Maritime Integrated Surveillance Awareness (MARISA)

Grant Agreement No.740698

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1. Introduction

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This D2.8 USER Community Report (final) is incrementally composed in MARISA (MARitime Integrated Surveillance Awareness) project, which has received funding from the European Union's Horizon 2020 Research and Innovation program, under the Grant Agreement which identification number is 740698. MARISA Project addresses to the security communities operating at sea with new data fusion toolkit which includes: a suite of methods, techniques and software modules to correlate and fuse various heterogeneous and homogeneous data from different sources, e.g., social network and Internet; with intent to improve collective information exchange, situational awareness, situation understanding, situation intelligence, decision-making, reaction capabilities, action competence and resilience. MARISA User Community is a collective expertise community as a steering forum including professional safety-security and emergency response practitioners operating in the MARitime Integrated Surveillance Awareness Domain.

The MARISA User Community recently and future facilitates the collective progress of data fusion connected operative mechanisms to get insights from big data sources, perform analysis of a variety of data based on geographical and spatial representation, use techniques to search for typical and new patterns that identify possible connections between events, discover predictive analysis to represent the effect of relationships of observed objects and phenomena. Mutual and collective mind of the MARISA User Community as a networked expertise community addresses to the establishment and management of casual relationships such as management of nexus and mutual impacts. The term 'nexus' used here, as mutual causalities and impacts are related to cross-border interaction processes which faces increasing speed of cross-border technological development, needs for mutual and collective trust building, effects of new updates and needs of adaptive-resilient systems-services for 'expected and legacy' as well as 'unexpected and emergent' local-global requirements, responses and collective interactions and operations.

In MARISA Project, the term 'innovation' addresses to the collective creation of new data fusion products, tools, processes, knowledge or services by using new or existing scientific or technological knowledge, which provides a degree of novelty either to: the developer, the industrial sector, the nation or the world or to succeed in the maritime operative domain. Here, the term 'innovation' takes place, for the most part, in a maritime shared context as the desired result. The focus of research is on investigations for understanding and development of artifacts, innovative maritime capabilities, situation understanding, action and decision-making competence. In addition, often, the achieved results of participators innovation-learning transactions are as the stakeholder's own or collective creations as trials, which in turn, may be disseminated to expanded domains or more general to internationally impacting high-value innovations.

In MARISA Project, the term 'innovation action' is realised within collective activities which are directly aiming at product design as well as guidance for co-creation and implementation of a 'Data Fusion Suite' including such as: data fusion tools, -products, -processes, -methods and -services. Here, the innovation action is end-user-centred: including cross-border collaborative activities, building of data fusion trials over national borders, co-creative development, nexus and mutual causalities management, collective testing and operational validation of data fusion tools.

The term 'trial' in MARISA addresses to validation and pre-operational validation of relevant user needs and socio-technical viability of a new data fusion technology, -product, -solution or -process in a particular maritime operational environment, whether industrial or otherwise, involving the larger scale trials and over-border trust-nexus management. The term 'market replication' intents here to support of first data fusion tools

settings as suite in the maritime emergent market of a data-information fusion innovation that are first demonstrated but not yet internationally validated or disseminated.

The term ‘animation’ in MARISA Project is addressed towards the goal of liveness of maritime data fusion and information sharing innovations: breath with user and stakeholder expressions and needs, understand user gain and pain, user-centred design and relevance, building collective strategic-operative-tactic value-service canvas, joint adoption model, dissemination and harmonisation to enhance cross-border and cross-sectoral cooperation to deliver maritime security. The applied Design Science Research (DSR) process includes here such animation targets as: involvement of end-user experience and anticipation-experimentation, facilitation of co-creativity, collective trust building, securing maritime traffic, understanding security of maritime assets, saving human lives, action competence in maritime work and furthering of ‘live pipelines’ between national and international stakeholders. The user-centred aspects and user-computer interactions are addressed also in the adoption model of MARISA process as early and long as possible, e.g., factors of design and realisation; users’ experience and anticipation-experimentation based value-service canvas, networked trust building, co-creativity and agile development, operational validation and train users to use the system so that the design-development-dissemination continuums can be as modular and effective as possible.

The User Needs and Operational Scenarios, Task 2.1, User Community Animation corresponds to Deliverable 2.1 of MARISA Work Package 2 (WP2). The specific objectives of WP2 Task 2.1 includes basic MARISA User Community principles, described in follow Table.

Principles of MARISA User Community as a Steering Forum	
1	The role of User Community is focused on the goal of ‘innovation’, delivering the benefits of data fusion to maritime surveillance through the MARISA toolkit and services.
2	The data fusion technological functionalities and services of MARISA project will first and foremost be driven by this User Community.
3	The User Community mechanisms will be created to foster interactions, leading to knowledge co-created through social interactions, competence sharing and collective service development.
4	The User Community will be set-up involving users and partners as well as external end-users invited to join the initiative.
5	The User Community aims to be as inclusive as possible, building also on the links of individual consortium partners of the MARISA consortium to past and on-going initiatives in the domain to speed up the process.
6	For each related User Community of Interest, such as generic, Data Fusion Expertise and Maritime Safety Agency, different representations of MARISA Data Fusion tools are available, based on access privileges assigned in the Consortium Agreement.

Table 1: Description of Principles of MARISA User Community as a Steering Forum.

The term ‘pipeline’ in MARISA Project addresses to the promotion of expanded spared of interactions and linking of externalities into the nexus of MARISA User Community, connecting such as needs of further cooperation in international network of data fusion expertise community. The role of external linkages are increasing in the regional-domain and science-based clusters, which is currently emphasising the role of external nexus management e.g., in mutual relations, causalities and sustainability. In MARISA, the term ‘pipeline’ presents an animation of internal and external linkages of the sector-domain related clusters’ external

information flow with partners from the outside which are implemented by local-global pipelines, including aspects such as interpretive schemes, learning scopes, shared values, attitudes, shared ethics, sustainability, information flow and social spirit. It is recognised that in the general maritime domain (MARE) there are also larger influencing geographical units, which are at the least of equal, even if not more concern.

1.1. Purpose of Document

This D2.8 USER COMMUNITY REPORT is addressed to MARISA stakeholders and partners for current and further development as well as adoption of authority-based collective activities for achievements of high-value maritime data fusion impacts. The first purpose of D2.8 is that it provides: a continuum of updated documentation of practical data fusion descriptions, terminologies, terminology explanations, practical descriptions, aspects of work packages, approach of decision-making and resilience, key references and remarks that should be used for optimising the MARISA implementation towards further adoptions and development projects. The second purpose of document is in: animation and expression of MARISA User Community and establishment, description of stakeholders visions-anticipations and motivation for maritime authorities cooperation, implications for experimentation and rationalisation of maritime functions and organisational streamlining, descriptions of authorities interactions and pipelines, investigation of possible expansions of potential data fusion activities in the maritime domain, legal and ethical transparency, mutual trust and responsibility, action competence, resilient learning, systemic of causalities and nexus, pre-operational validation and investigation of maritime cyber security aspects, risk settings and assets.

The one additional purpose of User Community report is in description of paths and outcomes towards availability of future MARISA Data Fusion Services and Suites: during MARISA Project, the Data Fusion tools are available only to the end-users for the purpose of validating the new tools in the five (n = 5) operational trials. According to the MARISA Consortium Agreement, the exploitation plan will be agreed among the parties during the project. The toolkit configuration based on the access privileges as access control is one of the capability of the toolkit that will be implemented and validated throughout the project and that will allow to configure the capabilities according to the community profile and needs. For each related User Community of Interest, such as generic, Data Fusion Expertise and Maritime Safety Agency, different representations of MARISA Data Fusion tools are available based on access privileges as assigned in the MARISA Consortium Agreement.

1.2. Agreement Documents

Grant Agreement-740698-MARISA (GA): The Grant Agreement is the contract document concluded between the EC, here representing the EU, and the beneficiaries under which the parties receive the rights and obligations, e.g., the right of the Union's financial contribution and the obligation to carry out the research and development work. The Grant Agreement (MARISA GA) consists of the basic text and annexes including such as Description of the Action (DoA) which is addressed to a specific description of the tasks that will be carried out along the project and the expected results, deliverables and milestones to be obtained. Consortium Agreement (CA) of MARISA PROJECT: The Consortium Agreement (MARISA CA) is the internal agreement signed between the members of the consortium establishing their rights and obligations with respect to the implementation of the activities in compliance with the Grant Agreement (MARISA GA).

1.3. Applicability of the User Community Report

The D2.8 MARISA User Community Report is a reference document in the MARISA Project. It is referenced as followed attributes: deliverable number is D2.8; deliverable title is MARISA User Community Report; related WP number is WP2; lead beneficiary is LAUREA UAS; deliverable type is Report; dissemination level

is Public; due date of D2.8 in months is 20 (December 2019). In addition: D2.8 is applicable to all partners from the months 20 of the project to its end; it is expected to remain stable, however, any changes will be agreed by the Executive Board (EB) and included in the final revised version which public due dates in months is 30 (October 2019). In the unlikely event of a conflict between the D2.8 MARISA User Community Report and other documents such as the Description of Work or the Grant Agreement, they will prevail in the following order: First: Grant Agreement (GA) including all Annexes; Second: Consortium Agreement (CA); and Third: D2.8 MARISA User Community Report (this document). The latter documents will have to be modified to remain consistent with the former. This is especially mandatory for issues regulated by either the [GA] or [CA] documents.

1.4. Description of Titles

In order to clarify some titles tied to certain words used in the MARISA Project, a record of related overall descriptions of most titles are described in follow Table.

Description of Titles	
Anomalies	Detection of an incident that falls outside the frame of normal operations. Typically detected within own sector work. May require action from other sectors. Services used may include sector- or domain-wide anomaly detection tools, risk analysis and planning tools. Typically, basic and additional information is shared on a regular basis.
Classification	Classification is the process in which the characteristics of a ship are used to associate it to a category, hence, two boats classified in the same way cannot not be easy to differentiated unless they are identified.
CONOPS	A concept of operations is describing the characteristics of a proposed system from the viewpoint of an individual who will use that system. A description of how a set of capabilities may be employed to achieve desired objectives or end state. It is used to communicate the quantitative and qualitative system characteristics to all stakeholders.
Correlation	The process which associates and combines data on a single entity or subject from independent observations, in order to improve the reliability or credibility of the information.
CISE	CISE is the Common Information Sharing Environment for the Maritime Domain. It will integrate existing surveillance systems and networks and give to all the relevant authorities (EU and national authorities responsible for different aspects of surveillance) concerned access to the information they need for their missions at sea. The CISE will make different systems interoperable so that data and other information can be exchanged easily through the use of modern technologies.
Data Fusion	The process of integrating multiple data sources to produce more consistent, accurate, and useful information than that provided by any individual data source. Is analogous to the ongoing cognitive process used by humans to integrate data continually from their senses to make inferences about the external world.
Detection	The process in which the system becomes aware of a real-life object such as a vessel, a buoy or a helicopter and creates its virtual counterpart in the Recognized Maritime Picture. Detection can be achieved using data coming from one sensor or from several sensors at the same time.

Description of Titles	
Extra ordinary	When major incidents or accidents occur there is a need to coordinate assets from several sectors and nations. Decision-making across sectors and borders is required. Information sharing outside normal patterns is required. Services should be designed to share information accordingly. Basic and additional information is to be shared as well as restricted as required.
European Interoperability Framework	A commonly agreed approach to the delivery of European public services in an interoperable manner. It defines basic interoperability guidelines in the form of common principles, models and recommendations.
Knowldge: empeded in system	A form of knowledge that is linked whith tools, practices and action environment. End users and operative actors are supported to overcome their desicion-making challenges and cognitive prosessing limitations by facilitating knowlege which is in the system, environment and knowledge of nexus.
Knowledge: distributed	Knowledge that is unique to participator, member, flow of work package or working team and it is not uniform accross all consortium members.
Knowledge: instructions splinders	Instructios addresses to knowledge sharing activities for reduction of the amount of irrelevant cognitive load to a minimun through an increased awarness of individuals and operative factors that influence cognitive processing; an instruction which may advance our capacity to handel complexity in understanding and learning.
Knowledge: shared	Knowledge that is uniform and shared accross all participators of a project or an activity related to the share development target. Type of knowledge which is prepresented in personal way by each member but in vey end the type of achieved knowledge is rather kind of uniform when it is shared.
Resilience	Addresses (here) to an ability to recover from adverse event. A descision-making ability releted to absorbtion and adaption. Main factors: readiness, clean data, additivity of capabilities, clusters and parallel options, nexus management and adaptive-dynamic capabilities of artifacts. Combines: engineering, infrastructure, organisational, psychological, ethical and socio-ecological impacts in decision-making.
Situational awareness picture	Sector, domain, regional, national or EU-wide services which are addressed to provide a recognised maritime picture. National or regional maritime situational awareness may be facilitaded for maritime domain, cross-domain or cross-border purposes depending on national legislation and agreements. Information exchange and sharing are in line with this principle. The services used provides as much open information as possible, e.g., map services, weather services, tools for visualization, augmentations and compilation which improves quality of information in data fusion.
Toolkit	In order to fostering faster detection of new events, better informed decision making and achievement of a joint understanding of a situation across borders, the MARISA toolkit it will be able to provide as a suite of services to correlate and fuse various heterogeneous and homogeneous data and information from different sources, including Internet and social networks.
Triangulation	The term ‘triangulation’ refers here to the validation of data through cross-verification from more than two sources. One focus of triangulation in MARISA would be that

Description of Titles	
	decision-maker can be more confident in an analysis for decision-making if different methods (algorithms and inquiries) lead to the same result.
Legacy System	The existing Maritime Surveillance systems in the National/Regional Coordination Centers or Coastal Stations to which MARISA toolkit can establish some kind of communications.
MARISA Toolkit	In order to fostering faster detection of new events, better informed decision making and achievement of a joint understanding of a situation across borders, the MARISA toolkit it will be able to provide a suite of services to correlate and fuse various heterogeneous and homogeneous data and information from different sources, including Internet and social networks.
Maritime surveillance	The set of activities aimed to understand, prevent wherever applicable and manage in a comprehensive way all the events and actions relative to the maritime domain which could impact the areas of maritime safety and security, law enforcement, defense, border control, protection of the maritime environment, fisheries control, trade and economic interest of the EU.
Saturation	Saturation has attained widespread acceptance as a methodological principle in qualitative analysis. It is commonly taken to indicate that, on the basis of the data that have been collected or analysed hitherto, further data collection and analysis are unnecessary.
SMART	'SMART' is a mnemonic acronym, giving criteria to guide in the setting of objectives, e.g. in project management, user-performance management and professional development. The letters S and M usually mean Specific and Measurable. The most common version has the remaining letters referring to Achievable, Relevant and Time-bound. However, so far, the term's inventor had a slightly different version and the letters have meant different things to different actors in context.
SMART MARE	The term 'SMART MARE' in MARISA addresses to smart information and communication technologies and data fusion capabilities to increase operational efficiency, share information with the public and improve both the quality of government (national on over borders services) and citizen responsibility and welfare; towards over national and international dimensions in MARE and MARISA context.
Track	The projection on the surface of the earth of the path of a spacecraft, aircraft or ship, the direction of which path at any point is usually expressed in degrees from North (true, magnetic, or grid). The term 'track' refers here to present and past kinematics such as position, speed, or heading -information.
Virtual interaction	An interaction based to online voice and video connection between decision makers, operators and on-scene commanders and coordinators when responding to events, coordinating CONOPS, resources and planning activities, both cross-border and cross-sector. The aim is to share information from person to person or between groups in order to attain a real-time recognizable picture of the event, whether for planning purposes, or during execution of a response operation. Services to facilitate this would include high quality video and audio streaming, video sensor information and document presentation.

Table 2: Description of Titles.

1.5. Acronyms

Acronyms	
AB	Advisory Board
AIS	Automatic Identification System
AOI	Area of Interest
AOR	Area of Responsibility
AR	Action Research
CA	Consortium Agreement
CACS	Centre for Automation of Combat Systems (Greece)
CENELEC	European Committee for Electrotechnical Standardization
CISE	Common Information Sharing Environment
CM	Communication Manager
COP	Common Operating Picture
CONOPS	Concept of Operations
CoopP	Cooperation Project Maritime Surveillance
CSDP	Common Security and Defense Policy
CSR	Case Study Research (Analysis)
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DoA	Description of the Action including Annex 1 of the Grant Agreement
DR	Design Research (Design Research for Information Systems)
DSR	Design Science Research
DSRM	Design Science Research Methodology
EB	Executive Board
EBCGA	European Border and Coast Guard Agency
EC	European Commission
EDA	European Defence Agency
EIF	European Interoperability Framework
EM	Ethics Manager
EMSA	European Maritime Safety Agency
EMSN	European Maritime Surveillance Network
ETSI	European Telecommunications Standards Institute
EU	European Union

Acronyms	
EUMSS	European Union Maritime Security Strategy
EUROPOL	European Police Office
EUROSUR	European Border Surveillance System
FRONTEX	European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union
FO	Financial Officer
GA	Grant Agreement
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
HCDD	Hellenic Cyber Defence Directorate (Greece)
HCI	Human Computer Interface
HMOD	Ministry of National Defence Greece
IA	Impact Assessment
IMDatE	Integrated Maritime Data Environment
IM	Innovation Manager
IMO	International Maritime Organization
INSPIRE	Infrastructure for Spatial Information in the European Community
IPR	Intellectual Property Right
IRL	Integration Readiness Level
ISO	International Organization for Standardization
IT	Information Technology
JDL	Joint Directors of Laboratories
KPI	Key Performance Indicator
MARISA	MARItime Surveillance Awareness
MS	Mile Stone
NCG	Netherlands Coastguard
MoE	Measure of Effectiveness
MoP	Measure of Performance
MS	Milestone
MSA	Maritime Situation Awareness
NCP	National Contact Point
NSS	National Surveillance System (Greece)

Acronyms	
NATO	North Atlantic Treaty Organisation
OSINT	Open Source Intelligence
PC	Project Coordinator
PERSEUS	Protection of European Borders and Seas through the Intelligent Use of Surveillance Project
POV	Pre-Operational Validation
PM	Project Manager
R&D	Research and Development
R&D&IA	Research & Development & Innovation Action
RMP	Recognized Maritime Picture
SAB	Security Advisory Board
SafeSeaNet	Vessel traffic monitoring and information system
SAR	Synthetic Aperture Radar
S&R	Search and Rescue
SE	System Engineering
SEIS	Shared Environmental Information System
SME	Small and Medium-sized Enterprise
SOA	Service Oriented Architecture
SOP	Standard Operation Procedure
TB	Technical Board
TLs	Task Leaders
ToC	Table of Contents
TRL	Technology Readiness Level (metric)
UC	User Community
UCL	User Community Leader
UoA	Unit of Analysis
URL	Universal Resource Locator
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service
WP	Work Package
WPL	Work Package Leader

Table 3: List of Acronyms.

2. Maritime Authorities Cooperation

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Maritime authorities community has been continuously involved in expanded cooperation activities towards a coherent approach to create a basis for clean data based solutions, data refining tools and trust base information sharing with the expanded data fusion functionalities in order to support knowledge transfers from research and development and for collective and operative decision-making on implementation of new confidence-based maritime concepts of operations. This continuum of collective maritime work have led to the development of the stakeholders-end-user needs based MARISA Project, stakeholder-end-user-centred adoption model and improvements of continuum focused methodology for design research in distributed maritime information systems. In MARISA Project, the user community as a steering forum will first and foremost drive the data fusion technological functionalities and services.

The term 'MARISA Adoption Model' addresses to the progress that is applied to drive an alignment paths of the innovative services based to the user needs and evaluate the implementations with respect to the needs. It provides an end-user-centred involvement for the design, development, improvement, integration and validation responsibilities; serving as a structured path on which the harmonisation and standardisation proposals stemming from this project can be build and promotes a use of stakeholders' action competence and knowledge in progress. MARISA Project is expansive also in the using of the open access to big data for maritime surveillance. The availability of large amounts of data, acquired from various sources ranging from sensors, satellites, open source, internal sources and extracting from these amounts through data refinement and correlation, which improves data triangulation and analysis, and furthers shared knowledge building towards high-value action competence.

2.1. Continuums of Projects

In MARISA environment, the path-dependent nature and continuums of high-value impacts can be described: 'what we can do in our own way is related to where we are and then where we have been'. Maritime Authorities Cooperation includes the path-dependency of related projects, history of legacy systems integration, development of action competence, research and development efforts and relevant suggestions to the legal and ethical settings. In this project, continuums, e.g., from BLUEMASSMED and CoopP to MARISA, the cooperative activity takes place in an innovation action process, which is rooted in a genuine national operative structures and its sector-domain related bindings, which includes strong elements of path-dependency and continuums of maritime development themes. The maritime integration and development activities are not progressed in isolation; they rarely depend on situation, geography, sector historic, legacy implementations and cultural bindings. This a relatively new over-border operative environment is a socially constructed user community, however embedded in its historic and legacy paths and ethical context.

In the Maritime Authorities Cooperation Environment, the excepted resonance of the path-dependent approach appears in such forms as a body of action related knowledge, a deep professional expertise, a historical experience and reasoning, legacy realisations and a level of trust building that is most vital to the cooperation. However, the setting includes realities like that realisation of cooperation is far from a linear process; instead, it is rather a result of a dynamic research and development process, here, as a bridge over anticipation-experimentation-trials that involves interactions between several stakeholders and things that no single actor can achieve or manage alone. This development includes a high level of uncertainty, unexpected events and rival implementation models. The path-dependency seams also included similarities with social constructionism, where historical and culturally specific knowledge is described in process that: 'a focus of

social constructionism is on interactions and social practices, a focus is on process, a focus is on mutual trust building and a focus is on collective potentials'. MARISA related project continuums in Maritime Authorities Cooperation is described in follow Table.

Maritime Authorities Cooperation	
BLUEMASS MED 2011 2012	The first European maritime surveillance pilot project launched by DG MARE, whose objective was to foster cooperation in maritime information sharing between 37 State partners from 6 Member States bordering the Mediterranean Sea and Atlantic approaches: operational users, data model, connectivity and capabilities.
CoopP 2012 2014	Test project on cooperation in excecution of various maritime functionalities at sub-regional or sea-basin level in the field of integrated maritime surveillance: identification of the Common Information Sharing Environment, definition of common data formats, semantics and data model, connection between information sharing and the operational aspect and description of the most important use cases.
PERSEUS 2011 2015	Protection of European Borders and Seas through the Intelligent Use of Surveillance: project represented a program and research consortium that furthered: large-scale integration, operational validation, demonstration of novel systems, collaboration of European research, a federative frame to joint research and collective steering forum as driver in areas of significant European interest.
EUROSUR 2007 2013	The European Border Surveillance system is a multipurpose system for cooperation between the EU Member States and Frontex in order to improve situational awareness and increase reaction capability at external borders. The purpose is to prevent cross-border crime and irregular migration and contribute to protecting migrants' lives in all Schengen area countries and Bulgaria, Romania and Croatia.
CLOSEYE 2013 2016	Collaborative evaluation project of border surveillance technologies in maritime environment by pre-operational validation of innovative solutions. Contribution in the validation of innovative services applicable to the surveillance of the EU Maritime Borders in real operational environment following the Common Application of Surveillance Tools and concepts established by EUROSUR.
SeaBILLA 2010 2014	Sea Border Surveillance Project which aims to: define the architecture for cost-effective European Sea Border Surveillance systems, integrating space, land, sea and air assets including legacy systems, apply advanced technological solutions to increase performances of surveillance functions and demonstrate significant improvements in detection, tracking, identification and automated behaviour analysis of all vessels.
MARSUNO 2011 2012	Maritime Surveillance in the Northern Sea Basins project addressed to support of CISE by identifying practical solutions to overcome legal, technical and administrative hurdles to cross-sectorial and cross-border information sharing between maritime authorities: the data-sharing across borders and across sectors like maritime transport, environmental protection, customs, border guarding, fishery inspection, law enforcement and defence is possible and improves reaction capacity.
ABC4EU 2014 2018	Automated Border Control Gates for Europe: the focus was in progress of border control flexibility by enhancing the workflow and harmonizing the functionalities of automated border control gates. Contribution is in improvements of border crossing processes: speed, security, automation, false rejection, e-passports management, biometrics, gate design, human interface, parallel processes and interoperability.

Maritime Authorities Cooperation	
EUCISE2020 2014 2018	European test bed for the maritime Common Information Sharing Environment in the 2020 perspective. EUCISE2020 is a Security Research project of the European Seventh Framework Program; it aims at achieving the pre-operational Information Sharing between the maritime authorities of the European States.

Table 4: The project continuums in Maritime Authorities Cooperation.

2.2. Cooperation Drivers

Maritime Authorities are looking forward to coordination and development of the national and cross-borders maritime functionalities, some targets for example: improve collective investments by maritime stakeholders in order to make activities for efficient realisations, building of collective trust management, understanding causalities and nexus impacts between stakeholders, sectors and nations, improve productivity and readiness levels and reduce overall costs. A setting of cooperation drivers in MARE is described in the follow Table.

Cooperation Drivers in the Domain of MARE	
1	Mutual trust building and causalities-nexus impacts management between stakeholders with partner authorities and over national borders (sector, domain, national and EU).
2	Cooperative investments by maritime stakeholders in order to make activities for efficient procurements management and realisations in perspectives of maritime sectors and domain.
3	Progress of new data fusion functionalities, improving communication and analytic for decision-making and validation of data fusion capabilities to maritime surveillance through the services and toolkits.
5	Improvements of situational awareness, situational intelligence and pre-operational validation that are valuable for the decision-making and the security of societies.
6	Data fusion functionalities addressed to the surveillance of border and maritime areas and in the production of proactive situational awareness and reaction capabilities.
7	Collective mechanisms, sush as User Community as a steering forum, which fosters interactions leading to knowledge co-created through social interactions, competence sharing and collective research and development.
8	Effective and credible border and legality control functionalities, sharing of best-practices and progres of new action competence.
9	Expansive data fusion initiative and building the links of individual consortium partners of the maritime domain to past and on-going initiatives to speed up the development process.
10	Exploitation process of information over silos data, leveraging on the fusion of heterogeneous sector data and taking benefit of a seamless semantic interoperability with the existing and legacy solutions available across Europe.

Table 5: A setting of Cooperation Drivers in the Domain of MARE.

2.3. Operational Drivers

One underlined theme in MARISA User Community is in the communication with the other authorities that benefit from co-created and shared services. MARISA project has addressed with operational and decision-making drivers: to realise of a detection of new and even unexpected events or emergent phenomenon (resilience), refine and analyse data for identification and decision-making, achieve collective understanding of situations across sector-regional-national borders (situation understanding); allowing seamless cooperation between operating authorities at sea and in air intervention forces and training of data fusion related action competence. A setting of operational drivers in MARE are described in follow Table.

Operational Drivers in the Domain of MARE	
1	Utilisation and integration of different kind of identification systems and data sources in operational tasks.
2	Progress for the data fusion based operative ability to detect new security threats e.g. threats of maritime assets and emergent phenomenon e.g. anomalies and terrori.
3	Data fusion implementation at the operational centres to improve and enhance the situational awareness in a command, control, intelligence and surveillance systems activities.
4	Expansion of maritime data model, operational information sharing, combining with security intelligence knowledge from a wide variety of sources.
5	Progress of data fusion for the operative surveillance capacity and its development scenarios and proactive design.
6	Transparency of data fusion in the integration of criminal investigations, chain-of-custody and monitoring-of-legality.
7	Operative description of the current and potential data fusion activities.
8	Operative description of the current and potential interactions by stakeholders.
9	Operative description of cyber security aspects and risk setting of maritime assets.
10	Operative description of maritime security actors cooperation activities and their challenges in arctic maritime domain.

Table 6: A setting of Operational Drivers in the Domain of MARE.

REMARKS: The mind of MARISA Authorities Cooperation is in steering functions as composing of collective steering forum for validating and revising of strategic policies and guidance for development of data fusion capabilities in the MARISA with the partner authorities. The MARISA Authorities Cooperation furthers transparency and focuses to the pre-operational validation, maritime operational concepts and progress from early phases of development towards implementation. The purpose is to achieve consistency in the cooperation of independent institutions and organisations, marking at a coherent approach and comparability of results across validation activities and current-further projects, while leaving ‘freedom within framework’ to describe and define the most practical planning and execution of individual operative activities and the work packages.

2.4. MARISA User Community

The view of MARISA User Community is addressed to stakeholders and end-users needs and for operational environment challenges in the maritime sector authorities on the every day and authentic maritime real work basis. The focus of User Community as a trigger-driver in MARISA Project in growing amount of maritime traffic and society's increasing expectations of emergent security aspects which are the most influencing factors in this innovation and action related development process and its reasoning of the long-time research and improvements as well as alongside of high-value authority related impacts and continuums. In the MARISA operative domain, every day expectations are focused on the ability to safeguard and secure maritime traffic and human lives and to protect the marine environment by the improved pre-understanding, pre-operational validation, decision-making, proactive economic and efficiency manners. Here, a relative new concept of 'THE SMART MARE' can be first addresses to further utilisation of information and communication technologies and fusion services to increase operational efficiency, share information with the public and improve both the quality of the government services and citizen welfare over the national and continental silos and borders.

It is perceived in MARISA that the theoretical approach in the maritime cooperation and MARISA User Community makes a strong resonance with the 'triple helix and quadruple helix models of innovation' (ref. wikipedia). Both actively and cooperatively, here the triple-quadruple helix model is addressed in relation to the study of social conditions of knowledge production and ethical-legal aspects. The emphases of the triple-quadruple helix are on the innovations produced through the interactions and communications among security-safety academia, industry and government institution and on the social mechanisms as citizens' responsibility and users of selection, variation and retention and responsibility for their evolution. One example in MARISA as related to the triple-quadruple helix is to identify our 'SMART MARE' environment consisting of new data fusion spin-offs, innovativeness, trilateral initiatives for knowledge-based economic development, and strategic agreements between the triple-quadruple helix stakeholders and the ethical and legal aspects.

In MARISA, a close and cooperative spirit 'the spiral model of innovation' is addressed to capture the evolution of multiple linkages of different stages of internalised and transformed knowledge and to the achievements of high-value impacts. It is noteworthy that in the MARISA there are at least four dimensions of development of the triple-quadruple helix model: (1) the international transformation (global pipelines) in each of the helices; (2) the influence of a helix upon another (sectoral pipelines); (3) the creation of a new overlay of institutional structures from the integration among the four helices (cooperation structures over borders); and (4) a recursive effect of these entities, both on the spirals from which they emerged and on the larger society, ethic and legislation. With the triple-quadruple helix model, the overlay of communications and expectations at the MARISA Network level guides the reconstruction of shared institutional arrangements.

2.5. MARISA Stakeholders

Securing European affordability and interests are of fundamental reasoning for our continued wellbeing and sustainability. One of the most imperative manner in MARISA is addressed to a cost-effective enhance of security and safety at sea with cooperation at national (local pipelines) and especially in over border and international (global pipeline) interactions. Towards more efficient use of data fusion by expanded resources and data sources is one of the first way to forward, when it comes to sharing clean and relevant data based information regarding maritime surveillance. For future continuums and next vision of MARISA Project, according MARISA research, there is a lot of room for further improvements in where importance is in the data refinement, clean data, information fusion, artificial intelligence, national services for authorities, collective decision-making and harmonisation of legal and ethical aspects and technologies which all will become as a key factors not only in determining effectiveness on the security in our domain but also in ensuring resilience against current and future security challenges and ethical-legal aspects.

Establishment of MARISA User Community is addressed to maritime stakeholders and user needs, relevance and operative effectiveness. These Maritime Stakeholders need to further seek and take benefit of the continuum of projects for enhanced cooperation, both national and at European level. The European Maritime Stakeholders can make benefit from this co-created and shared helix structure, in a systematic way, increase comprehensive and accurate activities, refining, cleaning and sharing the maritime information what they collect and operate, identifying the challenges in present practiced exchanges and participate to the cooperation for building of the proper conditions and dialogue in safety and security, entities and causalities (nexus as mutual causalities), interactions and trust building. The MARISA Stakeholders as end-users views are described in follow Table.

MARISA NETWORK: Stakeholders in MARISA User Community	
	Ministry of National Defence Greece (HMOD) http://www.dideap.mil.gr
The Hellenic Ministry of Defence (HMOD) applies the Government's National Defence Policy. HMOD implements interventions focusing on the facilitation of the interaction with citizens like the digitalization of recruitment archives and services, the generation of digital charts and weather reports, and also incorporates departments and units that address social issues like public protection, crisis management, humanitarian aid and social and environmental research. Recently, HMOD incarnates a very important social role in everyday life of Greek citizens and people. HMOD is a public authority - as of the latest act of Presidential Decree 35/1995 - primarily involved in the execution of the maritime surveillance, control and protection functions at national and/or regional level related to defence, while contributing with its personnel and assets in additional tasks, related to accident and disaster response, search and rescue. The Department for the Management of European & Development Projects is responsible for the coordination of actions pertaining to the formation and submission of proposals for the monitoring, control and the general management of the sum of projects carried out by the HMOD with external funding. In particular, it plans, proposes, coordinates and monitors projects and provisions that fall within the framework of Public - Private Partnerships or Operational Programs like Environment and Sustainable Development, Digital Convergence, Accessibility Enhancement, Education and Lifelong Learning, Improvement of the Administrative Capacity of Public Administration Human Resources Development. The Hellenic Navy is responsible for conducting the necessary naval and aero naval operations in the maritime area of national interest (including constant surveillance, intervention, reaction and Search And Rescue) in order to protect the stability, the integrity and the security of Greece as defined in the National Security Policy Document. The Hellenic Navy deploys military and civilian personnel, various types of vessels, sensors and units from and during peacetime in order to fulfil its mission. Under the umbrella of the Hellenic Navy acts the Centre for Automation of Combat Systems (CACS) which offers development and support software services for operational, automated and strategic computer systems e.g. Command and Control, Communications, Intelligence, Surveillance and Identification Systems. CACS develops, administers and maintains the National Surveillance System (NSS). CACS is especially active in Research and Development and Innovation projects on a national and international level. The Hellenic Cyber Defence Directorate (HCDD) is responsible for the cyber defence activities of Armed Forces. It has a number of well-educated personnel in cyber security field with experience in related operations. Its primary objective is to defend the information infrastructure of Armed Forces through continuous dynamic risk assessment and cyber threat intelligence in order to identify and implement the appropriate security measures. Both commercial and open source specialized software and hardware equipment along with the high expertise of its personnel are the main assets for conducting cyber defence operations. The HCDD is responsible for cyber defence operations in both strategic and operational level.	

MARISA NETWORK: Stakeholders in MARISA User Community
The coordination within the internal information technology related entities and with external cyber security related bodies in national level is also one of its main tasks. Furthermore, it is involved to the development of international cyber related activities such as planning and execution of NATO Cyber Defence Exercises and contribution to EU Cyber Defence concept and requirements for EU-led military operations. HMOD: WP2 activities dealing with the definition of User Needs and Operational Scenarios; active participation in WP7 addressed to the development of two trials: the Ionian Sea TRIAL and Aegean Sea TRIAL; and to the dissemination of MARISA achievements in WP8.
 Netherlands Coastguard (NCG) https://www.kustwacht.nl/en
The Netherlands Coastguard (NCG) is an independent civil organization with its own tasks, competences and responsibilities. The Netherlands Coastguard has three main goals: responsible use of the North Sea; to provide services that contribute to safety and security at sea; and upholding national-international laws and duties. The NCG carries out fifteen tasks for five ministries, seven provisions of service tasks and eight law enforcement tasks, such as: monitoring, handling and coordinating national and international distress, urgency and safety radio traffic; maritime assistance and search and rescue; limiting and dealing with the aftermath of disasters and incidents; implementing vessel traffic services such as buoys, vessel traffic service and instructions; maritime traffic research; and clearing out explosives. The Netherlands Ministry of Infrastructure and Water Management is committed to improving quality of life, access and mobility in a clean, safe and sustainable environment. The Ministry strives to create an efficient network of roads, railways, waterways and airways, effective water management to protect against flooding, and improved air and water quality. Directorate-General for Mobility and Transport and Directorate-General Public works and Water Management. The Netherlands Ministry of Defence comprises the central staff of Ministry and the four armed forces: the Royal Netherlands Navy; the Royal Netherlands Army; the Royal Netherlands Air Force; and the Royal Netherlands Marechaussee including Military and Border Police, Support Command and the Defence Materiel Organisation. The Defence organisation bears similarities to a large company. The Operational Commands (naval, land and air forces), the Marechaussee (military police), the Support Command and the Defence Materiel Organisations bear resemblance to operating companies. The Netherlands Ministry of Justice and Security is responsible for maintaining the rule of law, so that people can live together in freedom, regardless of their life-style or views. The Ministry is working towards a safer, more just society by giving people legal protection and, where necessary, intervening in their lives. Ministry of Security and Justice; Public Prosecution Service; National Police Force; National Crisis Centre. The Netherlands Ministry of Finance guards the national treasury and works towards ensuring the country is financially healthy and prosperous. The Ministry of Finance oversees the responsible and effective spending of government resources, makes rules to ensure a stable financial system and oversees the quality of financial institutions. The Ministry of Finance also works on equitable and solid tax legislation. The Dutch Tax Administration, part of the Ministry of Finance, levies and collects taxes. The Netherlands Ministry of Economic Affairs and Climate Policy promotes as a country of enterprise with a strong international competitive position and an eye for sustainability. It is committed to creating an excellent entrepreneurial business climate, by creating the right conditions and giving entrepreneurs room to innovate and grow. By paying attention to nature and the living environment. By encouraging cooperation between research institutes and businesses.

The Netherlands Coastguard is contributed the development of support system requirements inventory from the Coast Guard perspective using the National study Coast Guard 2015-2025 as reference. The architecture development was supported by identifying the operational requirements of the Netherlands Coast Guard system. The Netherlands Coast Guard is hosting the North Sea Node for the MARISA project addressed in WP7. The Netherlands Coast Guard and attendees of North Sea environment has identified legacy systems which will be involved in the MARISA North Sea trial as well as input data that is necessary for a successful operation North Sea TRIAL.

MARISA 1st WORKSHOP with internal and external end users has been held at TNO premises in The Hague, The Netherlands, 14 June 2018. The objective of the 1st MARISA Workshop was to present and discuss the novel techniques and algorithms implemented in the MARISA H2020 project to enhance maritime surveillance awareness capabilities by correlating and fusing various heterogeneous and homogeneous data and information from different sources, including Internet and social networks.

The first MARISA North Sea Operational TRIAL was successfully hosted by The Netherlands Coastguard on 12th and 13th of September in Den Helder. The Netherlands Coastguard organised a dedicated training exercise 'MARISA_Alert' with three relevant operational scenarios in Maritime, Security and Safety domain. The MARISA_Alert exercise involved three ships of the Netherlands Coastguard: The watch ship 'Guardian', patrol ship 'Visarend' and support ship 'Terschelling'. The three ships sailed 'anomalous patterns' as specified in the MARISA North Sea TRIAL scenarios. The MARISA Toolkit was connected to a live feed of the Coastal Surveillance System during the demonstration of the MARISA North Sea TRIAL. The MARISA Toolkit was situated in the Netherlands Coastguard back-up operations facility in Den Helder. The MARISA Toolkit services successfully captured, processed, analysed & visualized in real time the maritime big data stream. The MARISA Toolkit services for anomalous behaviour detection triggered live 'alerts' for the Coastguard vessels sailing 'instructed anomalous patterns' during the training exercise MARISA_Alert.

	Guardia Civil (GC) - Spain http://spanish-guardia-civil (GC)

The Guardia Civil is the first national law enforcement agency established in Spain. It was founded in 1844, early in the reign of Queen Isabel II of Spain, and with consensus among the different political forces. The organization of this new institution was entrusted to the Field Marshal Mr. Francisco Javier Girón y Ezpeleta, 2nd Duke of Ahumada, who proposed the Government to establish an Infantry and Cavalry Force devoted to 'the maintenance of law and order, and to assisting in law enforcement tasks as requested'. In this way, he was trying to fight the high level of insecurity in rural areas caused by banditry, and to set up a national law enforcement agency. The territorial expansion allowed this body to deploy its units throughout the national territory, reaching places where the Administration had not been present before. With the passing of time, and due to its closeness to the people, it has become an extremely valuable source of information for the State. Since its foundation, and up to now, the Guardia Civil has been undergoing constant changes that have allowed it to adapt to new situations, always with countless efforts aimed at modernization. This fact, together with its closeness to the people, has resulted in its being until currently one of the most appreciated institutions by the Spanish society.

Apart from the constant adaptation and modernization of Guardia Civil we should also mention that it has progressively assumed new responsibilities, such as counterterrorism, road traffic control, protection of coasts, borders and territorial waters, environmental protection, or mountain rescue. The Road Traffic Group (Agrupación de Tráfico) had the honour to become the flagship of the institution and to be its first specialised unit, paving the way for others that started appearing in the 1960s and the early 1970s, always with the aim of rendering a quality service to the citizens and provide humanitarian aid to whoever might need it. Among these specialized units we could mention the Maritime Service, the Mountain Rescue

Service, Air Service, the EOD Service, GAR (Early Intervention Group), or the Environmental Protection Service (SEPRONA). Currently Guardia Civil is an armed institution of military nature that is part of the National Law Enforcement Agencies. As such, the 1978 Spanish Constitution establishes as its main mission protecting the free exercise of the rights and freedoms of Spaniards and ensuring public security, always under the authority of the Spanish Government.

The Guardia Civil is an institution which renders essential services to the community, in conformity with the guidelines provided by its basic behaviour principles. These guidelines constitute a real ethic code binding together all the Guardia Civil members. Key-functions: Administrative Police functions; Protection of the Spanish economic interests; Public order; Assistance; Criminal investigation police; and Intelligence services. In order to carry out all these functions, Guardia Civil has 80,000 officers, over 3,000 of them are women, who are deployed all over the national territory and territorial waters. Guardia Civil carries out 3.9 million services per year, that is, approximately 10,000 a day; that amounts to 32 million work hours and one million actions. Two million humanitarian activities consisting in rescuing, aiding and assisting citizens are conducted every year. Guardia Civil constant work results in the fact that it investigates nearly 300,000 crimes, over 274,000 minor offences and 380,000 infringements against public safety; it solves over 200,000 criminal offence cases every year, and arrests almost 100,000 alleged criminals, i.e., 308 arrests a day. In order to develop these services, the Guardia Civil vehicles cover more than 350 million kilometres a year, enough to drive around the world almost 8,000 times.

Guardia Civil is aware that the development of threat detection systems in the scope of border surveillance is absolutely necessary. For this reason, Guardia Civil is involved in a large number of innovation projects with this goal. In this sense, the implementation of systems with the capabilities of the services of Marisa toolkit is going to provide new opportunities: improvement of the reaction time, situational awareness, information exchange. In order to test all the capabilities of the different services involved, choreography is going to be prepared with the participation of a Coastal Patrol Vessel of the Spanish Guardia Civil during the different trials. In addition, automatic identification system and information of our integrated system for external surveillance will be provided due to the radar configuration of SIVE (Sistema Integrado de Vigilancia Exterior) provides useful information about maritime targets that MARISA toolkit will correlate and fuse. In general terms, it is expected that the use of both systems (existing coastal surveillance system and MARISA toolkit) will provide a greater coverage area and a better situation awareness to monitor all the incidents in the area of responsibility of Guardia Civil and better conditions for decision making will be achieved. Finally, the knowledge acquired during the project will be use after it in order to improve other systems in charge of the detection of different threats.

Italian Marina Militare (ITN)

https://Italian Marina Militare (ITN)

The Italian Marina Militare (ITN) is one of the four services depending from the Italian Defence Ministry, which is called upon to operate with necessarily adequate personnel and assets to guarantee the Italian maritime security. Alongside its military tasks, ITN kept performing also some of customary tasks (which are underpinned by national laws and regulations) such as the fishing surveillance, the fight against illegal immigration and illegal trafficking and environmental protection which are performed non only in pursue of national interests but also, due to its pivotal position in the Mediterranean basin, those of the European Union, surveying its external borders. To perform the assigned tasks, ITN avails itself also of a robust and experienced capability in maritime surveillance and monitoring. This capability is achieved throughout a complex of maritime presence and patrolling activities performed, in the areas of national interest, using air and naval assets and also a series if remote sensors including the coastal radar network.

At the Command-in-Chief of ITN Naval Squadron (CINCNAV), a newly-designed ‘ITN Operational Centre’ accommodates the operational staff and enables them to acquire all collected maritime surveillance-related data including those acquired by ITN through its own equipment and sensors and

those obtained within the alliances and initiatives Italy is a member of. The major novelty is the newly-designed SIIMS – System for Interagency Integrated Maritime Surveillance – whose operations room is located in the newly-built CINCNAV HQs. All pieces of maritime surveillance-related information, presently made available by all the diversified agencies operating at sea, will be merged in a single hub. ITN was responsible of the implementation of the project, considering its specifying know-how. The Italian Navy also provides the Cartographic and Hydro graphic Services.

ITN experience has fostered active involvement in the MARSUR project that is producing a high value continuum to MARISA Project. A key characteristic of the MARSUR network is that there is no central EU component that collects and distributes information. Hence, each Member State is responsible for correlating its own data with the data received from other countries and for boosting the services within the community. MARSUR is a great example of efficient Pooling and Sharing of existing capabilities. The MARSUR project has now reached the point where it is ready to be used by European navies. MARSUR is designed to become the potential 'military layer' of the wider Common Information Sharing Environment (CISE) project led by the European Commission. MARSUR could work in conjunction with other 'systems of systems' to ensure efficient interaction with other European maritime security stakeholders and also in support of The Common Security and Defence Policy (CSDP) missions.

The enormous experience gained throughout the years in the maritime security domain and in carrying out maritime surveillance activities has been constantly supported by a deep consideration of technological developments to improve future surveillance capabilities, which in turns has involved different branches of the organization in MARISA studies experimentations and trials. As an example, the present, ITN has underway the improvement of the Coastal Radar network, in order to include Inverse Synthetic Aperture Radar (ISAR) technology and operational and compatibility test of shipborne fixed and rotary wing Unmanned Aerial Vehicle (UAS) as expanded sources of data in MARISA. The technical coordination and implementation activities carried out for the SIIMS project, as well as those for the BlueMassMed, has fostered the knowledge on interagency data exchange for the purpose of the Maritime Situational Awareness also to improve the reaction capability and decision-making of the authorities surveying the external borders of the EU.

Marinha	Ministério da Defesa Nacional (MDN) Portugal https://www.defesa.pt/Paginas/Inicio.aspx
Centro de Investigação Naval	Centro de Investigação Naval (CINAV) https://escolanaval.marinha.pt/pt/investigacao

CINAV is the Portuguese Navy's Research Centre, it was created in 2010 to coordinate the various research projects in which the Navy participates, and to support the research conducted by the faculty of the Naval Academy, where CINAV has its offices. It currently has 7 research lines, in the following areas: Signal Processing, Decision Support Systems, Mobile Robotics, Maintenance Engineering and Management, Maritime History, Maritime Strategy, and Naval Health. It has 25 permanent members that hold PhDs (mainly faculty from the Naval Academy), and over 100 associate members (mainly naval officers involved in research projects). Its research projects cover a wide range of areas, and go from theoretical research funded by the Portuguese Science Foundation, to more applied research funded by various national and European agencies, to very applied research (demonstration and testing) funded by the Navy itself.

The Portuguese Naval Academy where CINAV has its offices is one of the oldest higher education institutions for naval officers in the world, having been founded in 1779 as 'Royal Academy of the Navy', but heir to the 'Royal Cosmographer's Class', founded in 1559, where Naval Officers received their formal

MARISA NETWORK: Stakeholders in MARISA User Community
education. It presently offers Masters Degrees in Naval Engineering (Mechanics and Weapons and Electronics branches), Naval Administration, Navy Sciences and Marines), several Bachelor degrees, and some post-graduate courses in areas of interest to the Navy. As part of the Navy and thus of the Ministry of Defense, for administrative and legal purposes we act as a department of the Ministry of Defense (MDN- Ministério da Defesa Nacional). Being a Navy Research Center, CINAV profits from a very close proximity to the operational experience and expertise of the Navy in all operational fields and, in particular, in the fields of surveillance, security and frontier integrity. The Portuguese Navy operates the MRCC-Lisbon (Maritime Rescue Coordination Centre), and is responsible for conducting SAR operations in a large area of the North Atlantic. Besides the military duties of the Navy (which have included anti-piracy missions in the region of Somalia), the Portuguese Navy is also responsible for many 'state authority' tasks such as policing harbours and maritime areas and fisheries control. Related to MARISA research continuums and H2020 Innovation Action, CINAV have been involved in various research projects and development contribution in the domain of mobile robotics and decision support, either as participant and sub-contracted entities of EU funded projects, as Principal Investigators and researchers of projects funded by the Portuguese National Science and Technology Foundation (FCT), or as Principal Investigators and researchers of projects funded by the Ministry of Defence. CINAV is the research center of the Portuguese Navy (CINAV), and thus we have a close research and development interest with naval issues in the MARISA. Most of our researchers are naval officers or ex-naval officers with experience in the field. CINAV have been actively involved in various research projects concerning Maritime Surveillance, Maritime Situational Awareness and Mobile Robotics and CINAV has participate in all MARISA work packages, with planned degrees of involvement. Also the Portuguese Navy CIS Directorate will have a major involvement in the project being responsible for the link of the MARISA products within the Portuguese Navy Maritime data Network, where all the Maritime surveillance data and maritime information systems services run.

Table 7: Description of Stakeholders in MARISA User Community.

First vital focus of User Community was related to the Task 2.1: User community animation (M1-M30) [Task Lead: LAU] this task animated the MARISA user community focused on the goal of 'innovation', delivering the benefits of data fusion to maritime surveillance through the MARISA toolkit of services. The data fusion technological functionalities and services was first and foremost be driven by this user community. Community mechanisms is created (as part of the MARISA Web Site implemented in WP8) to foster interactions, leading to knowledge cocreated through social interactions, competence sharing and collective service development. The user community was set-up and continued for involving user partners as well as external end users invited to join the initiative [GA, p. 18]. The second imperative emphasis was related to the Task 2.7: Operational Scenarios & Trials Definition (M1-M20) [Task Lead: AST] Based on the initial definition of trials, the user community worked on the Operational Scenarios & Trials Definition which were adapted, developed and integrated, to accommodate the often quite different working practices and organization related decision procedures of the many actor, individual and group users. The user community is an essential driver to ensure the effectiveness for scenarios building and validation, metrics and trial selection, tuning of performance indicators, and validation of outcomes [GA, p. 19].

Data Fusion capabilities in MARISA can be further expanded to tasks of collecting, cleaning, analysing and sharing of information in order to ensure responsibilities and efficiency in maritime surveillance domain, e.g., search and rescue, prevention of pollution caused by ships, progress of marine pollution preparedness and response, development of overall maritime safety and sustainability, fisheries control, management of marine critical infrastructure and environment, customs, harbours, border control, general law enforcement, co-

creation of European rules of the regulation, ethical aspects and realisation of resilience and defence. In MARISA User Community, the term ‘expertise’ refers to an operational and action related competence that arise from mutual trust, interactions, knowledge and information sharing, and collective research and development of relevant user needs based data fusion capabilities. This expertise related dimensions are embedded in progress of user community and work packages which effort includes operational experts and professionals. Reasoning and intelligent abilities are not only individual mental activities but also ones that rely on path-dependency of actor and authority institution and culture as well as especially continuously led shared spirit for empowerment. These includes collective artifacts and capabilities as well as socially shared processes in interactions between individuals, communities and expanded networks supported by data fusion artifacts.

The MARISA project aims at creating a community of innovation to ease information sharing and cooperation among all MARISA stakeholders. A strong involvement of end users operating in the maritime context as well as the use of a large campaign of operational trials, involving different practitioners and operational systems, will be the basis for the MARISA development strategy. Minimizing the effort of integrating the MARISA Data Fusion products within the end-user operational environment and their relevant systems will be a project driver. The MARISA toolkit will provide a set of interfaces to be invoked by the end user operational systems to enhance their actual surveillance capabilities. Addressed in WP2 (addressing user needs), WP3 (data fusion modules and services design), WP4 (data fusion modules development) and WP5 (distribution services) [GA, Part B, p. 6].

Numerous high-value impacts have already been made (M20) to increase the efficiency of surveillance activities with the existing means, including cross-border cooperation and interactions. However, the benefits of data fusion and analytic can be much furthered towards maritime surveillance sectors, such as further remarks of a fruitful progress in the maritime environment by defining an expanded CISE data model such as described in the related SMART MARE: SMART MARITIME SURVEILLANCE discussion article for information sharing; and data fusion adoption model based on the sectorial use cases for maritime surveillance that were lively in user-cantered discussions and described in deliverables. MARISA User Community has concerned so far, that the increasing complexity of security challenges is as triggering force to the digital transformation of security instances which rests on the capabilities to search, collect and analyse large amount of data at very high speed in order to ensure appropriate and enough timely responses to unfolding and emergent threats. In addition, in consideration of the life-critical nature of our security decisions, it is important, when defining the operational requirements and resilience dimensions, to take into account the interactions between humans and operative decision-making systemic (ethical aspects and mutual nexus of decisions’ causalities).

REMARKS: The increasing amount of artificial and data fusion related intelligence in multiple security domains, such as cybersecurity, border management, protection of public spaces and critical infrastructure, requires further design-development research that the systems will operate in a secure, dependable and validated manner. In fact, it is required for security applications and services to be able to deploy capabilities such as feasible artifacts (here in form of adopted services) whose outcomes are comprehensible and able to national authority based validation and verifications, hence, in our cases the authority based validation is compulsory before operational realisation. It is also noteworthy that our decision-making needs learning, first learning for decision and then learning by feedback (anticipation-experimentation-simulation-feedback) for the next improved decision. Hence, an anomaly or as ‘an extraordinary phenomenon’ happens then learning for decision-making should make resonance with the resilient learning that addresses here to the increased rate of interactions and externalities as decision related pipelines for more resilient scopes and deliverables and for evidence of lessons learnt and using catalytic agents in a processes which shares that knowledge.

3. MARISA Value Co-creation Network

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The focus of MARISA Network value concentration lies in producing maritime understanding, building of new knowledge, and design of maritime artifacts in cross-border cooperation and sustainable-ethical ways. The MARISA Network utilizes the maritime 'co-creation' of strategy scenarios and common sense which act as facilitation triggers and motivation forces in shared expertise and value additions such as outcomes of MARISA Project. In addition, the MARISA Network is useful in utilizing operative and business scenarios in maritime domain which act as drivers and enablers of R&D collaboration, maritime higher education, and practical utilization. In the MARISA Network a concept of value concentration, the macro-level situation is that maritime domains are in a long transition from a linear production-operation economy to a knowledge economy, where competitiveness and operative-ethical success in a field is required to be approached by operative-action based competencies, knowledge, services, and applied technologies.

In followed four dimensional table, the key entity is categorized as 'transfer of knowledge into innovations' as a function between research and practice, and results and impacts are achieved by maritime profiled R&D collaboration of academia, education, and research-development industrial actors. It is noteworthy that there are R&D activities which addresses to higher education and which integrate academic values, education, and world class academic research into the maritime domain R&D processes, and the empiric results and impacts of R&D act as a vital feedback force in knowledge-intensive production of new services, security, and artifacts.

MARISA NETWORK: Concentrated Competiveness &Contribution				
V A L U E	**ACADEMIC**	word class academic research (design science research and service-value canvas)	value of knowledge (service oriended information systems design and realisation)	**E T H I C**
	RESEARCH	transfer of knowledge into innovations (knowledge for trials)	value of competivness and value transfers (services and use cases)	
	EMPIRIC	relevance to operative work (maritime situational awarness pictures and decision-making)	business value & value integration (decision-making systems)	
	EDUCATION	academic education (Humboldian)	intelectual value (value oriented applied research in university)	
MARISA NETWORK: Sustainable & Collective Value Building (co-creation)				

Table 8: Description of MARISA Concentrated Contribution Network.

In the MARISA Network, trust and collaboration play an active part in the strengthening of higher education, industrial business, and operative functionalities as well as operative government. The key maritime domain development contribution of this concept of value concentration includes 'co-creation' of innovative activities, knowledge transformation, and bringing the concepts of science and innovation closer to end-users needs and citizens' responsibility through living trial expansions, industrial clusters and cooperation, and maritime innovation systems. In the micro-level view, the operative environment is facilitated with knowledge for (1) well-being and safety of people (2) relevance to 'the world of operative work of authorities' and (3) furthers increasing citizens' responsibility. Here, the created competence, knowledge, and professional growth take place by using a concentrated and shared body of knowledge, and this particularly describes a direction of new or improved capability and knowledge building in maritime domain.

In MARISA Network, the trust was shared with academic, research, industry, education, and empiric parties in H2020 funded R&D&IA (Research & Development & Innovation Action). In the higher education domain, the drawn concept of value concentration can be assimilated to the kind of 'cluster of EU networked expertise', both in strategy scenarios and operation scenarios. One of the key contributions of MARISA is an achieved understanding that the strategy scenario and common sense (a mode of leadership, thematic interactions, domain profiles, and collective mind) act as facilitation trigger-drivers and motivations for shared R&D expertise and values, such as some of them described in followed table.

MARISA NETWORK: Facilitation Triggers and Motivation Drivers for Value Building	
1	Increased operative capabilities and entering new data fusion markets.
2	Developing new operative capabilities, products and services.
3	Fostering maritime domain and national-European R&D&IA profiles.
4	Co-creation of maritime R&D&IA strategies and management.
5	Networking of critical mass for starting new operative activities and businesses.
6	Flexibility and resilience of competitive response in data fusion and artifical inteligence.

Table 9: Description of Facilitation Triggers and Motivation Drivers for Value Building.

In turn, the operative and business scenarios act as linear drivers and enablers for:

MARISA NETWORK: Linear Drivers and Enablers for Value Building	
1	Leading and promising R&D data fusion scopes for industry and higher education.
2	Advances in operative response and business opportunities.
3	Increased innovations and entrepreneurship by way of collocation and profiles.
4	Innovation stimulation in the early stages of industrial development and higher education.
5	Familiarity, relationships, and knowledge bridges between actors in innovation systems.
6	Agile networking of simulations for understood end-user-centered incipient innovations.
7	Management of economical and operative balance in action and quality in R&D.

Table 10: Description of Linear Drivers and Enablers for Value Building.

From an empiric-operative perspective, in table above the role of end-users has changed dramatically during the latest years. End-users take a more active role in concentrated value creation, and the focus of the value creation processes is rapidly transitioning from a supplier-institution-centric view to a more end-user-citizen-customer-centric approach that aims to support end-users and customer experiences (pain-reliever-solutions) and joint value 'co-creation'. The maritime operative domain is moving from traditional tactic models in which value comes mainly from physical goods to models where value comes more from intangible things such as services, knowledge, action competence and relationships (nexus) management. In this shift, the empiric view in tables above can be compressed to the wording: transition to sustainable scenario-operative-tactic live: this is that scenario-operative-tactic actors, industry and the role of higher education can be seen as 'co-creators of high-value' and 'sustainability' rather than as passive recipients of goods, knowledge, and services.

The maritime border security organisations and authorities represent the primary market sector of the MARISA results. Security and surveillance domain is expected to lead the application market of situational awareness systems. The growing demand for the situational awareness in security and surveillance applications worldwide is one of the key drivers for the maritime market. Situational awareness in security and surveillance is vital for maritime security. As irregular migration, refugee smuggling and illegal activities are increasing, then it is expected that the situational awareness systems market for the security and surveillance applications is growing rapidly. MARISA Market Analysis [GA Part B p. 36]. In MARISA, one principle is that 'the ownership of joint knowledge' belongs to the parties that generate it according to their share of participation to the common work, the parties shall agree among themselves how that joint ownership will be exercised [GA Part B, p. 38]. Current view (M20) to the beneficiaries contribution, dissemination and exploitation outcomes for the development and exploitation of the MARISA Project results are included to the following table, confer preliminary strategy or the development and exploitation of the MARISA Project results and individual dissemination and exploitation plans [GA Part B, p. 39-42].

1. LEONARDO - SOCIETA PER AZIONI (LDO) - Italy
LDO business model looks at the exploitation of the MARISA toolkit results to enhance the MSA and introduce innovation solutions in the current systems. The complexity of systems of systems scenario requires sound integration tools and the ability to leverage on legacy components already in the company's portfolio. The adoption of a standard Data Model based on the CISE data model for interoperability aims at providing 'systems of systems' integrators with the means to connect multiple components developed by different parties without changing them. This implies the ability of systems and components to provide services to and accept services from other systems and components to interoperate. This is an essential prerequisite for an open competitive supply chain. LDO network of industries and subcontractors: Customers in Italy (Italian Coast Guard, Italian Navy and the Italian Ministry of Interior) and abroad. LDO exploitation is addressed to increasing its expertise on the maritime surveillance domain, at innovating its systems and at increasing its position on the national and international maritime markets. The expected grow of the LDO revenues in the Maritime sector is estimated around the 30% in the next five years.
2. ENGINEERING - INGEGNERIA INFORMATICA SPA (ENG) - Italy
The ENG R&D Lab of Intelligent Systems and Social Software, like the ENG R&D Department as a whole, has the mission of developing new solutions and promoting research outcomes to business units. In particular, the results of MARISA are of interest to several Public Administration business units, which could integrate them either in their offering or in new solutions, so as to convey them to existing or potential customers. In the Maritime Surveillance sector, ENG has customers in Italy (including the Italian Coast Guard, the Italian Navy and the Italian Ministry of Interior), and around the world (including EMSA, FRONTEX and EDA). These important customers are directly impacted by the results of MARISA to increase the effectiveness of their processes and the reduction of costs, especially concerning the automatic discovery and analysis of illegal immigration events. Stakeholders: Italian Coast Guard, Italian Navy, Italian Ministry of Interior, EMSA, FRONTEX. ENG is improving its own expertise and solutions on the maritime surveillance domain, maturated participating to several international projects (e.g. PERSEUS, SAGRES, PROMERC, BlueMassMed), while contributing to the MARISA data model definition and data fusion framework implementation. This experience, maturated in an international context, is considered fundamental by ENG for refining, in a significant way, its position on both domestic and international markets and value network.
3. GMV AEROSPACE AND DEFENCE SA (GMV A&D) - Spain
As a large Industry, GMV main activities during the project mainly deal with (a) the analysis of the market sector (b) the preliminary identification and subsequent consolidation of the business models leading to the (c) implementation of the business plan. Starting from the organizations of the Member States participating to the project, the MARISA value proposition will be introduced to the end-users of the other Member States. To achieve this objective a number of important events at European level will be selected.

The following Stakeholders events have been preliminary identified: border protection, management and security industry policy-makers and practitioners. GMV´s outcomes for MARISA regards fact that it enhances international cooperation in a transnational environment improving the capability to directly interact with final end-users in a manner not achieved before. MARISA provides industry the possibility to expose its technologies to the final users fulfilling their requirements and receiving first hand feedback.

4. AIRBUS DS SAS (AIRBUS DS SAS) - France

ADS uses MARISA developments and results to enhance this portfolio according to the following axes: (a) Enhanced integration of Intelligence data in surveillance systems (b) Fusion/correlation of external data to enhance the geographical coverage and the quality of information and (c) Better integration between airborne and ground components. In addition, ADS uses MARISA platform to complete the skills in data fusion domain which is an important research axis for the group as demonstrated by the high number of National Research activities performed by the division in dual domains. Stakeholders: ADS have access to a large panel of stakeholders and end-users (Coast Guards, VTS, Customs and Navies from many countries). MARISA outcomes is disseminated in this panel as the new capabilities developed during the project are of general interest for the whole Maritime community. Fusion and correlation of maritime data/information is a relatively new capability since Maritime surveillance until today has been generally focussed on Coastal Surveillance with some limited extension to EEZ. The expectations from MARISA are therefore high. However, as 'MARISA progress the new capabilities according to the European policy rules and with the necessary performances to qualify the systems, it will be (yet, as it is) an invaluable reference to access global markets'.

5. E-GEOS SPA (E-GEOS SPA) - Italy

e-GEOS will focus on the analysis and critical review of the proposed solutions, data information and feedback gathered from Practitioner during the Operational Trials execution, with the following main purpose: (a) identify strengths and weaknesses of the proposed EO products and services from a multi-faceted perspective (b) define a realistic action plan for wider service uptake and implementation roadmap, adopting the same multi-faceted perspective. The Operational Trials growths the main sources for defining the effectiveness of the EO based services, in order to evaluate the usefulness, sustainability and attractiveness of the proposed MARISA services. Stakeholders: e-GEOS is a leading international player in the geo-spatial business, with long-last relationships with European international, national, local and regional stakeholders in the Security and Intelligence Domains. The exploitation activities is based on the definition of the marketable results, and potential commercial exploitation agreements to be set up with the consortium partners. A roadmap for the operational implementation of the proposed development is addressed during the project.

6. PLATH GMBH (PLATH) - Germany

The results of MARISA concerning the tools for the correlation of AIS signal with position data can be exploited in different ways: (a) demonstration and dissemination of information to our customers involved in maritime surveillance (b) participation as authors and co-authors in the publication of scientific papers on topics related to the project (c) participation in fairs and conferences to enable the provision of information regarding the MARISA project results – directly to decision makers and specialists. Stakeholders: For an effective exploitation, coastal guards, Navy and other border authorities have been identified as the final end-users to adopt or apply the results of the project, and potentially benefit from the knowledge produced. Currently the validation of AIS data plays no yet major role in maritime situation awareness; often this data is assumed to be true without further verification. The project's outcome may lead to a higher prioritisation of AIS data validation in order to detect anomalies and manipulation regarding position and direction of travel of ships.

7. SATWAYS (Proionta Kai Ypiresies Tilematikis Diktyakon Kai Tilepikinoniakon Efarmogon Etairia Periorismenis Efthinis Epe) - Greece

The ORASYS Command and Control System, one of the main SATWAYS products development addresses to the integration with the MARISA services and CISE data and improves MARISA end-user application functionalities. In addition, the lately developed GCEP and tracks fusion engines testing in a very demanding operational environment and algorithms' improvement and performance enchantment is focused. Integration with third party's vessel info is expected to add additional functionalities to the ORASYS C2 product. The following actions to support efficient exploitation and commercial utilisation are foreseen after the termination of the project: (a) marketing and sales efforts via trade fairs, exhibitions and specific marketing initiatives to address and acquire new customers by presenting the technology and possibilities of the whole system (b) sales activities via our distribution network and (c) active participation in industrial seminars and networks to communicate selected exploitable results. Stakeholders: Coastal guards, Navy and other border authorities have been identified as the final end-users to adopt or apply the results of the project. MARISA offers to SATWAYS the opportunity to enhance its products capabilities as well as to investigate synergies with other MARISA partners to jointly promote related development as an integrated product to win business in this emerging market space of border surveillance.

8. INOVAWORKS II COMMAND AND CONTROL LDA (Inovaworks C&C) - Portugal

IW Command and Control's business model resides in licensing its core product GeoC2 command and control solution to key user communities and industry stakeholders, thus allowing them to gain competitive advantages in their domains of operation. Therefore, IW intends to use MARISA and its work package results as both guidelines and validations of its developing technologies, and to better infer how jointly developed algorithms and techniques can aid the overall industry to standardize on information fusion mechanisms. IW uses each project iteration to consult with end-user communities and project partners on the technological evolutions achieved up to that point, and infer if they should be integrated into its core product. Stakeholders: Maritime Awareness communities, Defence, Public Safety, and Security actors in the Portuguese, Iberian, EU and NATO scopes. IW's product strategy is heavily impacted by MARISA – 'the outcomes of the project shapes and imposes changes in the way in which our company does data fusion, and therefore in the way our clients' capabilities for data fusion grows. Progress of new IW modules and new capabilities is focused on existing and future clients alongside MARISA Project'.

9. ASTER SPA (Aster S.p.A.) - Italy

ASTER exploitation strategy envisages for the first year after the end of the project to target the users involved in MARISA. In turn, the satisfaction of these stakeholders will be the key to approach entities external to the Consortium, starting from those in the Mediterranean. Stakeholders: Navies, Coast Guards, Ministries (for Interior, Transportation, Defense, etc.), as well as international authorities (EMSA, FRONTEX, etc.). At the end of the project, few engineering and industrialization activities is improved to go to the market, give the high level of maturity of the solution (TRL 8). The focus will be only on commercial and marketing activities to grow market awareness about the new product. No extra charges for commercial or marketing activities are envisaged because, taking into account the highly sophisticated nature of the solution, it will be carried out by internal resources with previous experiences and relationships in the consolidated market segment.

10. LUCIAD NV (LUCIAD NV) - Belgium

Luciad sees the MARISA project as an important step to improve its presence in the Security, Safety and Maritime domains. By applying new techniques of data management, fusion and visualisation, Luciad's software will be not only enhanced but validated in an operational environment. Through participation in MARISA, Luciad wants to acquire the required background for being able to offer to clients within the

emergency, security and maritime markets enhanced solutions that comprise new techniques of data management, fusion and visualization. Stakeholders: Maritime, Defence, Public Safety, Telecommunications. Luciad improves many features of its software since not only that it allows integration into the MARISA toolkit but in other projects/domains as well. What can be applied to the MARISA use case for the border control topic will be transposable to other markets where situational awareness is required? Luciad has seen a growth in the last years and expects that MARISA will enable even more growth in the years following the project.

11. INOV INESC INOVACAO - INSTITUTO DE NOVAS TECNOLOGIAS (INOV) - Portugal

INOV plans to exploit the project results by using the know-how gained through the action to improve existing solutions and products; further develop product machine learning based features; exploring new business opportunities, either related to MARISA itself or to the technologies developed and demonstrated by the consortium. INOV will also continue collaborating with the consortium partners, providing consulting and technical support in the demonstrations and/or implementation of systems and the pursuance of business opportunities. Stakeholders: Portuguese Universities and Industry. As a non-profit research and technology institute with strong links to Portuguese technical universities, one important result of the participation in MARISA is addressed to the expertise in the field of data mining and machine learning, namely increasing the academic and research skills of the participants and transferring this knowledge to the Portuguese universities and industry.

12. NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO (TNO) - Netherlands

TNO's exploitation plans as RTD are focused to develop new knowledge and enrich existing knowledge for direct or indirect exploitation. TNO intends within a timetable of 5 years after the project to exploit: (a) one of the key results of MARISA is how to accomplish information management. These results will be exploited at the national Dutch level by supporting the sustainable development of surveillance and information systems (b) exploitation at the EU level is explicitly achieved by MARISA because this project contributes to the transition from European border surveillance to European border management. Stakeholders: Netherlands Coast Guard, Netherlands Ministry of Infrastructure and the Environment, Netherlands Ministry of Defence, Ministry of Security and Justice, Ministry of Finance, Ministry of Economic Affairs, EMSA, FRONTEX, Industrial partners. MARISA is contributing to the information exchange and cooperation between European Member States as well as strengthen European industry.

13. FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN (Fraunhofer, IOSB) - Germany

Since Fraunhofer is a non-profit research institute, its exploitation plan consists of providing the European community with innovative research results and supporting innovative SMEs research and innovation. Within MARISA, a social media analysis and a behaviour analysis prototype is designed and implemented. Results will be presented on international research conferences and will also be discussed with possible partners from SMEs. Stakeholders: Scientific audience on conferences, industry and organisations related to maritime topics (EMSA, FRONTEX, etc.) and German Ministry of Defence. Through the implementation and especially the evaluation of the developed modules in real environment, Fraunhofer IOSB is able to offer such modules as a product for industrial partners. German SMEs are already interested in such modules, especially for the application of coastal surveillance system. Additionally, Fraunhofer IOSB will be present in the scientific community by publishing the achieved results.

14. NATO SCIENCE AND TECHNOLOGY ORGANISATION (NATO STO) - Belgium

CMRE, explores the user domain through a set of structured games that will define a set of maritime use cases that may be used by all consortium partners throughout the project and by other interested parties after the project has come to completion. The insights, techniques and algorithms developed by CMRE, and proven to be beneficial through experimentation, improved market maturity by interested partners. Where appropriate, the same outcomes will be made available to interested NATO nations and partners,

providing a wide user-base for MARISA technology and information exchange. Stakeholders: All NATO Nation Navies and Coastguards, Partners for Peace (PfP), NATO Centres of Excellence (CoE), NATO S&T Panels/Programmes and in particular the NATO Shipping Centre (NSC). Worldwide scientific community in Information Fusion, Autonomy and Human Decision Making. Proven improvement in the fusion of heterogeneous sources of differing information quality. Robust discovery of routes and maritime activity areas to enable improved vessel prediction. A set of re-usable benchmarked maritime use-cases.
15. TOULON VAR TECHNOLOGIES (PMM-TVT) - France
By hosting the integration platform on our premises, in the Science and Technology Park in Toulon, we will enhance the key role of our cluster on the maritime security and safety domain in the Mediterranean Sea. Currently 90 members involved in this strategical domain, with major's players as AIRBUS DS, DCNS, THALES, ATOS are looking for partners to develop their offers. We hope to increase the high level of partnership between these leading industries in the future. We increases the number of collaborative project and members in this area, in our cluster. MARISA could offer great opportunities to SMEs to showcase their technologies to the panels of experts involved in MARISA.
16. LAUREA-AMMATTIKORKEAKOULU OY (LAUREA UAS) - Finland
Security is one of the strategic R&D&IA domains at Laurea UAS that utilizes its expertise of security research and innovation projects to exploit the relevant project outcomes. In particular, Laurea activate the outcomes of technological and scientific results according to all MARISA WPs and employ these results (research papers, recommendations, security metrics) in teaching Security Management (Bachelor and Master) and using results for furthering security-related research in doctoral university networks and post-doctoral studies. Stakeholders: Search-and-rescue end-user organisations participated in MARISA; Local, regional, national and European policy and regulation decision makers in the field of search-and-rescue-information society, social and public sector innovation and regional development; development companies and service providers (both large and small companies or even start-ups interested in new business continuums based on MARISA data fusion solutions); Citizens in general, for their awareness in the access to the new services, and also for their consciousness in the possibility of creating personalized data fusion based services. Several impacts are achieved so far and among the others: (1) to education and awareness by revising of curriculums and syllabuses (EQF and NQD) (2) to competence and skills; research is used for development and learning (3) to data fusion dissemination for health and well-being sector (4) to living by improved body of knowledge and fusion of sources of knowledge (5) to management and leadership models, especially in the domain of search-and-rescue.
17. ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA (UNIBO) - Italy
Since University of Bologna is a public education and research Institution, its exploitation plan consists of providing the European community with innovative research results and supporting innovative SMEs research and innovation in the field of maritime security. First a standard product for wind wave and hydrodynamics forecast downscaling and uncertainty estimation is improved. Secondly the related products can be merged with AIS and other objects detection products relevant for the MARISA Use Cases.

Table 11: An analysis of exploitation interests of the MARISA Project.

MARISA supports operational effectiveness and decisive information superiority, readiness and reliability, coordination and cooperation among different stakeholders, at national and international level, within multi authorities/multi -forces environment with the aim of building common understanding and platform for common procurement and creation of new market. Here, the major drivers towards maritime markets are the growth of data from many different sources and the ability to extract the information on which to act using analytics. Leveraging from the availability of the structured and unstructured data, MARISA proposes improved solutions to facilitate sharing information and to build decisions on a much wider range and variety of available data. MARISA progress value added services in full compliance with the CISE data model and

ensure interoperability among existing operational systems. Hence, the legacy surveillance systems of diverse Member States will exchange data, such as system level data and information fusion through the federated MARISA and CISE services [GA Part B p. 36].

‘MARISA will be applied to users from different Member States, while sharing the same information and having the same operational picture of current sea status at all time. MARISA services also allow end users to further improve their quality of services by customizing the services based on experienced results, learn from the experience’ [GA Part B p. 27]. ‘The MARISA toolkit enhances Search and Rescue (SAR) capabilities in terms of discovering, confirming and monitoring of threats and activities of interest with the timeliness and quality needed to decide, plan and execute. MARISA toolkit’s functionality of fusing information from heterogeneous sources combined with mapping of threats and activities of interest and weighing of their potential impact enables authorities with mission planning in search and rescue, disaster and accident response’ [GA Part B p. 27]. ‘MARISA exploits and fuses heterogeneous and asynchronous data shared by different COPs and originated in different time periods. MARISA will complement the current legacy systems of the involved authorities with additional sensor data. The situational awareness is further enriched by the effective use of heterogeneous data from different sources such as open source data, intelligence data and third party vessel data, dealing with the uncertainty and quality of data, using correlation tools, data mining and behaviour analysis. These capabilities will drastically improve decision-making and reaction capabilities of the involved authorities’. [GA Part B p. 28]

‘MARISA information sharing tools can build greater resilience to climate change implications, for instance water and food scarcity, in terms of EU coordinated interventions in SAR of an increased number of immigrants and humanitarian assistance. Moreover, one of the strategic maritime security interests of the EU and its Member States is the protection of the environment in maritime areas, in particular pollution and oil spills. MARISA promotes cooperation in maritime disaster awareness and response’ [GA Part B p. 30]. ‘Develop or support the development of EU maritime exercises to enhance readiness and preparedness of Member States and EU capacities to respond to security threats as defined in the European Union Maritime Security Strategy (EUMSS), including consequences of climate change, taking into account impact, level of vulnerability and adaptation measures in Member States.’ [GA Part B p.30]

‘MARISA information sharing tools can build greater resilience to climate change implications, for instance water and food scarcity, in terms of EU coordinated interventions in SAR of an increased number of immigrants and humanitarian assistance. Moreover, one of the strategic maritime security interests of the EU and its Member States is the protection of the environment in maritime areas, in particular pollution and oil spills. MARISA promotes cooperation in maritime disaster awareness and response. Better collection and sharing of information from different sources should lead to better outcomes in attributing responsibility and prosecuting those who have committed environmental crimes. MARISA will also enable rapid action and decision making and help authorities apply the proper procedures according to the characteristics of the incident. Consequently the social, economic and environmental damage caused by incidents will be minimised. Finally, considering that among the most significant innovation introduced by MARISA there are the improvements of information sharing and early warning capabilities, with the adoption of MARISA toolkit a sensible reduction of the number of mobile assets (e.g. ships and aircraft) involved in the patrol operations can be achieved. That reduction will have a significant direct consequence on both climate change and environmental impacts, considering the direct energy saving, reduction of both environmental and marine pollution, drastic decreasing of the incident risks’. [GA Part B p. 31]

‘MARISA promotes better handling of irregular immigration and human trafficking enhancing coordination and sharing of information among maritime surveillance authorities and border control Agencies between Member States including cooperation as coordinated by Frontex. Irregular immigration and human trafficking in the Mediterranean Sea concerns political refugees fleeing war in Syria and Middle East countries and migrants from North Africa and Sub-Saharan countries. Irregular immigration through routes from North Africa, Canary Islands and the Iberian coast also occur. Irregular immigration and human trafficking being mostly undocumented have impact on the ways migrants choose who to interact with and how; the range of social activities undocumented migrants engage in and the places where they socialize; the interaction with

community organizations, churches and mainstream support agencies. Human trafficking is organized by unscrupulous traffickers on barges in overcrowding conditions and in the absence of minimum safety conditions'. [GA Part B p. 31]

'MARISA will deliver the best opportunity to optimise the relationship between Industry and Government. It will create a coherent and a stronger supply chain between Large, Medium and Small Industries and Research and Technology Organisations and partnership with Governments. Companies will gain greater visibility in EU Institutions and National practitioners, helping to clarify the case for public and private investment, in order to improve industrial competitiveness. Direct advantages will include to link future investment decisions in better informed condition, where solutions have been tested and evaluated. Technology will continue to reshape customer awareness and offer companies ways to improve their competitive advantage' [GA Part B p. 32]. Here, the triple-quadruple helix model of innovation, as conceived by Etzkowitz and Leydesdorff can increase the interactions between: universities engaging in applied research, development and domain-regional-national development; industries producing commercial goods and services; governments that are regulating markets and well-being; and citizen's participation and responsibility. As interactions increase within this framework, each component evolves to adopt some characteristics of the other, which then gives rise to hybrid institutions.

'Another important aspect is related to the potential growing of employment levels in the EU area, considering the high level of technological innovation in the Data Fusion domain introduced with the MARISA. The availability of non-classified open data from different sources can be used to create innovative services by start-up companies working on applications and data analytics. These services have the primary mission to produce benefit for European citizens mainly in environmental management of the sea and the coastline. To do that, these services can take also advantage from Copernicus open data. MARISA expects to create qualified jobs in a sector that is estimated to grow from 7% to 10% per year and where also private investors and venture capital is looking for new investments. Moreover, a study of Harward Business Review highlights the potential absence of the skills to manipulate big data set. MARISA would like to contribute to create expertise employed in Large Industries and SMEs, in particular supporting the women scientists'. [GA Part B p. 32]

'MARISA will foster best use of and creating synergies between information, capabilities and systems managed by civilian and military authorities up to multipurpose and multinational missions. MARISA will promote pooling and sharing initiatives and projects, pursued by Member States including through EDA and other relevant civilian and military actors. MARISA will promote good coordination and mutual reinforcement with NATO in order to ensure complementarity and increase coherence'. [GA Part B p. 33]

'The MARISA Project uphold ethical standards for research as delineated in the Code of Nuremberg and the European Code of Conduct for Research Integrity. In addition, the project's research activities complies with the Code of Human Research Ethics of the British Psychological Society and hence following issues are complied with: (1) Autonomy and Dignity of Persons: this means that knowledge, insights, experiences and expertise of participants (both citizens, public administrations as well as companies) is respected; the characteristics of each individual including age, gender, disability, education, ethnicity, language, national origin, religion, sexual orientation, marital or family situation and socio-economic status is taken into consideration (2) Scientific Value: the project partners are committed to delivering high quality scientific outputs that have wide-ranging academic impact. In addition research must be transparent to ensuring deliverables reliability and impact (3) Social Responsibility: partners' work ethics must be based on integrity, mutual respect and sound collaboration, incorporating self-reflection and being open to challenges that question the contributions of the generated knowledge to society. Researchers are aware of their personal and professional responsibilities, and alert to the possible consequences of unexpected and predicted outcomes of their work. Researchers acknowledge the problematic nature of the interpretation of research findings (4) Maximizing Benefit and Minimizing Harm; the project aims to maximize the benefits of work at all stages. Guiding principle is that harm to research participants must be avoided, and where risks arise as an unavoidable and integral element of the research, risk assessment and management protocols will be developed and implemented. The risk of harm must be no greater than that encountered in ordinary life'. [GA Part B p. 128]

4. Methodology

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In this part of the deliverable (D2.8) report, the central methodological issues of Maritime Integrated Surveillance Awareness (MARISA) research, development and innovation action activities are described: (1) introduction of the quality approach; (2) animated operation and quality assurance processes as data collection practises; (3) continuum of the research, development and innovation methods used; (4) triangulation as a basis for analysis in development; (5) research and development attributes; (6) performance indicators; and (7) the setting of readiness level measures. In this report, the term 'research and development method' refers to procedures for collecting and analysing data, and the term 'analysis' addresses the processes of investigating and interpreting quantitative and qualitative data in order to gain a deeper understanding of and new knowledge for designs and realisation of MARISA Project trials.

4.1. Approach to Quality

Here, the approach to quality mainly addresses six terms: (1) internal validity refers to newly created trials (*n* = 5 realisations), both parallel and along-side the analyses and methods, models and new processes; the objective is to ensure that the new concepts and models are logical, authentic and internally valid from the perspective of the realisation of information systems, security and service, as well as suitable to the maritime context; in the MARISA GA, the management and quality assurance processes are included; (2) construct validity refers to the correct operational measures for the theme being developed; then, the view of construct validity is addressed to the extent that 'what was to be measured was actually measured' or 'it measured what you think it measures'; in this, the concept of evaluation design is presented in MARISA GA; (3) the related quality terms, authenticity and transparency of data displays, refer to participators' thinking and new ideas which emerge, new models, new services and new information systems; in this, the realisation process is seen as a continuum of proactive-strategy-process-result-impacts and its feedback, such as (a) development by success, (b) learning by failure and (c) development by feedback; (4) in turn, the terms reliability, dependability, and auditability refer to demonstrating that the operations of a trial, such as the data collection procedures and development interventions, can be repeated with the same results; (5) as well in this view, there is a real sense of objectivity when the quality-system-based data that are gained directly from the practice are not tainted or manipulated by the perspectives, biases, defences or experience of participators or other facilitators; therefore, the samples of evidence are gathered from concrete evidence and partially from the reality that came from the participators' anticipation-experimentation, which bring forth their experience based assumptions, views, thinking, beliefs, trust and spirit along with the collective reflection of the data; and (6) the last quality term, utilisation of the trials and concepts, is the use of guidance models and an action logic of quality with implementation of maritime operational development and globalisation to everyday learning, development, and research activities in the maritime domain, which refers to the utility of new artifacts (trials and services), possible further adapted services and methodologies.

4.2. Animation of Processes and Dimensional Levels

In MARISA, the discussion of a common operation process (data collection from operations) has been a multidimensional and relatively challenging theme; however, the observe, orient, decide and act (OODA) loop has been commonly considered to be one of the most expressive (animated) operation process models in the maritime and MARISA context. The process cycle includes the (1) observe, (2) orient, (3) decide and (4) act phases. The OODA loop was developed by military strategist and United States Air Force Colonel John Boyd. Boyd applied the concept to the combat operations process, often at the operational level during military campaigns; regardless of its military origin, it is currently also applied to understand commercial operations and learning processes (cf. resilient learning theme in the discussion part). The approach examines how agility and resilience can overcome raw power in dealing with human opponents.

The OODA loop has become an important concept in litigation, business, law enforcement and military strategy. According to Boyd, decision-making occurs in a recurring cycle of observe-orient-decide-act. An entity, whether an individual or an organization, that can process this cycle quickly, observing and reacting to unfolding events more rapidly than an opponent, can thereby 'get inside' the opponent's decision cycle and gain the advantage. Boyd developed the concept to explain how to direct one's energies to defeat an adversary and survive. Boyd emphasized that 'the loop' is actually a set of interacting loops that are to be kept in continuous operation during combat. He also indicated that the phase of the battle has an important bearing on the ideal allocation of one's energies. The O-O-D-A loop, which is described in the following 'animation table', focuses on strategic military requirements; however, it has a strong resonance for the business and public sectors' operational continuity planning, and it can be compared with the plan-do-check-act (PDCA) cycle or the Shewhart cycle.

Boyd's OODA Loop diagram, as a proposal for a process model, focuses on decisions that are based on observations of the evolving situation and are tempered with implicit filtering of the problem being addressed. According to Boyd, the observations are the raw information on which decisions and actions are based. Here, the first O represents observed information that can be processed to orient towards decision-making, as Boyd described in 'Organic Design for Command and Control'. The second O is orientation, as the repository of our genetic heritage, cultural tradition and previous experiences can be seen as the most important part of the O-O-D-A loop since it shapes the way we observe, the way we decide and the way we act.

MARISA: The OODA Loop as an Animated Operation Process (data collection method)		
Observe	Unfolding circumstances.	Outside information to orient.
Orient	Cultural traditions; previous experience; new information; genetic heritage.	Analyses, synthesis and implicit guidance and control to action.
Decide	Discussions.	Forward to action.
Action	Produce feedback.	Unfolding interaction with environment.
OODA FEEDBACK LOOP		

Table 12: The OODA Loop as an Animated Operation Process.

As stated by Boyd and shown in the Orient box, there is much filtering of information through culture, genetics, ability to analyse and synthesize and previous experience. Since the O-O-D-A loop was designed to describe a single decision-maker, the situation is usually much more complex than shown here; most business and technical decisions involve a team of people observing and orienting, each bringing his or her own cultural traditions, genetics, experience and other information to the project. It is noted here that decisions often get stuck, which does not lead to 'winning', according to Boyd, because in order to win, we need to operate at a faster tempo or rhythm than our rivals or, better yet, get inside the rival's OODA time cycle or loop. Such activity will make us appear ambiguous (unpredictable), thereby creating confusion and disorder among our rivals, since they will be unable to generate mental images or pictures that agree with the menacing, faster transient rhythm or patterns they are competing against.

In MARISA, the reflective steps of the quality assurance process (quality data collection process) can be assimilated in the viewpoints of PDCA cycles: (1) Plan: planning the activities, i.e. what should be done, what results should be achieved, and what is necessary to change in the realisation. This concerns the co-creative and participative nature of planning and the implementation of definitions into the design and optimisation of the quality sigma; (2) Do: making the realisation and implementation according to the plan, canvasing and

implementing interests and co-operating and participating, as well as generating new knowledge from the creation perspective of doing, e.g. the learning and maritime domain development process; (3) Check: checking the activities and the results achieved, which involves development, the research interest, the knowledge creation interest (e.g. the reviewing of deliverable reports and updating the 'lists of next steps'), the implementation of analysis, measurement and verification interventions in the quality sigma; and (4) Act: acting systematically, taking into account the observations and results of the checking and regarding the consequences and especially the implications of the realisation for the next stage and the body of knowledge, e.g. the binding of new models and writing of a draft for the next development scrums. The Act responds to the question of the management of the continuation of some activity or falsification as to forward future. In the MARISA meetings and user community discussions, the consensus in functional break down figure of the operation-quality process as functional dimensions (data collection category of operation functionalities) included diversity; however, one wide-open description can be reported as in the following table.

MARISA PYRAMID AS DIMENSIONAL LEVELS		
1	**Collect**	Sensor data | multisensor data | extended data sources | social media.
2	**Process**	Detection | radar clutter reduction | data refining and correlation | object detection | target identification | classification | tracking | target data integration and fusion.
3	**Fuse**	Sensor-fusion | tracking | data fusion | persistent-tracking | ontology alignment | terminology and common definitions | data models | information fusion.
4	**Analyse**	Context | spatial | temporal | interactions | reasoning | patterns recognition | anomaly detection | business intelligence | fusion of data from heterogeneous co-operations | alarm generation | threats analysis | density and risk maps.
5	**Decide Decision-making**	Expert knowledge | local situational picture | recognized maritime picture | decision support system for action and domain | human in loop | action competence.
6	**Disseminate Sharing**	Authorities co-operating | cross-border co-operations | CISE services | national service buss | international services | harmonisation | continuums of research.
7	**Act**	Inclusion of implications and findings into the furthered body of knowledge.

Table 13: MARISA Pyramid as Description of Operation Process.

REMARKS: The MARISA PYRAMID presented here is imperative: the data categories (1-7) can be analysed in the action research (AR) framework for investigation of organisational and maritime domain changes. The integrative perspective of design science research methodology (DSRM) is in the systemising of design for artifacts, and a multiple case study research (CSR) can be combined to bring an understanding of a particular research scope, which can produce new knowledge for design and action. Here, the unit of analysis (UoA) can be 'a trial' (n = 5) or 'a maritime use case' (n = 94), and an analysis can be addressed to the empirical in-depth data collection. The main strength of the action research framework is that it combines discovery and implementation in one process. Thus, action research can effectively be used to combine practical action and science. Action research involves a collaboratively developed relationship between the researcher and an organisation, aimed at both conducting development interests and generating new knowledge. Then, in the continuum of this research framework, action research can be included to solve current practical problems while expanding scientific knowledge. As a continuum of the case study analysis, in which the researcher seeks to study but not change the organisational phenomena (researcher is outsider), the integration of action researcher and DSRM seeks to bring about organisational- and domain-related change while simultaneously studying the process (researcher is insider and involved in change). This is strongly oriented toward collaboration and change and involves both researchers and end-users with the subjects. In this continuum,

action research can be an iterative and continuous research framework that capitalises on development by both the researcher as a member of the expert community and other domain participants, such as expanded end-users, colleges, collaborators and management as described in a triple-quadruple helix models.

4.3. Design Science Research Methodology

The DSRM process is applied in the MARISA Project and addresses the incremental alignment of the innovative services to the end-user needs and evaluates the implementations with respect to the needs. A key element driving in the MARISA User Community is the collaborative involvement not only of end-users but also of all stakeholders, bringing together expertise in data fusion technologies and maritime surveillance solutions, during and beyond the scope and lifetime of MARISA. In this case, the word 'stakeholders' refers not only to project partners, but also to additional organisations, both end-users and providers of data and services not directly involved in the project that support and advise project partners with their experience and know-how throughout the project's duration. In MARISA, the DSRM is addressed to provide end-user-centred 'space' for the design, development, improvement, integration, and validation responsibilities and to serve as a structured approach on which the harmonisation and standardisation proposals stemming from this project can be built. The MARISA DSRM process model includes interdisciplinary approaches and involves the use of stakeholders' knowledge for service design and development. The setting of the MARISA DSRM bottom-up process (1-7) model is described in the following table.

MARISA: Design Science Research Methodology			
7	**Continuums**	Furthered operational scenarios and trial definitions and potential.	**DELIVERABLES**
6	**Confidence Awareness**	Legal and ethical context analysis and impacts.	
5	**Emergent needs Resilience**	Innovative use of additional data sources.	
4	**Existing and legacy**	Integration design, CISE and research of interactions.	
3	**User-centred design and R&D**	Adoption model, service design and case study.	
2	**Define objectives & functionalities**	User needs and requirements for services; value-proposition-service canvas; interactive sessions and requirement analysis.	
1	**Involvement Participation**	User community creation; animation and motivated participation.	
MARISA user community: end-user-centred collaboration, innovation space and experience			

Table 14: MARISA Design Science Research Methodology.

This bottom-up table refers to principles of the R&D setting for the MARISA Project: the practical means for doing research for the development of maritime services. The MARISA DSRM process model is based on the triangulation of existing research data. It offers a mental model upon which the DSRM can be built, as well as the evaluation and representation of the results. The MARISA DSRM process contains seven phases that cover the parts of the system design-development-dissemination process in the MARISA Project. Here, the traditional DSRM process model is improved: it more effectively takes end-users and stakeholders into account when planning new information systems or when the system is changed, even fundamentally. Additionally, it can include a ready-made system or service (adoption) into the process or the phase for which it is designed.

In this setting, the basic thought behind the DSRM process is that, too often, only the designer knows the purpose for which the system is built; the difficulty with that is that the designer alone may know the processes and procedures, thus making the end-users unmotivated and their participation unnecessary.

Usability and confidence are vital parts of any information system; hence, the end-user and the user experience are considered when designing a system or information-intensive service. End-users and stakeholders are involved throughout the entire design process, making them more committed and giving confidence to the deployment of the artifacts, tools and services. Design theories and DSRM can be used in the engineering, but they also need to offer services and solutions for the actual end-users, actors and authorities that build confidence and promote trust-building-sharing, as well as the supporting co-creativity aspects. The contribution of the MARISA DSRM process model is in line with those in the literature in that many systems and services fail because technical experts do not fully understand the complicated processes and requirements of the end-users and actors. It was discussed in the MARISA User Community that even a poorly-designed system can function for a long time if it fulfils end-user and stakeholder needs. However, so far, the MARISA Project remarked for future that it is still possible to learn to contribute to the information systems and services design process. One difficulty involved with the methods may also be that these methods use only what has been used previously; they confer path-dependency of development and knowledge transfers as more or less a legacy. The challenges for MARISA were to create something new (anticipation-experimentation), to support co-creativity and to make (possibly outdated methods) and literature better for the next service development process.

CANVAS (Helsinki 27-28.6.2017): ‘The data collection and research objective of the first MARISA User Community Helsinki meeting was to identify the factors of business and operative models that can improve a value proposition of maritime end-users in the perspectives of product development and situational awareness services. The examined factors were based on the creation of a value proposition CANVAS. The research setting included the two-day meeting of continuous brainstorming in which structuring the needs with end-users was emphasised. Primary data were acquired through the method of participation in the four discussion meetings (n = 4 sessions) with end-users, stakeholders and developers (n = 41 participators) where photos, videos and canvas tables were saved to the cumulative research data collection (n = 165 documents). The leader inquiries (n = 45 trigger questions), focus points and procedures (n = 4 documents) were introduced at the beginning of the sessions. The first day’s session addressed the plan to share step-by-step brain-storming using the canvas model, including views covering user needs to business values and expressing the barriers and expected benefits: step (1) creation of groups (n = 5) according to MARISA use cases (n = 5) which were selected in advance (used cases were 13b, 37, 44, 70 and 93); step (2) each group started looking at the canvas together; step (3) the end-users described the tasks they tried to perform in their work and what functional problems they were trying to solve; step (4) objectives were defined in order to understand lines of responsibilities, the operational nodes involved and the needs for exchange, thus providing a clear picture of how operations were performed beginning with the cases selected in advance. The second day’s session included investigation and presentations (n = 5) of the most important end-user jobs, the most important gain creators, the most important pains and possible pain relievers, revising the needs, expected MARISA improvements, agreement on the benefits and barriers and the review of how services can be adopted (n = 38 documents)’. [Pirinen 2017]

SPLINTER SESSIONS (Madrid 16-17.1.2018): ‘According to MARISA, end-users, usability and design-development-deployment-dissemination issues of the systems and services are central factors for system utility, confidence, and trust-building, and they should therefore be detailed taken into account at every step of the system design-development-dissemination process. The changes made in the system should be managed in a novel way so that the users can commit to the changes, which may also affect work processes. Solid communication is of great importance, and, as the means of implementing the change, the managers must also commit deeply to it. The earlier the users participate in the design-development process, the easier the realisation of the system will be; the users will accept the new system, as well as the new working processes. Thus far, even though the end-user is not at the heart of the technological DSRM literature, the end-user view is too easily put aside in the behavioural sciences, with possible ties to related information systems research; end-users and actors, however, cannot be forgotten. The DSRM should include the end-users and co-creativity.

There is no point in making information systems, services or theories if the essential end-users-actors space is missing. The realization of the system is very much tied to the users and actors' trust and confidence' [Pirinen 2015 and revised 2018]. INCLUDED SPLINTER SESSIONS: Riverview and Status of the Project, Meeting Objectives and Organization; User Requirements Meetings; MARISA Toolkit Draft Architecture; MARISA Data Model Design; Adoption Models; Operational Trials Meetings (n = 3); and Ethics Session.

INTERACTIVE SESSIONS (The Hague, 14.5.2018): 'The Maritime Domain is challenged by the large amount of raw data collected by different sources and various assets from the Member States. Those data are often unexploited because they are not understandable for the current maritime systems. There is also the opportunity to complement the maritime data by integration of other data streams, such as open-source intelligence (OSINT) coming from social networks and the Internet. The objective of the 1st MARISA Workshop Hague meeting was to present and discuss the novel techniques and algorithms implemented in the MARISA H2020 project to enhance maritime surveillance awareness capabilities by correlating and fusing various heterogeneous and homogeneous data and information from different sources, including the Internet and social networks. The following topics were addressed: (1) extraction of information from open-source channels for maritime situation awareness, (2) satellite detection and reconnaissance for maritime situation awareness, (3) maritime traffic pattern extraction from large amounts of uncertain data, (4) vessel route analysis and extraction using machine learning algorithms, (5) statistical and semantic approaches and techniques for behavioural analysis and anomaly detection in maritime situation awareness, (6) ocean forecast integration into maritime situation awareness to support mission planning and search and rescue operations, (7) complex threat analysis and prediction in maritime situation awareness, (8) usage of big data infrastructure in maritime situation awareness and (9) human-computer interaction (HCI) and usability factors in maritime situation awareness. The data collection of the 1st MARISA Workshop included 34 documents'. [Breejen 2018]

4.4. Triangulation

The term 'triangulation' refers here to the validation of data through cross-verification from more than two sources. One focus of triangulation in MARISA would be that decision-maker can be more confident in an analysis for decision-making if different methods (algorithms and inquiries) lead to the same result. Triangulation can be used to test the consistency of findings obtained through different assets and increase the chances to control and evaluate some of the threats or multiple causes influencing alerts or results that need further action. It can lead to multi-perspective meta-interpretations and attempts to map out or explain more fully the richness and complexity of an asset or human behaviour by analysing it from more than one perspective. Four basic types of triangulation are used in traditional scientific literature: (1) data triangulation involving time, space, location and persons; (2) investigator triangulation involving multiple decision-makers or researchers in an investigation or interpretation; (3) theory triangulation involving the use of more than one theoretical scheme in the investigation and interpretation of the phenomenon; and (4) methodological triangulation involving the use of more than one option to gather data, such as multiple types of sensors, additional data sources, interviews, observations, questionnaires, social networks, social media and documents. Triangulation is a powerful technique that facilitates validation of data through cross-verification from two or more sources. In particular, it refers to the application and combination of several research methods in the examination of the same phenomenon. It can be used in both quantitative (validation) and qualitative (inquiry) studies. It is also a method-appropriate strategy for determining the credibility of qualitative analyses; triangulation is not solely about operational validation in MARISA but also about deepening and widening the understanding of an event, phenomenon or systemic (nexus). Some of the various triangulation types are itemized in the following table.

MARISA: PROPOSAL FOR TRIANGULATION TYPES		
1	**Operational**	Cross-over verification from more than two operations.
2	**Organisational**	Cross-over verification from more than two organisations.

MARISA: PROPOSAL FOR TRIANGULATION TYPES		
3	**Method**	Cross-over verification from more than two methods (algorithms).
4	**Service**	Cross-over verification from more than two services.
5	**Architecture**	Cross-over verification from more than two architectures.
6	**Data**	Cross-over verification from multiple data sources.
7	**Information**	Towards information fusion.
8	**Infrastructure**	Critical infrastructure protection.
9	**Resilience**	Technical resilience: adaptive, dynamic and reconfigurable; functional resilience; resilience engineering (i.e. anticipation-experimentation-simulation).

Table 15: MARISA Proposal for Triangulation Types.

4.5. Research and Development Attributes

The R&D and innovation attributes are established for describing the level of methodological rigor in DSRM and information systems research. While the level of methodological rigor has experienced modest progress with respect to some specific attributes, the overall assessed rigor is currently somewhat indeterminate, and there are still significant areas for improvement. One of the keys is to include sound documentation, particularly regarding issues related to the data collection, analysis processes and experimentations.

MARISA: RESEARCH & DEVELOPMENT & INNOVATION ATTRIBUTES	
Theme of study	Maritime Integrated Surveillance Awareness (MARISA). SEC-19-BES-2016. Data fusion for maritime security applications.
Research agreement	Grand Agreement 740698 from 01.05.2017 to 30.10.2019 (n = 30 months).
Overall research question	How can data fusion services be understood, developed, realised and disseminated in European maritime security, borders and domain? (Here, 'domain' addresses the selected geometric area and 'development' of trials).
Innovations	The North Sea Trial, Iberian Sea Trial, Strait of Bonifacio Trial, Ionian Sea Trial and Aegean Sea Trial.
Target of study	The target of the study is to provide the security communities operating at sea with a data fusion toolkit which provides a suite of methods, techniques and software modules to correlate and fuse various heterogeneous and homogeneous data and information from different sources, including the Internet and social networks, with the aim to improve information exchange, situational awareness, decision-making and reaction capabilities.
Research domain	Development of data fusion systems, improved resilience in decision-making, enhanced decision-making, progress of awareness and information among stakeholders, authorities and policy development and regulation-related stakeholders.
Unit of analysis	A data fusion system as a trial (n = 5) which is implemented, documented and experienced, based on maritime use cases (n = 5/94) which are 13b, 37, 44, 70 and 93.
Importance of study	Contribution: a data fusion toolkit, which provides a suite of methods, techniques and software modules to correlate and fuse heterogeneous and homogeneous data and information from various sources, including the Internet and social networks.

Methodological focus	DSRM including triangulation and implications for future studies in domain. The view can be expanded by case studies and an action research framework.
Form of analysis	Qualitative and quantitative analysis, saturation and triangulation.
Nature of study	Explanatory study of data fusion technology, interventions and potential in applied information systems and services.
Research approach	Inductive investigation for collective building of furthered data fusion systems (n = 5) in the European maritime domain.
Specification of constructs	Anomalies, CONOPS, extra ordinary, European Interoperability Framework, knowledge, embedded system, resilience, situational awareness, maritime situational picture, toolkit, data fusion, legacy system, maritime surveillance, SMART and virtual interaction.
Theoretical scope of study	Towards building, testing and validation of data fusion systems; authorities' interactions; nexus as mutual causalities; cooperation; and collaboration.
Scope-related literature	M. Riveiro, G. Falkman, T. Ziemke (2008). Improving maritime anomaly detection and situation awareness through interactive visualization, Information Fusion; M. Mazhar Ullah (2015). Real-time big data analytical architecture for remote sensing application. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing; R. Laxhammar (2008). Anomaly detection for sea surveillance. Information Fusion; Atkinson, Martin (2010). News mining for border security intelligence. Intelligence and Security; R. Laine, D. Nevell, S. Hayward, T. Beaney (2010). Maritime Anomaly Detection and Threat Assessment. Proceedings of the International Conference on Information Fusion (FUSION). Informatics (ISI), IEEE International Conference; and G. Pilato, A. Augello, M. Missikoff, F. Taglino (2012) Integration of Ontologies and Bayesian Networks for Maritime Situation Awareness. Proceedings of the IEEE Sixth International Conference on Semantic Computing (ICSC).
Research design	Design science research which includes the (n = 5) large data fusion systems; the outcomes of the analysis are compared to the literature references and maritime use cases.
Logic of evidence	First, the single information systems design research study and analysis (n = 5) with logic of building and testing and then validation of trials for dissemination and conclusion.
Data analysis literature	Triangulation: Campbell & Fiske, 1959; Corbin & Strauss, 2008; Locke et al., 2007; Miles & Huberman, 1994; Patton, 1990.
Data collection methods	The research data were collected, coded, reduced, archived and translated into English.
Data collection	MARISA Forum and Document Repository: https://www.marisaproject.eu/repository.
Used metrics	KPIs and Technological Readiness Levels (TRLs).
Notes	Meeting documents; researchers used notes to clarify answers and response.
Role description	Researcher as outsider (objective) and developer-researchers as insider (subjective).
Service Design & Development	Use Needs and Operational Scenarios; Toolkit Design; Data Model; Interface Definition; Data Fusion Level 1 & Level 2 and Level 3 Products; Toolkit Integration and Validation; Validation in Operational Trials; Supporting Capabilities and Infrastructure; Feedbacks; Results; and Recommendations.
IPR Management & Exploitation	Exploitation Framework. IPR Framework. Market Analysis. Business Model. Exploitation Plans: Definition of MARISA Exploitation Potentials; Definition of Individual Key Exploitable Assets; Definition of MARISA IPR Framework; Ownership and Exploitation terms and conditions; Market Trends; Segmentation & Target Customers; Competition Analysis; SWOT; CANVAS Business and Service Model;

	Extensions to New Data Sources; Alternative Market Uptake Opportunities; Partners' Individual Exploitation Plans; and Joint Exploitation Paths for MARISA Toolkit.
Research consortium	Leonardo S.p.A. (LDO); Engineering Ingegneria Informatica S.p.A. (ENG); GMV Aerospace & Defence S.A.U. (GMV); Airbus Defence and Space SAS (ADS); e-GEOS S.p.A (EG); PLATH GmbH (PLA); SATWAYS – Proionta Kai Ypiresies Tilematikis Diktyakon Kai Tilepikinoniakon Efarmogon Etairia Periorismenis Efthinis Epe (STW); Inovaworks II Command and Control (IW); Aster S.p.A. (AST); Luciad NV (LUC); INOV Inesc Inovação (INOV); Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO); Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V. (IOSB); NATO STO – Centre for Maritime Research and Experimentation (CMRE); Toulon Var Technologies (PMM); Laurea University of Applied Sciences (LAU); Alma Mater Studiorum University of Bologna (UNIBO); Ministry of National Defence Greece (HMOD); Netherlands Coastguard (NCG); Guardia Civil (GUCI); Italian Navy (ITN); Portuguese Navy (PN).
Standards	CEN-CENELEC (CEN) European Committee for Electro technical Standardization to start the MARISA Project Liaison. Provision of the requested information for the Research Liaison Project. Evaluation from CEN/CENELEC and request to comply with their Guides and concerning IPR aspects. The related cybersecurity study reviewed practically 480 individual CEN CENELEC, ETSI, IMO and ISO/TC8 maritime related standards with ISS framework. Additionally, there were also reviewed over 30 whitepapers and guidelines. The study found that the cybersecurity guidelines released by IET for ports and ships offer the best available framework for mitigating the cybersecurity risks in maritime environment. Both guidelines have holistic socio-technical and they refer many information security standards (e.g. ISO/IEC 27000 series, IEC, NIST and COBIT 5).
Research associations	International Standards Organization (ISO); Association for Information Systems (AIS); Association for Computing Machinery (ACM); and Institute of Electrical and Electronics Engineers (IEEE).

Table 16: MARISA Research, Development and Innovation Action Attributes.

4.6. Objectives and Indicators

A number of key performance indicators (KPIs) are used to measure the progress of the O1-O4 objectives described in the first table [cf. GA Part B, p. 4]. The second table addresses the KPIs identified for the project at the time of the proposal, whilst the final KPI table and relevant targeted values will be fully refined and structured during the project execution [GA Part B, p. 5]. It also defines the time frame for the achievement of the objective with reference to the work plan and project schedule defined in Section GA Part B, p. 47.

MARISA: OBJECTIVES		
O1	**Situational awareness**	Create improved situational awareness with a focus on delivering a complete and useful comprehension of the situation at sea.
O2	**Support the practitioners**	Support the practitioners along the complete life cycle of situations at sea, from the observation of elements in the environment up to detection of anomalies and aids to planning.
O3	**Collaboration**	Effect a productive collaboration among adjacent and cross-border agencies operating in the maritime surveillance sphere (navies, coast guards, customs, border police) in order to combine resources towards a common goal, resulting in cost-efficient usage of existing resources.

MARISA: OBJECTIVES		
O4	**User and provider services**	Foster a dynamic eco-system of users and providers, allowing new data fusion services, based on 'distilled' knowledge, to be delivered to different actors at sea by the integration of a wide range of data and sensors.

Table 17: MARISA Objectives.

MARISA: KPIs		
KPI Name	**KPI Description**	**Target Value**
O1: Create improved maritime situation awareness (MSA) with a focus on delivering a complete and useful comprehension of the situation at sea.		
MSA accuracy	Capability of generating MSA without redundant objects/tracks.	Less than 5% redundant objects/tracks.
MSA completeness	Capability to generate complete MSA by mixing several source feeds (offline and real-time data).	At least 7 heterogeneous source feeds in phase 1 and at least 10 in phase 2.
Targeted MSA	Capability of generating customized MSA for specific communities of interest.	At least 2: human, smuggling, safety & security.
O2: Support the practitioners along the complete life cycle of situations at sea, from the observation of elements in the environment to detection of anomalies and aids to planning.		
Level 1 data fusion services	Number of data fusion services related to the 'Observation of elements in the environment'.	At least 3 in Phase 1. At least 5 in Phase 2.
Level 2 data fusion services	Number of data fusion services related to the 'Comprehension of the current situation'.	At least 3 in Phase 1. At least 5 in Phase 2.
Level 3 data fusion services	Number of data fusion services related to the 'Projection of future states'.	At least 1 in Phase 1. At least 2 in Phase 2.
Level 4 data fusion services	Number of data fusion services related to the 'User refinement' (human in the loop).	At least 1 in Phase 1. At least 2 in Phase 2.
O3: Effect a productive collaboration among adjacent and cross-border agencies operating in the maritime surveillance sphere (navies, coast guards, customs, border police) in order to combine resources towards a common goal, resulting in cost-efficient usage of existing resources.		
Collaborative assets	Number of interfaced assets from several Member States' maritime border surveillance, security and search-and-rescue organizations.	At least 7 in Phase 1. At least 10 in Phase 2.
Collaborative trials	Number of trials expected to be executed in different scenarios among different agencies operating at sea.	5 (five).

MARISA: KPIs		
Cross-border agencies collaborating	Number of cross-border agencies operating in the maritime surveillance sphere (e.g. navies, coast guards, customs, frontier police).	2 (two) for at least 2 trials.
O4: Foster a dynamic eco-system of users and providers, allowing new data fusion services, based on a 'distilled' knowledge, to be delivered to different actors at sea by the integration of a wide range of data and sensors.		
Number of users	Number of users exploiting MARISA data fusion products (individual users and operational systems).	8 (eight).
Number of providers	Number of data and services provided to MARISA by individual users and operational systems.	8 (eight).
Number of sensors and data sources	Number of sensors (e.g. radars, E/O, satellite payloads, etc.) and open data sources (i.e. Internet data).	4 (four) in addition to the data provided by the legacy systems.

Table 18: MARISA Key Performance Indicators (KPIs).

The Technological Readiness Level (TRL) metric is developed to assess technology and research interventions, and it was included in numerous efforts by the National Aeronautics and Space Administration and United States Department of Defense. Many early works in this field included definitions of the risks and costs associated with various TRLs. In MARISA: TRLs are addressed to validate the readiness levels and maturity of an individual technology. Here, TRLs adopt a given technology from the basic principles as well as concept evaluation, validation, prototype demonstration, completion, and successful operations.

MARISA: Technological Readiness Level (TRL) Metrics [see analysis in GA Part B, p. 10]	
TRLs	**Descriptions**
TRL (8)	Networking and Integration Services: Big Data infrastructure providing a framework for dealing with data having characteristics as variety, volume, velocity and complexity. It also provides the other components (HCI, data fusion modules) with the right capabilities to quickly and concurrently access and process data in the storage. Adapter modules and gateways for the integration of the required external data sources and legacy systems. System-to-system interfaces to be used by the end-user operational systems or other external systems. Based on a SOA approach will allow each authorized external system to retrieve data fusion information.
TRL (7-8)	Data Fusion Level 1: Observation of Elements in the Environment. Multi Sensor/Target/COP Fusion with the focus on an enhanced geographical location of observed objects. Object Clustering based on their geographical position. Density maps. Multilingual Information Extraction and Fusion from social media w.r.t. to Named Entities, relations, temporal and spatial parameters. Maritime route extraction (contextual information). Fusion or Correlation according to Radar and Communication Electronic Support Measures.
TRL (7-8)	Data Fusion Level 2: Comprehension of the current situation: Behaviour Analysis, to detect suspicious behaviour of maritime entity (particular and irregular patterns) and infer the real vessel identity (fishing, polluting, smuggling) – based on JDL-1 level basic vessel anomalies. Anomaly Detection, Classification and Threat assessment, to assign probabilistic causes for an anomaly behaviour of a maritime entity and potential threats coming from it. Business Intelligence, as the production of relevant report and dashboard data to support rapid decision making and action against different type incident at sea. Multilingual event detection for social media data such as

	Twitter messages to enhance maritime security. Integration of OSINT to enhance abnormal vessel behaviour detection, to correlate. Non real Time object and real time tracks.
TRL (6-7)	Data Fusion Level 3: Projection of future states: Predictive Analysis, such as the prediction of future behaviour and near-future events based on a probabilistic approach of vessel attributes, trajectory prediction. Mission Planning based on predictive analysis.
TRL (7-8)	User Application: Identity and Access management services providing toolkit the capability to identify (authentication) and grant and access privileges (authorization) to all users, systems and devices connecting to MARISA. WEB presentation tools for the user interaction and the visualization of all available information on MSA available in the system and resulting from data fusion, ad-hoc reporting and advanced analytics processes. User refinement (JDL level 4) allows the user to interact with the data fusion services (human-in-the-loop). In end, the MARISA Toolkit prototype will have been demonstrated in Operational Environment

Table 19: MARISA Agreements of Technological Readiness Levels (TRLs) in MARISA GA.

MARISA: An Aspects of Technological Readiness Level (TRL) Metrics	
TRLs	**Descriptions**
TRL (9)	**Actual system proven in operational environment**: Competitive manufacturing in the case of key enabling technologies or in space | last mile research | high-value impacts | action research | field study | dissemination strategy | realisation of service-value proposition canvas.
TRL (8)	**System complete and qualified**: Networking and integration services | infrastructure providing a framework for dealing with data having characteristics such as variety, volume, velocity and complexity | components and modules with the right capabilities to quickly and concurrently access and process data in the storage | external data sources and legacy systems functions.
TRL (7)	**System prototype demonstration in operational environment:** System functions and objects | multilingual information | entities, relations, temporal and spatial parameters | contextual information | system-to-system interfaces | communication measures | external systems demonstration | authorisation issues | operational validation | identity and access management.
TRL (6)	**Technology demonstrated in relevant environment:** Industrially-relevant environment in the case of key enabling technologies | adapters and gateways for the integration | user refinement technology | field study | feasibility study | design science research.
TRL (5)	**Technology validated in relevant environment:** Industrially-relevant environment in the case of key enabling technologies | the basic technological components are integrated so they can be tested in a simulated environment | supporting elements in a simulated operational environment | pre-operational technological artifacts | design science research | development research | field study | feasibility study.
TRL (4)	**Technology validated in lab**: Following successful proof-of-concept work | components are integrated | test results and estimations of differences between validation and expected system goals | technological artifacts | laboratory accounting | development research.
TRL (3)	**Experimental proof-of-concept**: Laboratory tests | measure parameters | test environment | active R&D initiated | experimental critical functions | components availability and stability | technology transition | development research | scenario analysis | strategy analytic and canvas.
TRL (2)	**Technology concept formulated**: Application articulated | basic principles | design of artifacts: canvas, requirements | practical applications invented | publications or other references | analytic studies, PKIs defined | analysis to support the concept | case study analysis | design science research | development research | canvas.
TRL (1)	**Basic principles observed**: Applied research and development | studies of a technology's basic properties | scenarios and proactive studies | case study analysis | capabilities: studies of a technology's basic properties | scientific research begins to be translated into applied R&D | co-creation drivers | idea alignments | proposals | definition of trial scopes.

Table 20: MARISA An Aspects of Technological Readiness Levels (TRLs).

5. User Community Reflections and Recommendations

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MARISA User Community have open call for issues, opinions and recommendations in the form of manuscript and publishing themes as part of MARISA deliverable (D2.1 and D2.8). The User Community discussion document collection in MARISA addresses to the open category that provides a forum for the communication of well-articulated position statements concerning emerging, paradoxical, or even controversial development and research issues for progress of current MARISA capability development and further artificial continuums. The Issues and Opinions submissions channel should open new areas of discourse in MARISA project, close stale areas, and offer fresh views and recommendations on development-research topics of importance in the project and its continuums. The topic should identify the issues in terms and forms that are "as easy as" possible to understand and provide appropriate conceptual frameworks for the issue offer opinions and supportive arguments describe the suggestions of these opinions to the MARISA capability-service development and research, practice, or teaching to be supported, where appropriate, by empirical evidence. The themes are open and in end of document there are some examples of useful subjects discussed in MARISA interactions.

5.1. Pattern of Life

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The ability of Maritime Situational Awareness (MSA) to generate effective information superiority is essentially dependent on two factors: (1) technological capability and (2) an appropriate background and breadth of knowledge of the maritime environment that is not limited to the military navies but extends to all merchant traffic, fishing boats and pleasure boats at sea or in relation to it. While the first factor is a function of the development of technological systems implemented at the national, European or multinational organisational levels in order to meet specific operational requirements, the knowledge factor is a collection of several mutual aspects related to maritime surveillance, among which the Pattern-of-Life (PoL) concept is considered a pillar.

A Pattern-of-Life (PoL) can be defined here as a set of usual or recurrent behaviours that, as such, can be foreseen in consideration of factors associated with various sectors, such as political, economic, social, technological, environmental, legal, safety and security, which influence the behaviours and the activities in a given area (not necessarily and not only geographical). As an example, we can mention the standard routes followed by containers or oil tankers, the maritime flows related to the immigration phenomena, i.e. the increase of migrant transit routes due to socio-political phenomena and their relative intensity in relation to seasonal and climatic conditions, piracy events, embargo operations, etc. Likewise, a PoL considers fishing areas, the areas dedicated to maritime natural reserves, the access routes to the ports and the maritime lines of separation of traffic in areas with high traffic density, such as straights, channels, choke points and canals. The above puts into perspective the necessity for systems and software innovations for command and control and maritime surveillance.

In short, an approach to Maritime Situational Awareness (MSA) that is restricted to operations and/or only areas of operations is strategically limited to the extent that it does not take into account what happens outside of them. Hence, we need to develop knowledge of Patterns of Life and all of the different algorithms associated

with them in order to exploit all the sources (in real-time, near real-time and the information available in the 'historical' archives). An example are those that pertain to a single contact of interest and on the events that interested the individual in the past and on all the associated elements that distinguish him/her or are related in some way.

In synthesis, it is necessary to develop knowledge of the PoL, which are activities that occur with cyclic repetitiveness, the knowledge of which allows for predicting, locating, recognising and identifying any anomalies relevant to the building of a reliable Recognised Maritime Picture (RMP), the pillar of information superiority. 'Pattern-of-life analysis' is a method of surveillance specifically used for documenting or understanding a subject's or many subjects' habits. The subject being observed can then potentially use this information to predict future actions. This form of observation can, and is, generally done without the consent of the subject, with motives including but not limited to security, profit, scientific research, regular censuses, and traffic analysis. Unlike these specific areas of surveillance, pattern-of-life analysis is not limited to one medium and can encompass anything in an individual's (or system of individuals') life from their internet browsing habits, to a record of instances of choices made in order to determine a statistical favourite.'

5.2. Patterns of Life in MARISA

Nicola Forti

Recently developed satellite and terrestrial networks of cooperative self-reporting ship location systems, such as the Automatic Identification System (AIS), provide ever-increasing volumes of maritime traffic data that can be used to enhance the general awareness of vessel pattern-of-life activities in both coastal and open waters.

The H2020-EU Project MARISA aims to build on the huge opportunity that comes from the availability of the large amounts of data for maritime surveillance in order to automatically extract and improve knowledge of the maritime situational picture, as well as provide a usable characterization of vessels and their typical movements. In the context of H2020-EU Project MARISA, different tools for patterns of life extraction have been developed and applied to real-world operational trials by NATO-STO CMRE. In particular, CMRE is involved to provide Density Maps, Ship Prediction, and Ship Routes services.

The Density Map service provides the historical intensity of maritime traffic in a given area and during a time interval of interest, computed as the total number of ships whose positions fall within a footprint grid. Maps can be arranged by season and traffic category, in order to selectively highlight relevant traffic patterns. Traffic density maps are effective means of visualization of vessel movement patterns and significantly contribute to a better understanding of the maritime situational and operational picture, as they can highlight the presence of main shipping lanes, congested areas, or recurrent patterns for specific categories of traffic.

While density maps are directly generated from the available raw AIS data, the Ship Routes service is designed to process data, such as to extract, in an unsupervised fashion, maritime patterns of life as statistically similar clusters of historical ship tracks. AIS-based ship trajectories are reduced into clusters of waypoints and navigational legs. This makes it possible to extract a compact, low-dimensional model of maritime traffic from historical AIS data where waypoints nodes and navigational legs are represented as geo-referenced vector entities characterized by different attributes and statistics that can be directly extrapolated or computed from the available AIS. The above attributes may include waypoint identifier, distribution of type, geographical location, traffic data category, statistics about the inward/outward speed of ships, and number of vessels that passed through the waypoint.

Finally, the Ship Prediction service enables to accurately predict future positions of a vessel based on its AIS track. This service utilizes a novel statistical formulation of ship motion model in order to maintain the uncertainty of the prediction at acceptable levels as the prediction time increases. This prediction service estimates future positions of vessels with an uncertainty that is order of magnitudes lower than that of conventional motion models commonly applied in target tracking applications. The ability to accurately predict future vessel positions is important to operators to have a realistic understanding of the future evolution of ship trajectories within hours from their last observation. The service can be also used retroactively to reduce the correlation uncertainty of heterogeneous and strongly asynchronous ship detections, such as those provided by AIS and SAR.

5.3. Smart Maritime Surveillance

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ABSTRACT: Followed recomendations viewpoints addresses to new initiatives encompassing the high-value potential of maritime security and the next continuums to the European Common Information Sharing Environment (EUCISE) research, development and innovation action (R&D&IA) paths. The current situation of the development efforts achieved thus far in Europe's maritime and digital domains and existing calls for proposals for the implementation of European Commission (EC) maritime policy and documentation for the European Organisation for Security (EOS) are considered. The focus of this Maritime Integrated Surveillance Awareness (MARISA; Laurea) deliverable article is on reasoning and future progress as endorsements to common information sharing environment (CISE) continuums and the proposed concept entitled 'the smart mare', which here first addresses smart maritime surveillance and the transformation of marine and maritime data for: (1) safety and security services, (2) methodology development, (3) collective knowledge building, (4) economical high-value-returns and (5) expected growth in the maritime domain.

In this recomentation document, key aspects of SMART MARITIME SURVEILLANCE for approval of the concept are addressed first as follows: (1) sharing a common understanding of innovation potential, and a more widely accepted understanding and the expression of common innovation and standardisation needs among practitioners towards the same discipline in the maritime user community; (2) a more articulated and coordinated uptake for innovative solutions among practitioners from parallel disciplines, who are often called upon to act together to face major crises; (3) more attractive and novel investments across Europe in demonstration, testing, and training facilities for first responders; (4) synergies and harmonisation with already established European, national and sub-national networks of practitioners, even if these networks are currently only dedicated to aspects of practitioners' work unrelated to research and innovation (in general, to the coordination of operations); and (5) improved and professionalised National Country Point (NCP) services, consistent across Europe, thereby helping to simplify access to current and future EC-based funding calls, decreasing the entry barriers for newcomers and raising the average quality of submitted proposals.

PARTICIPATOR: Security is one of the strategic research, development and innovation action (R&D&IA) domains at Laurea University of Applied Sciences (a Maritime Integrated Surveillance Awareness [MARISA] participator) that utilises its expertise in security research and innovation projects to exploit relevant project outcomes. In the MARISA project, Laurea activates the outcomes of technological and scientific results according to all MARISA work packages and employs these results, such as: (1) the continuum of research papers, (2) recommendations, (3) security metrics, (4) the teaching of bachelor's and master's studies in security management, and (5) using the results for further security-safety research in (6) doctoral university networks and (7) post-doctoral studies. The Laurea network and stakeholders include: search-and-rescue end-

user organisations that participated in MARISA; local, regional, national and European policy and regulation decision makers in the field of search-and-rescue-information society, social and public sector innovation and regional development; development companies and service providers (both large and small companies or even start-ups) interested in new business continuums based on MARISA data fusion solutions; and citizens in general to increase their awareness about accessing the new services and to raise their consciousness about the possibility of creating personalised data fusion-based services. Several impacts have been established thus far and, among others, include: (1) educating and raising awareness by revising curriculums and syllabuses; (2) competent and skilled researchers for security-safety development and learning; (3) the dissemination of data fusion for the health and well-being sector; (4) living by an improved body of knowledge and the fusion of sources of knowledge; and (5) management and leadership models, especially in the domain of search-and-rescue.

REASONING: The EU maritime common information sharing environment (CISE) is an information technology solution for organisations from different sectors in member states to exchange relevant information using their own legacy surveillance systems. It is well known that organisations often miss and have duplicated information, which hinders their performance. Therefore, to overcome this lack of information, organisations often invest in new sensors and other means to acquire it. However, if that information is already being collected by another organisation, then those resources are not being used efficiently. Moreover, when different organisations collect the same data through parallel processes, this can result in inconsistent information, which may lead to poor decisions and coordination.

Consequently, it is understandable that the best option for organisations is to exchange information among themselves. Organisations in Europe related to the maritime domain are quite heterogeneous. Even if they primarily belong to the same sector, e.g. defence, they usually act in other sectors, e.g. search and rescue and fisheries control as well; hence. their missions, tasks and organisation vary significantly. Their operational processes, which are optimised to their reality, are also quite different. To support these processes, organisations have been developing customised computer applications throughout time, which, if replaced by more generic solutions, will cause losses in efficiency and effectiveness. For many years, organisations lacked information for decision-making.

After the introduction of information technology, we (maritime stakeholders) have the opposing paradigm: our information has become overwhelming, and it is now quite common to find various service-oriented and agnostic services supporting different processes of an organisation. It is recognised that such a strategy is a mistake that hinders decision-making that requires information from different processes. Therefore, to support these processes, a single situational figure for each purpose that integrates different information sources is preferred and recommended.

Ultimately, an option could be to develop the ‘application of the applications’; that is, an application so complete that it would seamlessly implement all requirements from all organisations, thus replacing the existing applications without provoking any loss of efficiency and effectiveness. It is quite clear that this approach is utopic, especially if we consider that in Europe there are over 400 different public organisations involved with the maritime domain.

According to CISE, the best option for organisations is often to keep using their own applications, enhanced with the capability to share information with applications from other organisations as required, which is already implicated by the impact assessment of CISE. The EU maritime CISE is therefore an add-on to the applications of organisations that wish to exchange information among themselves in a seamless and cost-effective way. The CISE is relatively domain agnostic; hence, independent from each specific sector and common. That is, it is shared and dependent on the consensus of all organisations involved. The CISE is also technology agnostic;

that is, it is grounded on open standards and components, and it is voluntary, meaning that public organisations are not obliged to use it. Nonetheless, the business case for any cross-sectorial information exchange initiative should favour, in principle, a CISE-like approach.

It is noteworthy that the CISE is not meant to replace any legacy and existing application because it is unique, and it is not an application per se. In fact, several rival initiatives related to the maritime domain exist in Europe that may resemble the CISE but are quite different. Their greatest difficulty is that they are either not cross-sectorial or not domain agnostic. In general, the CISE aims to make maritime surveillance cheaper and more effective by decreasing costs, eliminating gaps in information and improving operational and business processes. The cost for an organisation to obtain information from another organisation through the CISE should be much lower than developing their own capabilities, e.g. radar systems, to acquire it. Inconsistent information often introduces errors and misunderstandings, which hamper the business processes and may have costly consequences, e.g. engaging a helicopter in a mission triggered by a false alarm, which are usually higher than the cost of exchanging information through the CISE and with other organisations.

It is understood that the most cost-effective approach for integrating information systems is by using common semantics and technology. This becomes even more evident as the number of organisations involved increases, and this is the reason why the CISE takes this approach. Therefore, adopting the CISE (at least the adapted instance of the CISE) should be cheaper than other alternatives for exchanging information. As a truly comprehensive cross-sectorial and cross-border maritime information exchange system, the CISE contributes to European maritime safety and security, pollution prevention and response, customs management, border control, law enforcement, fisheries control and defence, and data sources for resilient and transparent decision-making. In fact, its common and collaborative nature is an important contribution to strengthen the collaboration and cooperation of such diverse organisations throughout Europe.

The CISE genesis is in the EU's integrated maritime policy. By supporting integrated maritime surveillance, one of its pillars, the CISE has been developed with the objectives of supporting the creation of the basic conditions of human activities at sea, helping to determine human pressures in the marine environment and supporting maritime spatial planning. All this can be much better accomplished if the organisations involved share the relevant information among themselves in a cost-effective way, that is, through the CISE. However, the CISE also contributes to Europe's maritime policy strategy 2020 (EUCISE2020) by fostering the creation of jobs and growth related to the maritime domain. This happens indirectly by contributing to blue growth and directly by initiating new IT business opportunities and jobs. We should not forget that the CISE will be a solution as a service distributed throughout Europe among many organisations. Hence, it must be maintained and its users supported. Moreover, the information newly available through the CISE will trigger new ideas, which, in turn, will foster the development of new technologies, which, in turn, will also have to be maintained and supported.

What have we achieved thus far? Currently, and after the different pilot projects (MARSUNO, BMM, CoopP) and now the EUCISE2020, there is a sound cross-sectorial Pan-European community of maritime practitioners and services, i.e., MARISA data fusion. Additionally, common technology and standards have been developed collaboratively by the members of this community over the past years, which are now being tested, and by the time the EUCISE2020 is over, it will become necessary to expand and support their wide utilisation to finally start achieving the benefits expected from the CISE (between €1.6 billion and €4.2 billion over 10 years). In fact, so far only the first (perhaps the toughest) step has been accomplished in terms of the development of tools. Now it is time to put them into service, so that maritime surveillance in Europe can become cheaper and more effective, and to support the development of Europe's smart, sustainable and inclusive growth. However, these are not easy tasks because information exchange among organisations must be increased, and the CISE

must support the creation of jobs and sustainable development. In the following are our recommendations for CISE operations that can be addressed after EUCISE2020.

RECOMMENDATION: Towards reliable and audited CISE: The CISE is based first and foremost on the trust and confidence among the authorities involved in maritime surveillance. As much as this is a question of culture and a shared perspective of operational procedures, the chosen technology must also enable the sharing of validated and clean data and confidential information. It must be ensured that the technical solution developed in the EUCISE2020 is thoroughly security audited and operative validated from end-to-end and information security aspects are fully covered. Even if recent developments on open interfaces have led to a situation where information on maritime surveillance could be exploited through direct customised interfaces, the CISE would also bring high value to sharing open and unclassified information by revealing potentially useful information services. However, it would be most advantageous to put most efforts into further CISE development to ensure the sharing of classified and confidential information and operative validation. The technical maintenance and development of the CISE should be designated to an EU agency in the field of communication and information technology or as a part of the Tripartite Working Arrangement of coast guard-related agencies (FRONTEX, EFCA, EMSA). New technologies, such as the block chain technology, for certificate and access right management should be researched and developed.

RECOMMENDATION: Several H2020 coordination and support actions (CSA) have recently addressed the association between practitioners (end-users) and user communities from different geographic areas. The practitioners are expected to be from different disciplines and concerned with current or future security or disaster risks and crisis management issues in a specific geographic area, and to monitor research and innovation projects with a view to recommending the uptake or the industrialisation of results. Moreover, they are expected to express common requirements about innovations that could fill in capability and other gaps and improve their performance in the future. They are expected to indicate priorities about common capabilities or interfaces among capabilities, requiring more standardisation. Considering the present situation of the CISE, the known developments in Europe's maritime and digital domains, and existing calls for proposals (EC maritime policy implementation), the new European Organisation for Security (EOS) initiative is a good opportunity to support maritime security and the next continuums of the CISE.

5.4. Maritime Artic / Nordic Collaboration

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ABSTRACT: This MARISA opinion article addresses the ARCTIC, including NORDIC maritime security practitioners: the Arctic Coast Guard Forum (ACGF) and its current and future cooperation and collaboration needs, and future anticipation-experimentation-implementation viewpoints, especially in the domains of: (1) information sharing, (2) content management, and (3) data-information fusion. The focus is on the secure and scalable information sharing and data-content management and data-information fusion needs of both Arctic maritime security authorities, such as coast and border guards, and academic actors. The reasoning: the Arctic maritime authorities and academic actors request strengthening and increasing their cooperation and improving the Arctic-user community's information sharing and data management and fusion in the future. This is because it has been acknowledged that academic actors have delivered an abundance of research results that support authorities to enhance their activities, including: (1) exercising evaluations, analysing best practices and recognising gaps in daily operational practices, using cases and Arctic-domain related requirements; (2) actualising new tools for strategy-operation-tactic designs and working to enhance information sharing and delivery; (3) adopting-adapting data fusion services and enhanced methods to analyse current and emergent

data sources; and (4) utilising secure data and information content on daily operative-tactic work as well as its design and research, development and innovation action (R&D&IA).

First, the article considers what the main information sharing and data fusion areas are that Arctic maritime security practitioners can enhance; second, the article ponders if a new and improved platform could respond to the content-information and trust-sharing issues as well as the data fusion needs to provide a robust and flexible base. The focus is on: (1) content management functionalities that can support the growing volume of information that is required for daily operative-tactic work and critical decisions; (2) a secure and scalable foundation designed to address data and information management; and (3) collective and actors' workflow requirements for the Arctic actors. Concerning future Arctic maritime security authorities' collaborations and users' needs in information sharing and data fusion, here LAU efforts focus especially on the viewpoints and requirements presented by the Arctic Coast Guard Forum (ACGF) and Nordic security authorities because they are the main Arctic maritime actors in the Arctic and North Atlantic Security and Emergency Preparedness Network Project (ARCSAR) and MARISA. In addition, this effort addresses the cooperative work, which serves as a bridge between the CoopP-CISE-MARISA-ARCSAR projects, and is included in the documented part of MARISA D2.1 and D2.8.

The amount of information available to Arctic maritime security authorities and other practitioners is increasing dramatically. Finding and managing the relevant information from various websites and platforms is time consuming and challenging. Therefore, Arctic maritime security authorities and other practitioners have announced the need for an information sharing platform that could help sort the large amount of existing information that is relevant and useful to Arctic maritime security practitioners in one common place. The aim of the new, future information sharing platform is to give its users added value for their daily work according to their interests and preferences. However, because many different platforms and portals already exist for Arctic maritime security practitioners for their daily use, such as the CISE, BarentsWatch, Arctic ERMA and EPPR, the new future information sharing platform should provide additional benefits. Still, the new platform should not rule out those existing and agnostic platforms that meet and fulfil the needs of the users already (at least at some level). This means that a platform-of-platforms is needed, a so-called one-stop-shop platform for Arctic maritime practitioners. This would ease their cooperation and collaboration because all the needed information would be easily found and safely monitored via a platform that all stakeholders can use.

Arctic maritime security authorities have indicated an overall need to have a platform that serves two different purposes. First, a common, operational information sharing platform is needed where various practitioners can find information on resource assets, incident reports, point of contacts, and sharing other information to support practitioners' daily work. Second, it should act as an information exchange portal for managing reports and documents, procedures, lessons learned, guidelines and other documents in one common place. In short, the content of the platform should serve at least the following six acknowledged thematic focus areas for Arctic maritime practitioners to enhance their collaboration: (1) information on Rescue Coordination Centres (RCC) and point of contacts (POC); (2) information for operational purposes, including an overview of available resources, information contributing to the situational picture, meteorological data, traffic and procedures; (3) information sharing on guidelines, reports, gap analysis, risk assessments, experiences and lessons learned, articles, relevant projects, and news and new topics relevant for search and rescue (SAR) and safety monitoring; (4) information or links to relevant projects, other portals, forums and authorities; (5) information on national requirements for education and training; and (6) information on innovations that might enhance existing procedures or methods.

Even though the functionalities of the new extended information sharing platform for Arctic maritime security practitioners have been acknowledged, identifying whom and how the platform can be established and hosted

among the Arctic maritime security practitioners is still a challenge. One suggestion is that the platform would be linked as a new platform to one or many existing platforms, e.g. the CISE or BarentsWatch. This would be a cost-effective solution as these platforms already exist, are funded and are maintained continuously. However, if the new functionalities are added to existing platforms, one challenge will be getting permission for new users, especially academic actors, to use the existing platforms, which often only allow authorities to access and use the information. Another challenge will be attracting new users to use the existing platform, since it might continue to carry its earlier image of serving only a certain type of users or nationalities.

Therefore, perhaps the most practical idea is to establish a new information sharing platform that works as a one-stop shop and includes or collects information or links from existing platforms used by Arctic maritime security practitioners. Furthermore, the costs of establishing and maintaining the new platform could be covered by the ministries in each Arctic country, which would simultaneously support and guide, perhaps even force, more stakeholders in Arctic countries to benefit from the extended information sharing platform (a platform-of-platforms). Even if this could be arranged, the key concern is still to ensure that Arctic maritime security practitioners are engaged in using the new information sharing platform so it claims its usefulness.

REMARKS: A novel viewpoint of the one-stop-shop platform and the reasoning behind it is that it would sort many types of information into categories from various databases, and this information could include, for example, strategic and operational-tactic information relevant to Arctic emergency responses in various data categories, such as international, regional and national manuals, procedures and best practices, research reports, risk analyses and assessments, news, innovations and technology, training and education, projects, and other relevant categories. These thematic information areas, i.e. meta data, could, in turn, be linked and divided into various topics, such as maritime environment, meteorological data, traffic, exercises, resources/assets and other similar sub-topics. Hence, the goal is to establish a platform that can link various open-source databases into one information awareness picture (a platform-of-platforms). Additionally, users of the platform could filter/subscribe to the content that interests them most, and this would bring added value in terms of everyone's expertise and interests as well as finding information in one place. Best of all, the platform awareness picture could link the same level of experts together to share relevant information and discuss best practices.

5.5. Study of Maritime Standards and Guidelines

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Modern technological developments make it possible to design novel and fascinating solutions and services. However, quite frequently, the possible benefits and functionalities come before safety and security issues. This marked phenomenon covers whole human communities, making our environment vulnerable, especially if needed safeguards are not properly implemented. In the maritime environment, traditional safety and recovery aspects are covered quite well, but cybersecurity aspects are still somewhat outside the scope of enlargement. However, new innovations, such as autonomous watercrafts, will be a reality sooner than we expect, and it could be an interesting landscape for hackers and undesirable events. The primary purpose of this study is to review existing maritime standards as well as white papers and guidelines, and to describe a situational picture of how cybersecurity is covered in the maritime environment. It has been found that the coverage of cybersecurity issues in existing standards is either very limited or non-existent. Currently, the reviewed white papers and guidelines offer a better view of cybersecurity compared to the standards, with only two of the latter found to be feasible and applicable in the real maritime operative environment. For the future,

it is evident that more efforts, research and contributions are needed for standardisation and continuum in the management domain.

This study briefly reviewed almost 480 individual CEN CENELEC, European Telecommunications Standards Institute (ETSI), International Maritime Organization (IMO) and International Organization for Standardization (ISO) Technical Committee 8 (TC8) maritime-related standards with the information systems security (ISS) framework. Additionally, over 30 whitepapers and guidelines were reviewed. It was found that the cybersecurity guidelines issued by the Institution of Engineering and Technology (IET) for ports and ships offer the best available framework (until now) for mitigating cybersecurity risks in the maritime environment. Both guidelines have a holistic socio-technical approach, and they refer to many information security standards, e.g. ISO/IEC 27000 series, IEC, NIST and COBIT 5. The content and coverage should be verified against common information security checklists, guidelines and standards; the reviewed standards addressed individual safeguards. The standard EN 61162 covers Ethernet interconnection safety and security for maritime navigation and radio communication equipment and systems. The IMO offers seven documents that cover fire protection, maritime cyber risk management and the human element. ISO/TC8 has 13 standards that include standardising ship communications networks, fire suppression and port-related security issues. Additionally, the ISO/TC8 Working group is developing a standard for maritime security. Lastly, ETSI does not offer any standard that falls under the cybersecurity umbrella.

Acronyms	
ABS	American Bureau of Shipping
CIA	Confidentiality, Integrity and Availability
DNV GL	Global quality assurance and risk management company
ENISA	The European Union Agency for Network and Information Security
ETSI	The European Telecommunications Standards Institute
HF	High Frequency
IET	The Institution of Engineering and Technology
IHS Markit	Analysis and guidance service provider
IMO	International Maritime Organization
INMARSAT	Mobile satellite communications service provider
International Chamber of Shipping	Principal global trade association for ship-owners and operators
INTERTANKO	International Association of Independent Tanker Owners
ISS	Information Systems Security
JWC International	Global training, consulting and special projects group
Lloyd’s Register	Professional service provider for engineering and technology
Marsh	Insurance broking and risk management company
MF	Medium frequency

Acronyms	
NCCGROUP	Cybersecurity and risk mitigation company
NORTH	Marine mutual liability insurer company
Safety4Sea	PRO BONO project fostering Safety Excellence and Sustainable Shipping
TRANSAS	Ship and fleet operations solution provider, including professional training and simulation
VHF	Very high frequency

Table 21: Acronyms Frequently Used in the Maritime Standards and Guideline.

RESEARCH FRAMEWORK: Currently, many options are available for implementing information security in an organisation or in a company. The most traditional approach is to use the confidentiality, integrity and availability (CIA) model where the data is protected against recognised threats. However, the CIA model has been criticised for being too narrow, and it is not capable of recognising the needs of applications, e.g. data sharing and data interpretation (see the reference 'Information System Security Management in the New Millennium', Dhillon & Backhouse, 2000). Another but less familiar dimension is in the organisational role of information systems security. The organisational role of an information system has three views: (1) technical, (2) social and (3) socio-technical; the reference was originally used in 'Analyzing Information Systems Development: A Comparison and Analysis of Eight IS Development Approaches' (Iivari & Hirschheim, 1996). The technical view only concentrates on technical safeguards, but it misses the view from the end-user aspect. The social view sees technical platforms as enablers for communication and interactions. The third one, the socio-technical view, integrates the technical and social views in the design phase, but it can lead to compromised solutions. Many well-recognised information systems security models have combined previously mentioned models, i.e. the CIA model and organisational view. According to Siponen (2005), five classes of traditional information systems security methods have been recognised: (1) checklists, (2) ISS standards, (3) ISS maturity criteria, (4) risk management and (5) formal methods.

Information Systems Security Methods (ISS)	
Checklists	Checklists contain a collection of recommended safeguards or best practices, but they do not sufficiently recognise organisational needs. Checklists are usually general guidelines with technical views.
Standards	Standards are usually based on industry best practices, and they can be technical or socio-technical. Basically, they are wider and broader than checklists, and accreditation is possible. They also provide information security management systems.
Maturity criteria	Maturity criteria help an organisation or a company to improve the quality and availability of information systems. The process is continuous, and there are different levels to assess information systems security, e.g. five levels. The maturity criteria are based on a checklist approach with levelling criteria. Maturity criteria can be technical or socio-technical.
Risk management	Risk management divides the protectable system into small fragments (assets) and defines needed safeguards based on risk analysis. Risk management is a continuous process, and it helps an organisation or a company protect their most valuable assets. The risk management process is usually integrated with a standard and benefits from checklists.

Information Systems Security Methods (ISS)	
Formal methods	Formal methods aim to develop an abstract model of an information system. A formal method models the solution before a solution is put in place.

Table 22: Information Systems Security Methods (interpreted according to Siponen, 2005).

STANDARDS AND GUIDELINES: Existing maritime standard structures rely on traditional divisions where standardised items are categorised by need and purpose. For example, there can be categories for maritime safety, piping & machinery and ship design, but cybersecurity is not covered with a systematic approach. In this approach, a proposal is that cybersecurity should be an integral part of the design and implementation, and it should cover every aspect of a system or a solution. This part analyses how selected standards cover information systems security. The analysis summarises the following standards: (1) CEN CENELEC, (2) ETSI maritime-related standards, (3) IMO and (4) ISO/TC8.

CEN CENELEC					
Safeguard/ Guideline	**ISS Checklist**	**ISS Standard**	**ISS Maturity**	**ISS Risk Management**	**ISS Formal Methods**
1	0	0	0	0	0
Standard	**Description**				**ISS Relevancy**
EN 61162-460:2015	Maritime navigation and radio communication equipment and systems: Digital interfaces (Part 460), Multiple talkers and multiple listeners, Safety and security and Ethernet interconnection.				Safeguard Guideline

Table 23: CEN CENELEC Standards.

Summary tables describe the CEN CENELEC European standards (EN-series) concentration on maritime navigation, radio communication and safety systems. Among 50 standards, one (EN 61162) was found that can be interpreted as reasonable for cybersecurity safeguard.

ETSI delivers 20 standards for maritime radio communication. The standardisation covers transmitters and receivers in medium frequency (MF), high frequency (HF) and very high frequency (VHF) radio bands. No standard was found that covers cybersecurity.

The European Telecommunications Standards Institute (ETSI)					
Safeguard/ Guideline	**ISS Checklist**	**ISS Standard**	**ISS Maturity**	**ISS Risk Management**	**ISS Formal Methods**
0	0	0	0	0	0
Standard	**Description**			**ISS Relevancy**	
0	N/A			N/A	

Table 24: The European Telecommunications Standards Institute.

The IMO offers over 80 titles, including maritime safety, security, environment, legal affairs, human element, facilitation, technology, support and communication. Seven documents were found that fall under the cybersecurity umbrella. The documents cover fire protection, maritime cyber risk management and the human element.

International Maritime Organization (IMO)					
Safeguard/ Guideline	**ISS Checklist**	**ISS Standard**	**ISS Maturity**	**ISS Risk Management**	**ISS Formal Methods**
7	0	0	0	0	0
Standard	**Description**			**ISS Relevancy**	
SOLAS Amendments 2000	Fire protection.			Safeguard/Guideline	
FSS Code 2001	Fire Safety Systems.			Safeguard/Guideline	
FTP Code 1998	Fire Test Procedures.			Safeguard/Guideline	
MSC-FAL. 1/Circ.3	Guidelines on Maritime Cyber Risk Management.			Safeguard/Guideline	
Resolution A.947(23)	Human element; Vision, Principles and Goals.			Safeguard/Guideline	
Resolution A.647(16)	Human element; Safety Management.			Safeguard/Guideline	
STCW	Human element; Training and Certification.			Safeguard/Guideline	

Table 25: International Maritime Organization ISS Standards.

ISO has TC8 for ships and marine technology. ISO/TC8 has published 327 standards and 123 standards are under development. ISO/TC8 covers maritime safety, marine environment protection, piping and machinery, outfitting and deck machinery, navigation and ship operations, inland navigation vessels, ship design, intermodal and short sea shipping, and ships and marine technology. The standards that cover cybersecurity (*n* = 13 standards) include standardisation for ship communications networks, fire suppression and port-related security issues. The ISO/TC8 Working group is developing the standard for maritime security.

International Organization for Standardization Technical Committee 8 (ISO/TC8)					
Safeguard/ Guideline	**ISS Checklist**	**ISS Standard**	**ISS Maturity**	**ISS Risk Management**	**ISS Formal Methods**

International Organization for Standardization Technical Committee 8 (ISO/TC8)					
13	0	0	0	1	0
Standard	**Description**				**ISS Relevancy**
ISO 16425:2013	Ships and marine technology – Guidelines for the installation of ship communication networks for shipboard equipment and systems.				Safeguard/Guideline
ISO 3935:1977	Shipbuilding – Inland navigation – Fire-fighting water system – Pressures.				Safeguard/Guideline
ISO 15371:2015	Ships and marine technology – Fire-extinguishing systems for protection of galley cooking equipment.				Safeguard/Guideline
ISO 22488:2011	Ships and marine technology – Shipboard fire-fighters' outfits (protective clothing, gloves, boots and helmet).				Safeguard/Guideline
ISO 3935:1977	Shipbuilding – Inland navigation – Fire-fighting water system – Pressures.				Safeguard/Guideline
ISO 15371:2015	Ships and marine technology – Fire-extinguishing systems for protection of galley cooking equipment.				Safeguard/Guideline
ISO 17338:2009	Ships and marine technology – Drawings for fire protection – Indications of fire rating by divisions for ships and high-speed craft.				Safeguard/Guideline
ISO 17631:2002	Ships and marine technology – Shipboard plans for fire protection, life-saving appliances and means of escape.				Safeguard/Guideline
ISO 22488:2011	Ships and marine technology – Shipboard fire-fighters' outfits (protective clothing, gloves, boots and helmet).				Safeguard/Guideline
ISO 20858:2007	Ships and marine technology – Maritime port facility security assessments and security plan development.				ISS Risk Management
ISO 28005-1:2013	Security management systems for the supply chain – Electronic port clearance (EPC) – Part 1: Message structures.				Safeguard/Guideline
ISO 28005-2:2011	Security management systems for the supply chain – Electronic port clearance (EPC) – Part 2: Core data elements.				Safeguard/Guideline
ISO/AWI 21745	Electronic record books for ships – Technical specifications and operational requirements.				Safeguard/Guideline
ISO/CD 28005-2	Security management systems for the supply chain – Electronic port clearance (EPC) – Part 2: Core data elements.				Safeguard/Guideline

Table 26: ISO/TC8 ISS Standards.

For the development of standards continuums, independent authorities and companies have released cybersecurity-related whitepapers and guidelines. The content of the reviewed (over 30) whitepapers and guidelines varies greatly, and they do not follow any common structure or framework. Many whitepapers concentrate on discussing general threat scenarios and risks in the maritime environment. However, two guidelines in the maritime context, released by The Institution of Engineering and Technology (IET), were deemed noteworthy: Code of Practice: Cyber Security for Ports and Code of Practice: Port Systems and Cyber Security for Ships.

Whitepapers and Guidelines					
Safeguard/ Guideline	**ISS Checklist**	**ISS Standard**	**ISS Maturity**	**ISS Risk Management**	**ISS Formal Methods**
28	0	0	0	2	0
Publisher	**Description**				**ISS Relevancy**
#becrypt	Protecting IP in the Oil, Gas & Minerals sector.				Guideline
ABS	ABS Cyber Security Principles to Marine & Offshore Operations.				Guideline
ABS	Cyber Security Implementation for the Marine & Offshore Industries.				Guideline
ABS	Data Integrity for Marine & Offshore Operations.				Guideline
Centre For Cyber Security	The cyber threat against the maritime sector.				Guideline
Transport, IET Standards	Code of Practice Cyber Security for Ships.				Guideline
DNV GL	DNV Cyber Recommended Practice (Ships & Mobile Offshore Units).				Guideline
ENISA	Cyber Security Aspects in the Maritime Sector.				Guideline
Global Security	Maritime Cyber Security White Paper Safeguarding data through increased awareness.				Guideline
IET	Code of Practice Cyber Security for Ports and Port Systems.				ISS Risks mgmt..
IET	Code of Practice Cyber Security for Ships.				ISS Risk mgmt.
IHS Markit	2016 cybersecurity survey.				Guideline

Whitepapers and Guidelines		
IMO	Guidelines on Maritime Cyber Risk Management.	Guideline
IMO	Guidelines on the Cybersecurity On-board Ships.	Guideline
INMARSAT	INMARSAT takes mature approach to maritime cybersecurity.	Guideline
International Chamber of Shipping	The Guidelines on Cyber Security On-board Ships.	Guideline
International Chamber of Shipping	Cyber Security On-board Ships.	Guideline
IACS	Green Book Of International Association of Classification Societies	Guideline
INTERTANKO	Social Media Guidance for Seafarers.	Guideline
JWC International	Cyber Security Offshore; The New Virtual Battlefield.	Guideline
Lloyd's Register	ShipRight procedure assignment for cyber descriptive notes for autonomous & remote access ships.	Guideline
Lloyd's Register	Deploying information and communications technology in shipping – Lloyd's Register's approach to assurance.	Guideline
Marsh	The Risk of Cyber-Attack to the Maritime Sector.	Guideline
NCCGROUP	Maritime Cyber Security.	Guideline
NORTH	Cyber Risks in Shipping.	Guideline
Safety4Sea	Online is quickly becoming the new frontline.	Guideline
Ship Management International	Hackers Wage Cyber War at Sea.	Guideline
The Nautical Institute	The lowdown on cybersecurity.	Guideline
The Nautical institute	Cyber Security – Cyber Hygiene and the use of ICT on board.	Guideline
TRANSAS	Connected Ships & Cyber Security.	Guideline

Table 27: Whitepapers and Guidelines (appropriate).

RECOMMENDATIONS: It is clear that the maritime industry does not have a focused and systematic approach for covering cybersecurity in the maritime environment. Legacy ISS standards and checklists could offer good starting points when they are applied systematically. The checklists are usable in well-known legacy environments, but they are unable to identify special needs. The checklists can be fulfilled with risk assessments when needed. The use of ISS maturity criteria should be considered carefully because they can create the so-called 'double standard phenomena', where the results are manipulated to look better than they are. Finally, formal methods could be usable when the system is designed from scratch and end-user requirements are carefully considered. Then, further research is recommended: the maritime environment should be modelled diligently and protectable assets should be found. A good starting point could be a more detailed review of existing practices in the maritime environment (literature review), an individual vessel (single case) study or a group of selected vessels (multiple case) study. An outcome of research could be the formation of a model of a vessel's protectable assets. In addition, differentiated legacy information systems could be protected with the legacy frameworks and maritime-specific information systems that need further analyses. The result will be a technology neutral logical model with European compliancy that recognises protectable assets and proposes needed baseline security controls.

REFERENCES: (1) Dhillon, G. and Backhouse, J. (2000). Technical Opinion: Information System Security Management in the New Millennium. ACM, 43(7), 125–128. (https://doi.org/10.1145/341852.341877); (2) Iivari, J. and Hirschheim, R. (1996). Analyzing Information Systems Development: A Comparison and Analysis of Eight IS Development Approaches. Information Systems, 21(7), 551–575; and (3) Siponen, M. (2005). Analysis of Modern IS Security Development Approaches: Towards the Next Generation of Social and Adaptable ISS Methods. Information and Organization, 15(4), 339–375. (https://doi.org/10.1016/j.infoandorg.2004.11.001).

5.6. Readiness Level Metrics

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According to the MARISA GA statement: 'the indicators (such as metrics) are fully refined and structured during the MARISA Project execution' [GA Part B, p. 5]. This expansive proposal of readiness measures addresses the contribution of the combined total maturity measures approach and the pre-operational validation of shared and adaptive information services and systems; the current design is described in Figure 1. The purpose of this proposal is to improve the manner in which actors and authorities across national borders conduct information system acceptance, operational validation, pre-order validation, risk assessment, the development of adaptive mechanisms and the integration of information systems and services. The main contribution of this proposal can be its validation of maturity of operative information systems regarding their technology, integration and resilience, including an examination of revised factors and descriptions of technical resilience. In addition to the validation of maturity, the proposal expands the revised compatibility of maturity levels by upgrading the earlier seven-layer model of Resilience Readiness Levels (ResRLs) to a nine-level model.

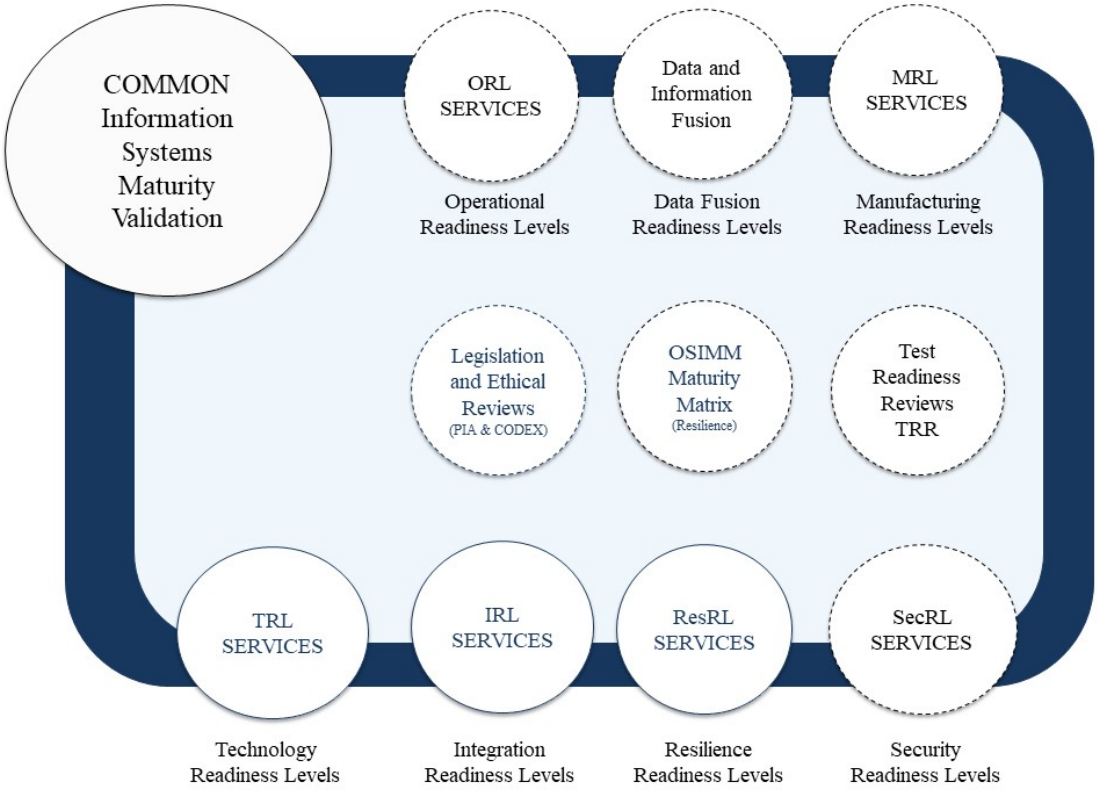

Figure 1: Common information systems maturity validation approach.

MARISA consists of the recommendations formulated to guide the examination of the ways in which the descriptions and definitions of existing Technology Readiness Levels (TRLs), Integration Readiness Levels (IRLs) and new ResRLs as well as their criteria, references and questionnaires can be employed to realise and validate the integration, communication and adaptive dynamic resilient functionalities in operative information systems and information sharing. MARISA addresses cases of operative maritime and data fusion systems, and focuses on the descriptions, factors, initiators and drivers of resilience readiness in order to contribute to future discussions and investigations about maturity validation processes and pre-validation processes with regard to research and innovation action funding by the European Commission H2020.

MARISA: Technological Readiness Level (TRL) Metrics [see analysis in GA Part B, p. 10]	
TRLs	**Descriptions**
TRL (9)	**Actual system proven in operational environment**: Competitive manufacturing in the case of key enabling technologies or in space | last mile research | high-value impacts | action research | field study | dissemination strategy | realisation of service-value proposition canvas.
TRL (8)	**System complete and qualified**: Networking and integration services | infrastructure providing a framework for dealing with data having characteristics such as variety, volume, velocity and complexity | components and modules with the right capabilities to quickly and concurrently access and process data in the storage | external data sources and legacy systems functions.
TRL (7)	**System prototype demonstration in operational environment:** System functions and objects | multilingual information | entities, relations, temporal and spatial parameters | contextual information | system-to-system interfaces | communication measures | external systems demonstration | authorisation issues | operational validation | identity and access management.
TRL (6)	**Technology demonstrated in relevant environment:** Industrially relevant environment in the case of key enabling technologies | adapters and gateways for the integration | user refinement technology | field study | feasibility study | design science research.
TRL (5)	**Technology validated in relevant environment:** Industrially relevant environment in the case of key enabling technologies | the basic technological components are integrated so they can be tested in a simulated environment | supporting elements in a simulated operational environment | pre-operational technological artefacts | design science research | development research | field study | feasibility study.
TRL (4)	**Technology validated in lab**: Following successful proof-of-concept work | components are integrated | test results and estimations of differences between validation and expected system goals | technological artefacts | laboratory accounting | development research.
TRL (3)	**Experimental proof-of-concept**: Laboratory tests | measure parameters | test environment | active R&D initiated | experimental critical functions | component availability and stability | technology transition | development research | scenario analysis | strategy analytics and canvas.
TRL (2)	**Technology concept formulated**: Application articulated | basic principles | design of artefacts | practical applications can be invented | publications or other references | limited to analytic studies | analysis to support the concept | case study analysis | design science research | development research | canvas.
TRL (1)	**Basic principles observed**: Applied research and development | studies of a technology's basic properties | scenario and proactive studies | case study analysis | studies of a technology's basic properties | scientific research begins to be translated into applied R&D | co-creation drivers | idea alignments | proposals | scope.

Table 28: MARISA Technological Readiness Levels (TRLs).

The first widely well-known model used to investigate the validation of TRLs, IRLs and ResRLs was described in the early literature on computer networks at the time the open system interconnection (OSI) model was developed. Here, the OSI model is embedded in the internal factors of TRLs, IRLs and ResRLs. Subsequently, the OSI model was used as the starting point in the development of maturity readiness levels. The OSI model has been widely used in computer networking to structure data transmitted on a network. The model allows for the integration of various technologies on the same network, networking themes and system approaches to computer networks. A reflective view of the technology readiness (TRLs) assessments theme was presented in a white paper and a subsequent retrospective description by NASA. In the continuum of TRLs–IRLs development, this development path was described as follows: 'it was necessary to develop an index that could indicate how integration occurs'. This index 'considered not only physical properties of integration, such as interfaces or standards, but also interaction, compatibility, reliability, quality, performance and consistent ontology when two pieces are being integrated'. Table 1 provides interpretations and descriptions of the TRL metrics and applied methodologies in the MARISA context. However, in a possible review, the following references may also be consulted: U.S. Department of Defense (DoD) TRL definition; NASA TRL definition;

European Space Agency (ESA) TRL definition; European Commission TRL definition; U.S. Department of Energy (DOE) TRL definition; and the definition of TRL in Wikipedia.

MARISA: New Proposal of Integration Readiness Level (IRL) Metrics	
IRLs	**Descriptions**
IRL (9)	**Integration is mission-proven through successful operations, e.g. harmonised operative and industrial realisations**. Integration of the information system and its sustainable maturity management is achieved; information system sharing and information sharing are realised.
IRL (8)	**Integration completed and mission qualified though tests and demonstrations**. Examples are test bed, living lab and final validation. Integration of service-based sharing level; integration of the information system is realised, implemented and described, and actor-specific services are activated.
IRL (7)	**The integration and technologies have been verified and validated with sufficient detail to be actionable.** Integration of communication and interaction; readiness for completing the information system integration is achieved and actor-specific services are validated.
IRL (6)	**The integration technologies can accept, translate and structure information for its intended application.** Readiness of technological functionalities for completing an integration is realised.
IRL (5)	**There is sufficient control among the technologies necessary to establish, manage and terminate the integration.** Integration process of management facilities is validated and implemented. Quality system for integration management is activated.
IRL (4)	**There is sufficient detail in the quality and assurance of the integration among technologies**. Readiness of technology for integration management functions is achieved.
IRL (3)	**There is compatibility among technologies for orderly and efficient integration and interaction, such as a common language.** Compatibility in the infrastructure, architecture level and ontology is achieved.
IRL (2)	**There is some level of specificity that characterises the interaction among technologies through their interface.** Infrastructure and architecture outlines are planned and agreed upon; integration of 'proof-of-concept' is activated.
IRL (1)	**An interface among technologies has been identified with sufficient detail to allow characterisation of the relationship.** Usefulness, scope and need for integration are understood, and the medium is described.

Table 29: Proposal of MARISA Integration Readiness Levels (IRLs).

In Table 2, IRL metrics contribute to TRLs by checking the location of a technology on an integration readiness scale and offering suggestions to improve integration with other technologies. In general, similar to TRLs, IRLs were designed to assess the risk and development needs of information systems integration. The rationale for the present IRLs research is that TRLs do not accurately capture the risk involved in adopting a new technology, and technology can differ architecturally according to integration readiness and system integration. In the MARISA environment, because the complexity of a system or information can increase, and a practical implementation involves a service-oriented network and shared systems, it is reasonable to employ a reliable method and ontology to achieve integration readiness. Hence, other readiness levels can be combined in the development of complex information-intensive systems of information sharing and the integration of systems in a shared system. IRL metrics were introduced by the Systems Development and Maturity Laboratory at the Stevens Institute of Technology. They were developed to assess the progress of information system integration and communication in the engineering field. The efforts aimed at realising and validating IRL metrics in the extended context of the ISO DIS 16290 standard development framework were established by the International Organization for Standardization. IRL metrics have been defined as systematic measurements of the interfacing of compatible interactions for various technologies and consistent comparisons of the maturity between integration points. IRLs are used to describe and understand the integration maturity of a developing technology by using another technology or a mature information system.

MARISA: New Proposal of Resilience Readiness Level (ResRL) Metrics	
ResRLs	**Descriptions**
ResRL (9)	**Responsibility:** Social and ethical; actor engagement; shared roles; action competence and capability; education in organisations and higher education; responsibility of citizens, actors and authorities; mutual trust; action formats; path dependency; cultural dependency; knowledge management; trust-based information sharing; transparency; confidence; sustainability.
ResRL (8)	**Mutual impacts:** Nexus and interactions; cooperation validation; regulation; standards; collective resources; ontological alignment; hybrid and cyber systems; external actors management; collective training and awareness; network updates; collective R&D and I activities; cognitive maps and tools; impact animation; proactive activities.
ResRL (7)	**Situational intelligence:** Situational awareness and analytic system; guidance services; resilient learning; machine learning; action competence and skills; recovery automation; belief-false-bias recognisance; pre-operational validation; priorities and decisions; adaption strategy; belief functions; graphical models; simulation; rationale for target.
ResRL (6)	**Activation: resilience demonstrated in a relevant environment:** Industrially relevant environment in the case of key enabling technologies; parallel adapters and gateways for the integration; user refinement technology; field study; feasibility study; design science research.
ResRL (5)	**Dynamic and adaptive operation resources:** Adaptive capabilities in the concept of operations; human in loop; situation analytic and data fusion tools; reaction capabilities; response design and logic; performance and adaption indicators; data management; network management; resource management; disaster recovery; replication management; priorities.
ResRL (4)	**Resilience validated in lab:** Following successful proof-of-concept work; components integrated; test results and estimations of differences between validation and expected system goals; technological artefacts; laboratory accounting; development research.
ResRL (3)	**Mutability:** Modular strategy; configurable mechanisms-entities-services; adaption models; dynamic systems; divergent communication routes and methods; encryption management; mean time between failures; manual disaster control functions; socio-technological interactions; task and sharing management; location and time management.
ResRL (2)	**Modularity:** Compatibility; parallel functions; clustering; high availability; data and information refinement; manual-automation redundancy functions; diagnostic structures; renewable components; component availability; replicative providers; reimbursable management; modularity design; device data and modular structure control.
ResRL (1)	**Events and Mechanisms:** Components; devices; drivers; kernel functions; technological compatibility; parallel options and devices; serialisation and transactions; pool of interfaces; routing paths and network functionalities; manual modes; attributes; parameters; sensors; logs.

Table 30: Proposal of Resilience Readiness Levels (ResRLs).

Table 3 describes a proposal of resilience research aspects for a nine-level model of ResRLs categories in MARISA: (1) basic resilience principles and relevant user needs-based requirements for trials, e.g. dynamic and adaptive requirements, and a resilience-threat risk study of critical aspects (critical assets and aspects of cyber and hybrid threads); (2) concept of operations and field-domain–related regulations, such as assets, risks and vulnerability factors; (3) planned pre-operational validation, designed analytics, designed experimental critical functionalities, conducting a vulnerability study, and establishing proof-of-concept; (4) dynamic capabilities and modularity validation in a laboratory environment, e.g. security and resilience measures; (5) capabilities and modularity validation in a relevant operative environment, e.g., process, human and technical factors; (6) trial demonstration in a relevant operative environment (actionable resilience and concept of operations); (7) demonstration of resiliency in a shared operative environment, e.g. dynamic, adaptive and resilience factors in nexus; (8) validation of resilience functionalities completed and thorough testing and demonstration; (9) harmonisation of resilient system operations through successful mission operations.

5.7. Privacy by Design (PbD) in Open Source Intelligence (OSINT)

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In a world where technology grows exponentially, more information is available to consider and us every day. States and their governments have collected information on their citizens for a long time now, but currently people give out more and more personal information voluntarily through social media. Information available on the Internet is easier to analyse with modern technologies and the original source of information is also easier to track down. Information is available to all of us and that information can be used to investigate personal data, defeat competitors in a corporate world, solve crimes or even win wars.

This study analyses open source intelligence with the emphasis on cyber reconnaissance and how personal security is part of that entity. The main question is how privacy manifests itself as part of OSINT (Open Source Intelligence). At the same time the study analyses how law enforcement authorities can act so that their reconnaissance actions would be publicly approved. The study uses case study methodology by gathering a comprehensive list of sources for the theory section. The theoretical framework consists of open source intelligence and privacy questions (especially Privacy by Design and Privacy Enhancing Technologies). In addition, EU´s General Data Protection Regulation acted as a legal framework, as well as many news articles and news reports were analysed in order to gain information about how these phenomena present themselves in the real world.

As a result of the study, a comprehensive real-life description of how OSINT is practiced, how it affects everyone and how privacy is part of that was created. Based on the theory, news articles and blogs, a model will be constructed which describes how good and ethical reconnaissance should be performed.

5.8. Maritime Interactions and Data Fusion Potentials

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The emphasis of this MARISA (WP2 Task 2.1) research is in extended verification (explosion and dissemination activity) of the MARISA end-user requirements and review of maritime use cases (n = 94) which are descripted in MARISA D2.2 MARISA USER REQUIREMENTS and later in MARISA 3rd User Community & Innovation Management Meeting. The effort is addressed to a collective research with the Finnish Maritime Authorities Consortium (FIMAC) which is a consortium of: (1) The Finnish Transport Infrastructure Agency (VÄYLÄ); (2) The Finnish Transport and Communication Agency (TRAFICOM); (3) Finnish Border Guard (FBG); and (4) Finnish Navy (FINNAVY). Later this expanded review can be enlarged with covering of Finnish Customs, Polis and other related authorities.

Research Design: All of the maritime use cases (n = 94) is checked and the most suitable ones for FIMAC is nominated to the deeper investigation. The proposal of MARISA maritime use cases and current requirements is under review with the FIMAC experts (n = 4 institutions) as an institutional and collaborative viability study. The purpose is to clarify the benefits of MARISA and achieve the top-level understanding and acceptance of FIMAC agencies and participation to dissemination activities e.g., explanation of the differences between EUCISE_2020 and MARISA projects and also explicate how MARISA could improve partners maritime situation awareness and support authorities in their daily business. In addition, the assessment of the MARISA trials and the preparation of the Validation Results will be addressed; based on: the experience of MARISA Phase 1; review of MARISA Deliverables; and assessment transactions of the MARISA trials.

5.9. Mind in Resilient Learning

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In this MARISA User Community opinion article, the term of Learning by Research and Development (R&D) is furthered towards the term of Resilient Learning in the setting of security related to the MARISA Innovation Action (IA) Project and research for the development of co-creative tools, services and resilient decision-making capabilities and maritime action competence. The background of this opinion article includes an interdisciplinary combination of service science, security, computer science, pedagogy, engineering and management science. The interdisciplinary combination involves MARISA stakeholders, participators, researchers, learners and teachers connecting and integrating the academic disciplines, professions and technologies, along with their methods and perspectives for co-creation of a common goal. This goal emphasises results as high-value impacts, as well as the value of services, products and innovations as 'deliverables' of the integrative learning process.

The integration of externally funded and critical national R&D activities and their results and deliverables for high-value impacts in higher education institutions is a complex and interaction-based process, not only within technology but merged with economic, legislative and social environments, where research, development and innovation action (R&D&IA) integration is also influenced by government policy and programmes, financial instruments, laws and regulations, and economic boundary conditions. In this MARISA context, an investigation of higher education functions and EU research systems addresses the collective contribution of: (1) knowledge, (2) competence, (3) capability, (4) operative performance, (5) action proficiency, (6) adaptive capability, (7) ethics and (8) resilience. In higher education institutions, research activities and high-value impacts achieved by adaptive capability and resilience have become globally important for regional-national development and maritime societies, due to the requirement for new competencies and for competent networking experts to meet and adapt to current and future challenges for novel ways of learning.

In this view of integrating higher education, externally funded R&D&IA, such as in MARISA and domain-regional-national development, Learning by R&D is understood as a pedagogical and collective approach, in which learning is linked to applied R&D projects and a development-innovation culture. This indicates that learning expertise arises from social interaction, reflection, knowledge and competence sharing, researching, and solutions finding of shared agenda-based R&D objects, such as 'learning scopes' and collective adaption and co-creation of R&D 'deliverables'. The integrative model has thus far emphasised cooperation and creating learning by 'research and development path-dependencies', and makes it possible to include and use various scientific perspectives and methods of learning, especially for action-related competence and divergent continuums of studies and R&D projects.

As in MARISA, it is frequently impossible to clearly define the work objectives as 'R&D-related learning scopes' in advance; instead, they are specified throughout the cyclic anticipation-experimentation-solution development process (elastic nature and high-maturity skills levels). However, the R&D-related learning process requires critical thought strategies and expert skills to justify solutions, resilient dimensions and the design of evidence evaluation. Usually, R&D work consists of a multidisciplinary setting, a continuous solution-development process that focuses on research, cyclic anticipation-experimentation, artefact development and generating new competencies and action-related capabilities. The end result as 'deliverables' can be, for example, a creation, an artefact, a new operating method, an improved methodology, a model, an action capability, a service or a product as evidence, which is achieved by integrating learning and R&D&IA.

One basic assumption related to this theme of Resilient Learning in MARISA is the realisation that maritime domain-national development, R&D&IA, and its leadership-management functions are rather far from a linear-normative process; instead, this political-decision-making setting is shared by the results of dynamic R&D&IA processes that involve interactions between several actors and things that no single actor, such as one higher education institution, can achieve or manage alone. However, the integrative model and collective resilient learning perspective, such as the value-service CANVAS and ADOPTION model in MARISA, can face a high level of uncertainty, unexpected events and rival configurations and implementation models.

In this MARISA article, the term 'resilient learning' refers to the increased rate of interactions and external R&D&IA pipelines as more resilient-elastic scopes and deliverables for evidence of lessons learnt and catalytic agents in processes, which share that knowledge and higher education can be preserved as a service, methodology, product, activity, capability, demand of change, required adaption, performance, policy, or as educational, innovative or intellectual assets that can be exported for high-value and impact returns. This resonates with the utility-related Humboldtian university model: (1) the school as a centre of inquiry, (2) metaphors of learning, (3) situated learning and (4) interaction between learning and development.

In the previous continuum of this article as background, the terms 'integration', 'integrative learning' and 'resilient learning' addressed an interactive way of learning, whereby an individual learns along with a workplace, institution, school and R&D&IA community, such as an international research consortium, as well as alongside a learning organisation and across borders and disciplinary silos, as in a collective learning space that can be regional or individual-global oriented. In this setting, the term 'learner' refers to a student, teacher, researcher, decision maker, participant, stakeholder or even artefact, such as 'intelligence as a system-based Bayesian belief network', which can enrich the learner's own decisions through collaborative R&D&IA by sharing knowledge and expertise and learning from others. 'Student' is used here to indicate that a person is registered as a student in the database of the national Ministry of Education and Culture.

The role and mind-set of the term 'resilience' in this MARISA context is imperative because it can further our survival and 'operative capabilities and decisions' by relating changes on demand and fostering novel learning designs and curriculums. This learning design as a 'resilient learning' concept addresses what we need to study when faced with inevitable difficulties, such as the scopes often described in national strategic research agenda and H2020 calls: grounded thus far, the emerging concept of 'resilient learning' is approached as achieving survival capabilities to change on demand and manners to enhance capabilities at all levels of activities to create paths that are robust yet flexible, to monitor and revise risk models, and to use resources proactively in the face of disruptions or pressures of ongoing activities, such as learning, control, production, service, trade or industry. Resilience also addresses an ability to recover from misfortune or build new positions, or the adaption (here, the adoption model) of mandatory change. The term 'resilience' typically includes four abilities: (1) to plan and prepare (maturity of knowledge, expert skills and competence); (2) absorb disturbance; (3) recover from; and (4) adapt to known or unknown threats. In this MARISA context, the empirical and multidisciplinary R&D results point to the rather practical technological basis of the term 'resilience' and necessitate revisions of resilience theories and genealogies of resilience.

Focusing on regional and national development and R&D&IA is a significant purpose of all higher education institutions in Europe. For example, in the past few years, the structural reform of higher education in Finland has been represented, and this reform has been actively and widely discussed nationally in order to develop a national and regional innovation system and to clarify the shared nature of the higher education system. This produces new, collaborative knowledge and competencies, and searches for creative solutions for focused problems and challenges at various levels and project continuums. The importance of R&D&IA integration is clearly emphasised when combining regional competence, maturity of skills, network participation and

utilising different partnerships in shared R&D&IA processes. The functions of R&D&IA at all higher education institutions can be reasoned by a purposeful and experiential approach, as producing expertise in processes of knowledge transfers, transformations and catalysts related to resilient learning aspects.

The term ‘high-value impact’ addresses the amount of realised economic and social value as well as achieved value and impact returns, which are created by applying knowledge generated by a research consortia and R&D&IA collaboration. The terms ‘value’ and achieving ‘high-value impacts’ are in line with the concept of value concentration, where values are related to knowledge and produce outcomes described as a revised concept of value concentration. The concentration quartet includes the following: (1) academic value as intellectual property; (2) value of research and development; (3) value of education; and (4) empiric value, such as MARISA trials in operative practice. In MARISA, the term ‘empiric value’ also addresses the high-value returns by disseminated artefacts, operative services and value concentrations for competitiveness-business, policy development and ethical-sustainability aspects.

One micro-level purpose and contribution of this MARISA article addresses the form and development of higher education that focuses on the demands of the individual-national-global comprehensive security domain. Here, teachers, policymakers and authority representatives work together and interact more closely as a collective learning community that involves students (legitimate peripheral participation) and the implementation of study units in higher education and shared R&D&IA. This shared R&D&IA includes learning by national-international research consortiums and work packages as realisations, such as in manners of catalytic and adaptive acquisition, participation and co-creation, e.g. manners of R&D&IA and more resilient learning for building something new: resonance towards the realisation of R&D and creating entrepreneurial universities. Here, the term ‘scope’, such as ‘research-learning scope’, can be actualised for interactions of a ‘resilient-elastic nature’ and for focusing on the meaningfulness of learning integration, learning paths and creativity. Especially from the perspective of a student’s integration into R&D&IA and domain-regional-national development, some USE CASE (n = 4) examples are as follows:

USE CASE (1): Resilient Learning for MARISA adaptive-dynamic aspects is where emphasis is on high-value attractiveness and competitiveness factors, such as MARISA models, data fusion capabilities, operative decision making and services, in which ‘more resilient, adaptive or dynamic instances’ can be feasible for strengthening the competitiveness of an industrial concentration in the European Union (EU) or knowledge capital of a country with interconnections of EU competitiveness objectives and strategies.

USE CASE (2): Resilient Learning for Hindering of Technical Debt (also known as design debt or code debt): The term ‘technical debt’ can refer to inefficiencies, additional processes and extra work (causalities where resilience is needed), which demand creation due to outdated or out-of-control technology or unmanageable services over a long-term maintenance period. Recognising the resilience-related aspects of technical debt allows stakeholders to address possible technical vulnerabilities, reserve proactive resources and pay further attention to the balance from maintaining the lifecycle (linear maintenance process) to innovating artefacts (cyclic-proactive innovation-development process), including its continuity management.

USE CASE (3): Resilient Learning Against Software Debt: In addition, a more fine-grained focus of resilient learning can address the five software development-related learning scopes: technical, quality, configuration management, design and platform software debts, such as software-related adaptive maintenance and continuity aspects and factors.

USE CASE (4): Including Resilient Learning alongside MARISA trials validation: The study of integration and resilience maturity (Design Science Research or CANVAS-based Service Design) of all MARISA trials to find the best design and top implementation model (including adaptive, dynamic and integration factors) for

building and improving the next operative data fusion system. The Open Group Service Integration Maturity Model (OSIMM Maturity Matrix) and resilience readiness metrics can be used as reference.

It is noteworthy that new and small enterprises, particularly knowledge-intensive ones, are involved as legitimate actors in the innovation system. In this view, higher education institutions are seen as significant producers of new knowledge and competencies, and users of the latest findings and bodies of knowledge in action, which places them in the role of collectors within the thematic centre of the innovation system. Their thematic nature comes from their operative action, and their resilience is their ability to combine knowledge from several sources, such as lead innovation systems, or institutions, such as strategic centres of excellence in science, technology and systemic innovations. In addition, multiple helix cooperation ensures that a body of knowledge is co-created with other organisations to contribute to innovations in industry and society as a whole, e.g. national strategic research agenda.

Thus, resilience-related research is necessary in future studies. In the perspective of security management-related higher education, a regional-national capacity to provide security-related knowledge-competence-capability pathways and knowledge interconnections depends on the ability to continuously innovate in order to ensure technological leadership and credibility as a networking partner for a concentrated contribution. Hence, current and emergent challenges should be mentioned, such as the recent dramatic falls in investment in R&D and risk management undermining efforts to support the security sector, and broader defence and security goals. In this security view, one piece of advice for future study is that creativity and innovative learning scopes should be more systematically designed and adapted with flexibility for research, development and innovation activities in the context of current knowledge, competence, mature skills, capabilities and performance (action competence) settings. Hence, the creativity and innovation approach steers R&D&IA process planning towards increased participatory, dynamic and creative forums of new competence production, and will enhance learning and resilience.

Comprehensive security-related R&D integration as a concept of value concentration has a high-value impact on pedagogy, which is delivered in students' knowledge, competencies, skills maturity and capability-building processes. The crucial factors as deliverables do not only include subject-specific competence, but also a research-oriented developmental approach, interaction and innovation abilities, the capability to engage with colleagues, students and partners dialogically, and pedagogical, participatory and leadership competence. The quality of an expert's deliverables promotes the implementation of novel, high-quality teaching, and fosters students' motivation, participation and dignity. From the students' points of view, the emphasis is on motivation, spirit, dignity, guidance, the learning process, mutual reflection, ethical aspects, professional and human growth, and a research-oriented, developmental approach to one's own and the organisation's work.

REMARKS: Resilient Learning is addressed for pedagogical and communal progress, in which learning is linked to novel R&D&IA themes, projects and culture. It means that learning expertise arises from social interaction, knowledge and competence sharing, researching and problem solving of collective objects. Resilient Learning emphasises cooperation and creating a learning-developing-innovation culture, and makes it possible to include and use various scientific perspectives and methods of learning, researching and developing in operation and action. The learning process starts by identifying the initial problem or research object, boundary objects, analysing and describing it (elastic nature and maturity of expertise & skills), and co-creating an appropriate study plan and maturity-increasing methods. Then, learning consists of continuous skills-expertise maturity development, a problem-solving process, a focus on emergent R&D&IA themes, and the generation of innovation competencies. This is in line with the concept of expansive learning, the progressive inquiry model, a knowledge-building approach, learning to work creatively with knowledge, and communities with a networked expertise approach. The innovation developing approach emphasises aspects

of social and service innovation generations, services development and services design process implementations.

The User Community discussion document collection in MARISA addresses to the open category that provides a forum for the communication of R&D&IA themes for progress of current MARISA capability development and further artificial continuums. The themes are open, for end remarks as examples such as useful themes discussed in MARISA interactions and meetings are comprised to the followed table.

Collection of Themes Discussed in MARISA User Community	
1	Applied behaviours analysis
2	Rule-based reasoning and analysis
3	Anomaly detection
4	Semantic and ontological issues
5	Towards integration of MARISA and CISE
6	Integration readiness levels (IRLs)
7	Description of more holistic approach in MARISA
8	Issues related to algorithms in MARISA
9	Issues related to the data owning (data ownership) in data fusion services
10	Issues in Law Enforcement Agencies (LEAs)
10	Towards ethical realisations (description of ontology and capabilities for development)
12	Issues related to MARISA dissemination e.g. expansion of ports and shipping companies
13	Using data fusion for import and export e.g. custom interactions
14	Building new capabilities for boarder security
15	Future management of requirements and needs in MARISA development and continuums
16	Building improvements in operational response and CONOPS
17	Towards of centre of end-users (EU PROXY in MARE)
18	Towards of interoperable systems
19	Data fusion readiness levels (DFRLs)
20	Furthering of machine learning (ML)
21	Furthering of artificial intelligence (AI)

Collection of Themes Discussed in MARISA User Community	
22	Usage of Big Data in Maritime Situation Awareness
23	Human Computer Interaction (HCI) and usability factors in Maritime Situation Awareness
24	Mind and reasoning of historic data in MARISA context (data cube)
25	Access control issues in MARISA services
26	Reduction of overlapping work in a way of cooperation
27	Towards multipurpose drones (under water and flying)
28	Automation of data sources combination e.g. vessel, cargo, peoples
29	Augmented reality (AR)
30	Virtual reality (VR)
31	Cooperation in crime preventation
32	Quality control in networked development (subcontracts)
33	Extraction of information from open source channels for Maritime Situation Awareness
34	Satellite detection and reconnaissance for Maritime Situation Awareness
35	Maritime traffic patterns extraction from large amount of uncertain data
36	Vessel routes analysis and extraction using machine learning algorithms
37	Ocean forecasts integration in Maritime Situation Awareness
38	Mission planning and Search and Rescue operations
39	Social Network Analysis (SNA) and communication networks
40	Description of data fusion potential and benefits
41	Towards design of system for transparent surveillance
42	Advanced risk analysis by data fusion services
43	Research of cybersecurity in maritime environment
44	Security Readiness Levels (SecRLs)
45	Threat analysis and prediction in Maritime Situation Awareness
46	Research of authorities interactions in MARISA
47	Towards adaptive and resilient system for decision making

Collection of Themes Discussed in MARISA User Community	
48	Resilience Readiness Levels (ResRLs)
49	Issues of related standards
50	Future behaviour of maritime security actors in the arctic maritime domain
51	The OODA Loop
52	MARISA Pyramid Model
53	Maturity of Data Fusion Systems
54	From Value Business and Service CANVAS to Adoption Models
55	From adoption to adaption and dynamic configuration
56	GUCI model in MARISA
57	PaaS (Platform as a Service) and (SaaS Software as a Service)
58	Legal Constraints: Government sovereignty and control over the information/data
59	Maritime Government Procurement
60	Data protection and data security
61	Privacy Impact Assessment (PIA)
62	Classified information in Data Fusion
63	Classified information in CISE (e.g. issues of cryptography)
64	Development related outsourcing management in future activities
65	MARISA NEXUS (mutual causalities and affects)
66	Pattern of Life
67	Anticipation-Experimentation-Simulation-Realisation
68	Engineering Resilience in MARISA
69	What constitute resilience in MARISA
70	How to create resilience in MARE
71	Triggers, Drivers and Enablers for Resilience
72	Risk and Resilience Integration by Data Fusion
73	The Open Group Service Integration Maturity Model (OSIMM)

Collection of Themes Discussed in MARISA User Community	
74	Building Resilience Through Data Fusion
75	Adoption and Adaption in Resilience Engineering
76	The Functional Resonance Analysis Method (FRAM): to model the impacts of decision
77	The System Modelling Language (SysML)
78	The Unified Modelling Language (UML): to modelling of adaptive-resilient systems
79	Networked Resilience Needs in MARE
80	Integrative Education Model for Resilience in Higher Education
81	Extraction of Information from Open Source Channels for Maritime Situation Awareness
82	Satellite Detection and Reconnaissance for Maritime Situation Awareness
83	Maritime Traffic Patterns Extraction from large amount of Uncertain Data
84	Vessel Routes Analysis and Extraction using Machine Learning Algorithms
85	Statistical and semantic approaches and techniques for behavioral analysis and anomaly detection in maritime situation awareness
86	Ocean forecasts integration in maritime situation awareness to support mission planning and search and rescue operations
87	Complex Threat Analysis and Prediction in Maritime Situation Awareness
88	Usage of Big Data Infrastructure in Maritime Situation Awareness
89	Comparison of Application and Command Levels
90	Mechanisms towards Clean Data and Data Refinement
91	SMART MARE
92	Relation of Common Operating Picture (COPs) and Recognized Maritime Picture (RMP)
93	Cost-benefit analysis and interoperatibility enquiry (European Interoperability Framework)
94	Interoperatibility (organizational - sematic - technical) questionnaires
95	Data Fusion approach to Hybrid Threats (Explanatory Multiple Case Study)
96	Privacy by Design (PbD) in Open Source Intelligence (OSINT)
97	Expansion of Data Fusion innovations against Hybrid Threats (Design Science Research)

Table 31: Collection of Themes Discussed in MARISA User Community.