis an in-build feature of cameras

	Service: Secure Boarding System IDM	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Contactless biometric technology. • Expert R&D (#1 Face Recognition Vendor Test (FRVT) du National Institute of Standards and Technology (NIST)). • Passenger Flow Facilitation portfolio (end-to-end solution, biometric devices, enrolment solutions, Biometric e-gate solutions).	▪ Regulation ▪ Fragmentation ▪ Fear for privacy and Security
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Pandemic situation • Request for facilitation of travel • What trends could you take advantage of? • Be able to propose either part of the system or the complete system	▪ Shyness about face recognition ▪ Strong competition for Biometrics ▪ Cyber-attacks

	Service 5.5.1 – Crisis Classification NTUA	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Does not require large datasets for training prior to deployment. • Considers a wider range of security incidents/ threats compared to existing modules /software in the market. • Crisis level estimations are aligned with the three (3) security levels described in the ISPS code, with additional sublevels for enhanced decision support. • The module is not computationally demanding.	▪ Confidence interval depends on the accuracy of collaborating modules. ▪ Provides estimations to incidents related to the defined PUCs.
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• With minor adjustment, the module can adapt to additional use cases covering a wider range of security incidents/ threats. • At a conceptual level, the module can adapt to non-security related incidents. • Given appropriate input data, the module can adapt to incidents outside the maritime domain.	▪ Unforeseen, unexpected, and previously unobserved malicious tactics may not be within the scope of the module's capabilities, given the complexity and unpredictability of security incidents. ▪ Competitive solutions may be more focused on specific security incidents. ▪ End-users' may opt for solutions that are already available in the market and have been deployed on several vessels before.

	Service 6.1 – Risk Management Modelling CENTRIC	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• The risk models in development have a high level of configuration/customisation that can be adjusted for different ships and shipping companies and regulations.	▪ Extensive consultation could be required to tailor the system to specific operations ▪ The service is inherently complex to configure requiring expert setup in new cases.
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• The models developed can be shared, updated, and improved to meet future standards, or integrate future technology inputs such as new advanced sensors. • The parts of the system in development could be used for applications beyond the maritime domain.	▪ Other systems are benefiting from growing a dataset as they are already deployed and collecting data.

	Service 6.2.1 – Warning Message CENTRIC	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Semi automate passenger communications relieving command to deal with the incident.	▪ The warning message communications are only as good as the communication channels themselves, without a direct interface with emergency alert broadcasting systems to reach all mobile users without constraint. Only those passengers who uptake the technology will be reached. Therefore, information is only viewed as supplementary
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Communications could be extended to provide information regarding non-emergency situations including advisories and general announcements onboard.	

	Service 3.2.2 - UUV Data Acquisition MST	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Better resolution. • Autonomous execution.	▪ Expensive entry cost. ▪ A manned vessel is still needed for deployment and recovery.
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Improvements on battery energy density will lead to longer endurances. • Improvements in global communications (such as starlink).	▪ Risk of losing the vehicle is greater when compared with manned/ surface vessels. ▪ Manned vessels can also perform automated data acquisition.

	Service 3.5.1 Drones Platform IBM	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• Tackle different kinds of missions in different fields – easy to create new mission kinds • Save cost and time for performing various inspection tasks • Easily and quickly reach (even hard to get) areas of interest • Platform for heterogenous tasks to be carried out by heterogeneous drones • Support an end-to-end system via flexible plugins • Provide real-time data to be analysed, potentially influencing dynamic automatic flight plan.	▪ Sensitive to obstacles ▪ Currently does not operate well in a GPS denied environment ▪ Some amount of customization required per inspected element ▪ multidisciplinary team required for initial setup ▪ Training professionals to use the system is hard and time consuming
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Inspection of infrastructure is currently a large scale problem, to which we have a powerful solution • Use of drones relatively new, our proposition of automatic piloting of a swarm of drones may open up interesting opportunities. • Lots of interests from different fields	▪ Regulations – change and variability in different areas ▪ Current inspection practices are well rooted and sometimes difficult to change

	Service 7.3.1 CYBERLENS	
	FAVOURABLE FACTORS	**ADVERSE FACTORS**
INTERNAL FACTORS	**STRENGHTS**	**WEAKNESSES**
	• High potential for innovation & commercialisation. • Real time monitoring & evaluation of security vulnerabilities in the ICT infrastructure of modern ships. • Improved vulnerability detection based on automated threat analytics and detection methods. • Integration with legacy monitoring and control systems installed in ships. • Reduced OPEX by minimising human intervention.	▪ Dependence on the availability of commercial and open-source software and tools. ▪ Non-uniformity in the adoption speed of new technologies by the Member States. ▪ Staffing, training, operation, and maintenance costs.
EXTERNAL FACTORS	**OPPORTUNITIES**	**THREATS**
	• Surging concerns of advanced threats targeting IT and OT infrastructures of modern ships and vessels. • Need for increased cyber hygiene in all critical economic sectors, including the maritime industry. • Insertion into the market of a low-cost, dynamic vulnerability assessment and testing solution.	▪ Concerns of ISOLA stakeholders regarding data privacy ▪ National and/or international legislation barriers. ▪ Increased competition from existing products. ▪ Low rate of willingness to increase key cybersecurity competencies in the maritime domain.

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