ANNEX TO PROJECT FINAL REPORT

Final publishable summary report

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Name of the scientific representative of the project's co-ordinator[1], Title and Organisation: Agostino Longo, Land & Naval Divisional Engineering, Selex ES Roma Italy

Tel:+39 06 41504237

Fax: Tel:+39 06 41501

E-mail: agostino.longo@selex-es-com

Project website address: www.seabilla.eu

[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

Executive Summary

Today's European Surveillance needs can be seen from multiple perspectives: Early Warning addresses the capability to detect threats far beyond the European Frontier, Border surveillance means the capability to tackle irregular immigration and illicit trafficking of goods when they occur either at blue and green borders, Territory Control means the capability to meet the homeland and citizens security needs.

These challenges can be faced with a sound mix of technological and organizational tools in a framework of information sharing at national and European level, underpinned by an appropriate legal framework and the individual capabilities provided by the national operational agencies.
Information sharing at all levels (from EC agencies to national authorities in charge of border surveillance) is a key step to increase the overall situational awareness and the related preparedness against threats (either man made, or natural).

Today's European Maritime Surveillance policies are set by the roadmap establishing CISE (Common Information Sharing Environment) and by the development of EUROSUR (European Border Surveillance System); these two main EU programmes are driving the implementation of EU policies in these sectors in coordination with other GMES / ESA policies for surveillance from space.

Seabilla is an integrated project conceived to develop solutions for Maritime Surveillance based on a mix of existing and near term available solutions and test them on end user validated operational scenarios.
The Seabilla project approach is based on a scenario driven mechanism and a tight interaction with end user to elaborate Solution Use Cases able to satisfy evolving needs from the stakeholders communities.
The development activities have been organized focusing different technological areas in terms of space, air, land and sea based surveillance and arranging three different scenario areas for investigations: Atlantic, Mediterranean and English Channel.
For each scenario different Solution Use Cases (SUCs) have been elaborated and scored with respect to the initial surveillance baseline available in those areas. Such SUCs have been tested through dedicated and focused trials enabling components and/or through simulation. At the end of the project measurable results have been achieved on all the three mentioned scenarios.

Seabilla project is one of the key steps in progressing towards European Maritime surveillance implementation, being a cornerstone between preparatory actions like Operamar project and final demo as Perseus Project. The Seabilla'a main project aim is to identify key issues to improve interoperability and reduce the information gap arising from heterogeneous surveillance systems, legislations, mandates and modes of operation. Seabilla groups a number of important actors involved in several European initiatives in the field of maritime surveillance and its findings have been exploited in the Marborsur an informal panel to consult Frontex and DG Home for the EUROSUR implementation.

Description of project context and objectives.

SeaBILLA aimed at developing Sea Border Surveillance capabilities to address a number of perceived surveillance challenges in current critical EU regional theatres. The main goal were:

- Reduce the number of illegal immigrants attempting to enter undetected in the EU blue border
- Increase internal security by contributing to the prevention of cross-border crime;
- Enhance search and rescue capacity, especially to save more lives of migrants who attempt risky ways to cross the borders

SeaBILLA aimed at contributing to these objectives by studying, developing and demonstrating cost-effective solutions for extending, in general, the areas covered by surveillance, with special emphasis on:

- open sea, where surveillance is currently limited to areas with ongoing operations
- improving the capability to detect small and/or non-reporting vessels typically used by immigrants and illegal traffickers
- improving the capability to maintain tracks, classify and identify non-reporting vessels

SeaBILLA is a User-Driven project and the User defined scenarios dictated the project work-plan in four project areas:

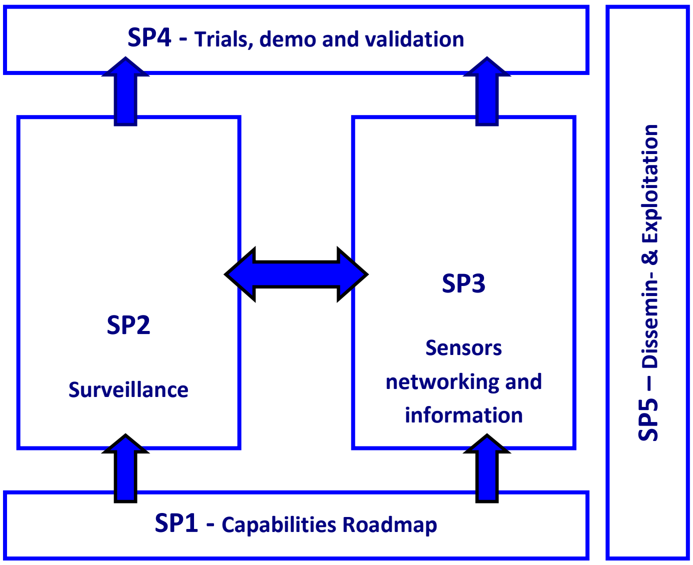


Figure 1: SeaBilla subprojects

Project Area 1 (SP1) - Capabilities Roadmap: for each scenario, very realistic “vignettes” describing illegal actions have been outlined with the Authorities in charge; this baseline of operational requirement have been used to identify the required Operational Surveillance Capabilities, surveillance systems solution, for each scenario, gap filler of the legacy systems.

In this phase the following main activities have been carried out:

- Tight dialog with Regional Stakeholder driven by the the different Partner (Selex for Italy, Indra for Spain, Thales, Cassidian and Sagem for France, Baes for UK, Edisoft for Portugal, just to name a few)
- Setting of the most significant areas where to localize the research
- Organize End User workshop to have a cross fertilization view from different stakeholders
- Dialog with Frontex through Marborsur (Maritime Border Surveillance Informal Implementation Group) channel

14 vignettes have been elaborated for the three scenarios and 7 proposed SUCs have been developed.

Project Area 2 (SP2) – Surveillance segments improvements, to increase the detection and tracking of small and non-reporting boats focusing Airborne, Space borne, Land and Sea based surveillance tools available in the near term or new application of the existing solutions. Main focus has been:

- Developments of new algorithm for change detection and ship detection from spaceborne sensors
- Comparison of manned and unmanned aerial means. Evaluation of the RPAS performance in selected scenarios varying platform and playload features and capabilities
- active and passive solution detection from shoreline radars; processing improvement for the existing coastal surveillance systems

Project area 3 (SP3) - Sensors networking and information fusion, that addresses sensors networking, data fusion and high level processing techniques and solutions which boost the operational capabilities through more effective exchanges of information, correlation tools, data mining engines, abnormal behaviour detection from both currently available but not fully exploited information, and from the improved sensor chains. In particular:

- Sensor networking between radar and electroptical sensors to tracking small boat close to the coastline
- Behaviour analysis algorithm to help decision makers highlighting suspicious boat in the Common Maritime Picture

Project Area 4 (SP4) – Trials, demonstrations and validation. SeaBILLA partners, and in particular the associated End-Users, will evaluate the effectiveness of the SeaBILLA results of Project Area 2 and 3, through their integration and extensive simulation in laboratories to compare the achieved capabilities in the context of the various operational "vignettes" to measure the improvements respect to the current situation and selected demos on sites for single surveillance sensor or for a sub-set integrated solution. Trials have been organized following two main approaches:

- Performing real tests with candidate technologies and improvements
- Performing overall assessment of the quality of the proposed Solution Use Cases through simulation environment equipped with artifacts / simulators / emulators of the real systems in order to determine the quantitative response with respect to the baseline situation

Suitable simulation environments have been chosen on the basis of the foreground partner capabilities. Regional Hub taking the responsibility to manage the regional basins have been established: Cassidian in Paris supporting either the Atlantic and the English channel Scenario and Selex in Genova and AleniaAermacchi in Turin to support the Mediterranean Scenario

Physical trails were performed by:

- Selex ES Passive Radar in Lampedusa, Civitavecchia and Livorno
- Thales Communication France Passive Radar in Cherbourg
- FOI Radar Improvement Processing techniques in Sweden
- TNO Clutter suppression and behavioural analysis in Netherlands applied to the existing Coastal Surveillance Systems
- Sagem RPAS trial in Cherbourg

The demonstrations objectives were:

- To implement at least the seven solution use case providing means to evaluate the proposed improvement; this in turn to be coherent with the WP1.2 deliverable and the scenario presentation made in the first end user workshop
- To gather quantitative data about the demonstration trials to enable related analysis and synthesis of the results (WP4.6 and completion of the last task of WP1.2)
- To deliver exploitable material (movies, testimonials, visit to industrial and end user sites) to support the end user involvement and SEABILLA exploitation
- To be in line with the objectives stated in the SP4 DOW

The following table summarizes the Measures of Effectiveness (MoE) by vignette and by simulation tools/partners:

MoE	Atlantic		English Channel			Mediterranean	
	Drug trafficking	irregular immigration	Drug trafficking	irregular immigration	Terrorism	Drug trafficking	irregular immigration
Available time to decide					BAES		
Detection	SeaLion + SpaceApp + SAR simulator	SeaLion + SpaceApp + SAR simulator	SeaLion + SpaceApp	SeaLion+ SpaceApp		SELEX Simulation Lab	SELEX Simulation Lab
Coverage	Multi-satellite tasking + RPAS simulator	Multi-satellite tasking + RPAS simulator	SeaLion + SpaceApp	SeaLion + SpaceApp		SELEX Simulation Lab	SELEX Simulation Lab
Tracking continuity			SeaLion + SpaceApp	SeaLion + SpaceApp		SELEX Simulation Lab	SELEX Simulation Lab
Identification/ Classification	Multi-satellite tasking + RPAS simulator	Multi-satellite tasking + RPAS simulator					
Refresh time		Multi-satellite tasking + RPAS simulator					

Table 1 Expected Measures of Effectiveness

The glue between the different subprojects has been represented by the Seabilla “methodology” aimed at assuring that all the improvement factors identified in the selected scenario have been verified by the demonstration.

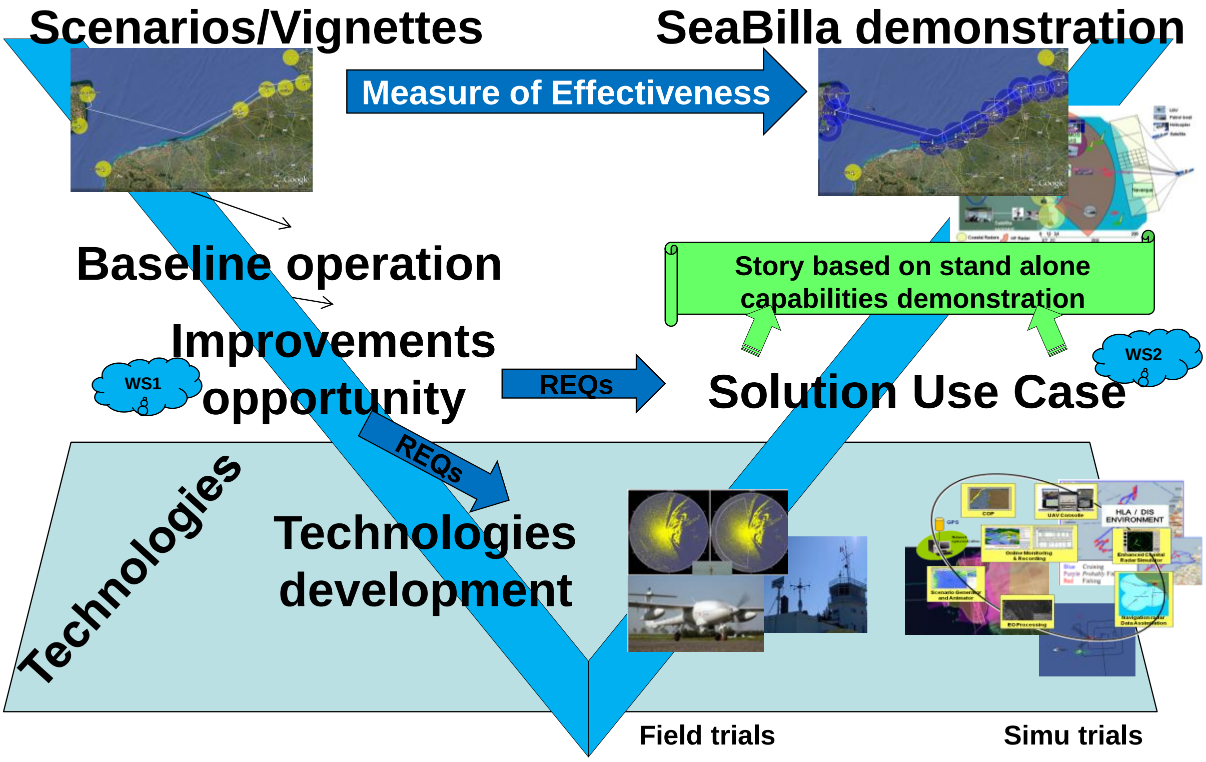


Figure 2: SeaBilla "methodology" from scenario to demonstration

Main S&T results and foregrounds

The project has devoted a significant part of the overall effort to investigate the detection and the how it can be done either developing new solutions or elaborate solution from proper combination of the existing technologies.

Taking into consideration the pyramid of functionalities covering the spectrum of the maritime surveillance, the Seabilla's focus on the different scenarios is herewith reported. The different achievements of the project have been presented through an allocation over the three selected scenarios.

The pyramid shows at the bottom the list of functional requirements elaborated in WP1.2. The main functions investigated in Seabilla were Collect, Process, Fuse and Analyse. In the right side of the pyramid are shown the most important metrics managed to evaluate the performances.

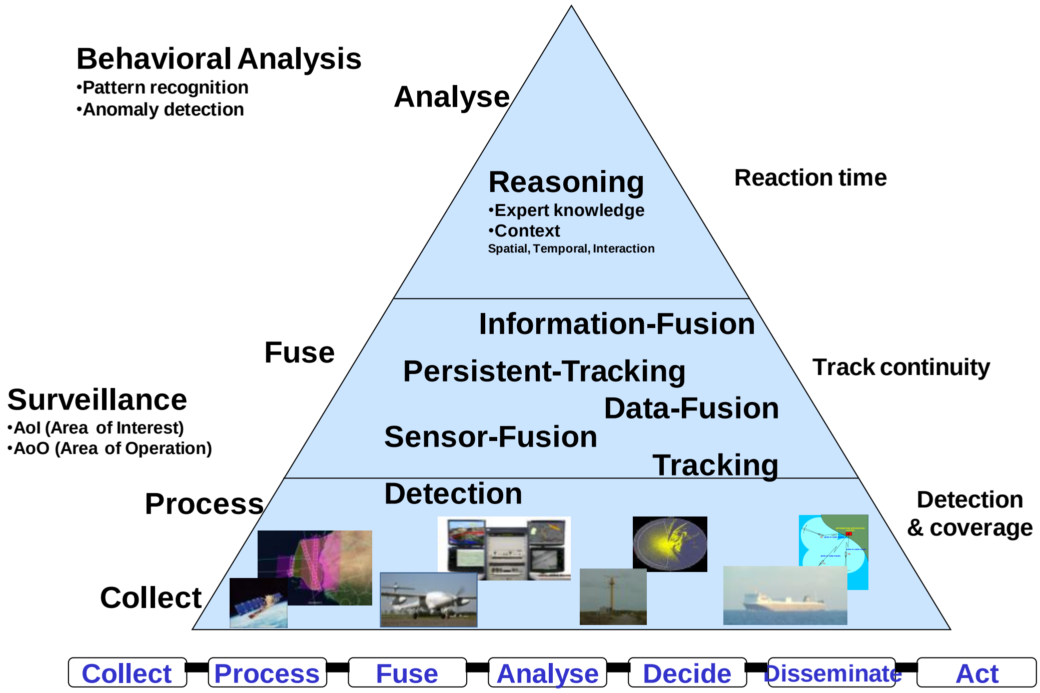


Figure 3: The SeaBilla's Pyramid

A description of the various S/T achievements can be done by contextualizing such pyramid with respect the research performed in the different scenario under consideration.

MEDITERRANEAN SCENARIO

For the Mediterranean scenario a significant focus has been put on the Space Component; a wide study has been undertaken in the WP21 in which the state of art of the different space related tools has been analyzed. The various improvements described here have been partially translated into concrete developments. The change detection algorithm developed by E-geos, the improved SAR processing undertaken by Edisoft and the study on the Elint potential to allow discrimination among the non cooperative vessels are the most significant. Concerning the Air component for the Mediterranean Area, Alenia Aermacchi provided an extensive investigation, supported by simulation facilities, to evaluate the performances of RPAS platform in different payload configurations; for the land and sea based surveillance, active radar, passive radar and assimilation of cooperative traffic radar data have been the key investigated aspects.

Among the possible metrics, the following have been selected to gauge the improvements:

- The Detection in Mediterranean scenario is intended as the capability to detect small boat as overlapping layer of information gathered by multiple sources. In this case, and especially at high sea, detection of “suspicious ship” translated into an “highlight flag” in the National Situational Picture display.
- The Coverage is the sum of all the sea sectors covered by all the sensor deployed in the scenario; this value have been compared with the baseline coverage for the same AoI and the improvements have been expressed in terms of increasing percentage with respect to the baseline
- The Tracking Continuity is part of the path followed by the target that is covered by a sensor; it can be expressed in terms of increasing percentage with respect to the baseline

Different configurations combining Space, Air and Land and Sea based components have been considered as shown in the customized Seabilla pyramid for the Mediterranean

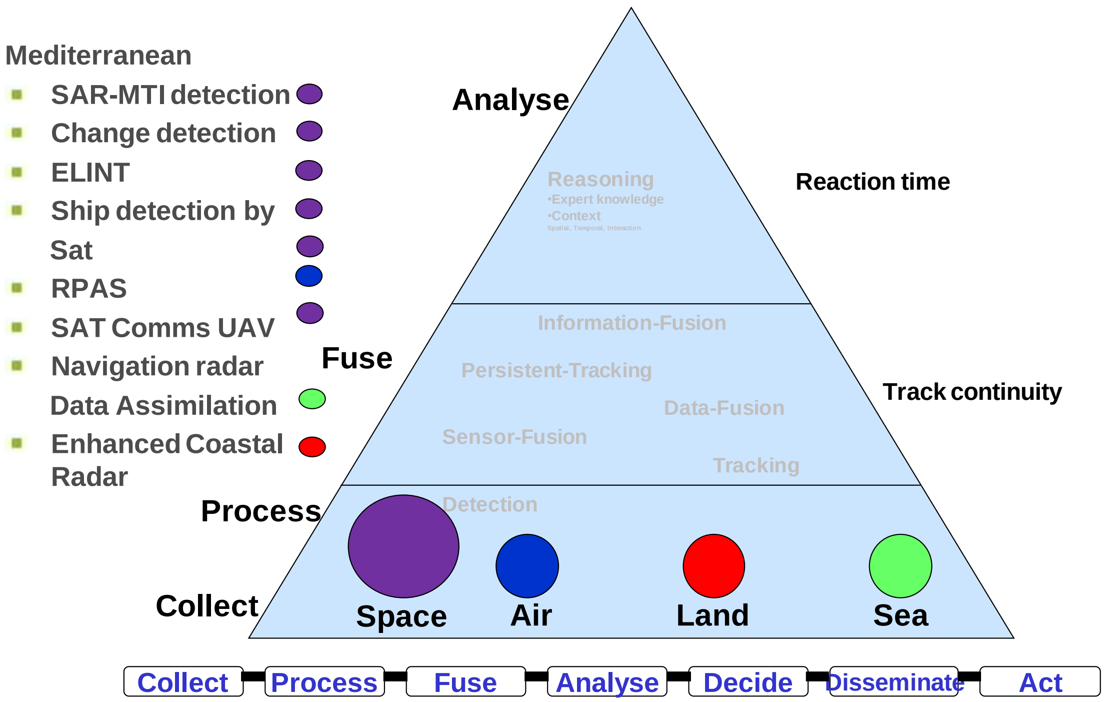


Figure 4: The SeaBilla's Pyramid – The Mediterranean Scenario

Mediterranean Physical and synthetic trials

AULOS passive radar

For the Mediterranean scenario three physical trials for the Aulos Selex ES radar passive technology have been planned and executed. The first wave has been carried out at Lampedusa in June 2012; it was based on FM source of opportunity; the results have been described in the D23.2 Report. The second has been carried out in selected dates in December 2012 and March 2013 at Civitavecchia near Rome; this campaign was based on DVB-T as source of opportunity. The third test wave was held at Livorno in September 2013 in collaboration with the Italian Navy. Also this campain has been based on DVB-T. The findings have been described in deliverable related to SP4 Area

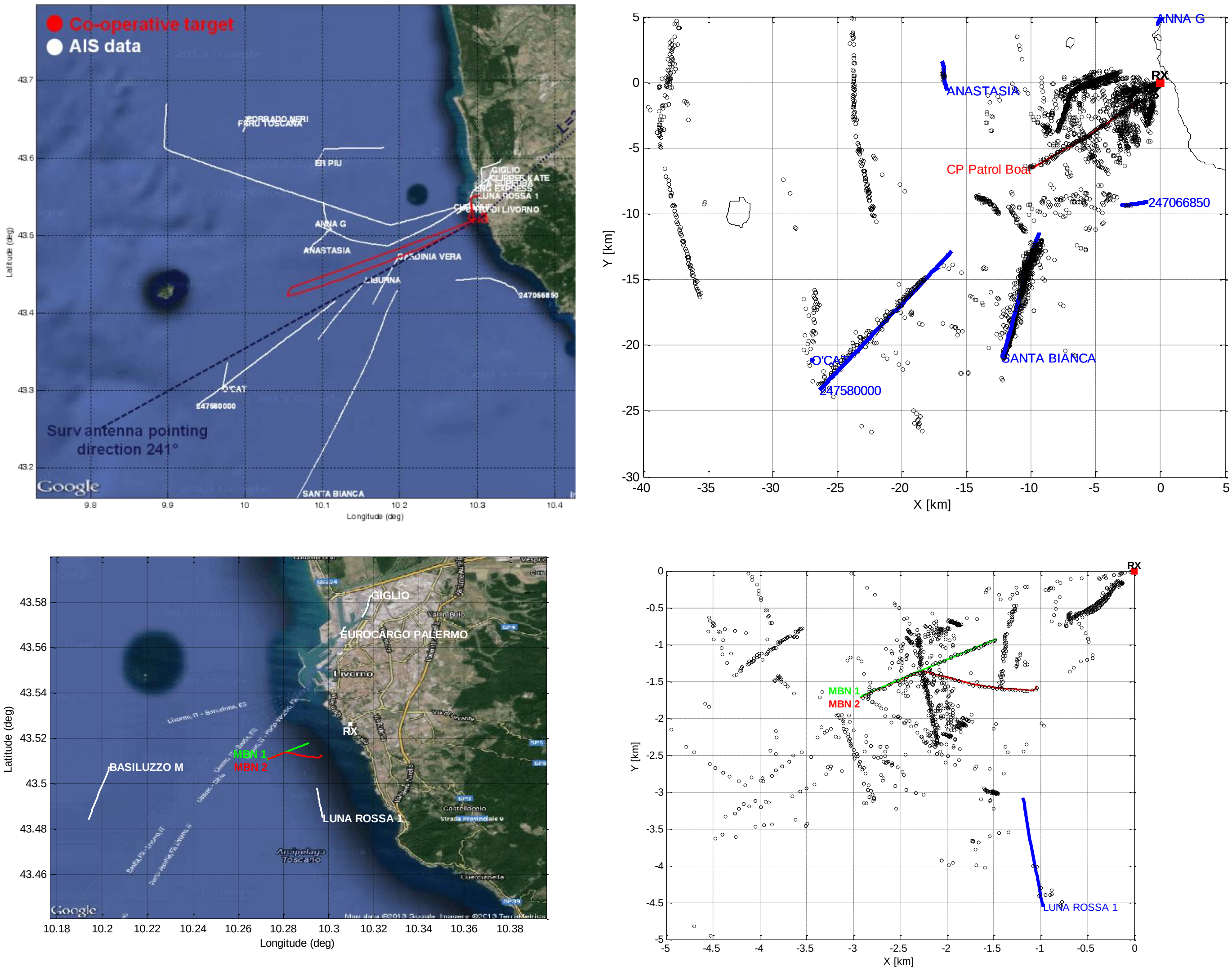


Figure 5: Impressions of the Selex Passive radar test in Livorno Sept 2013 and test results

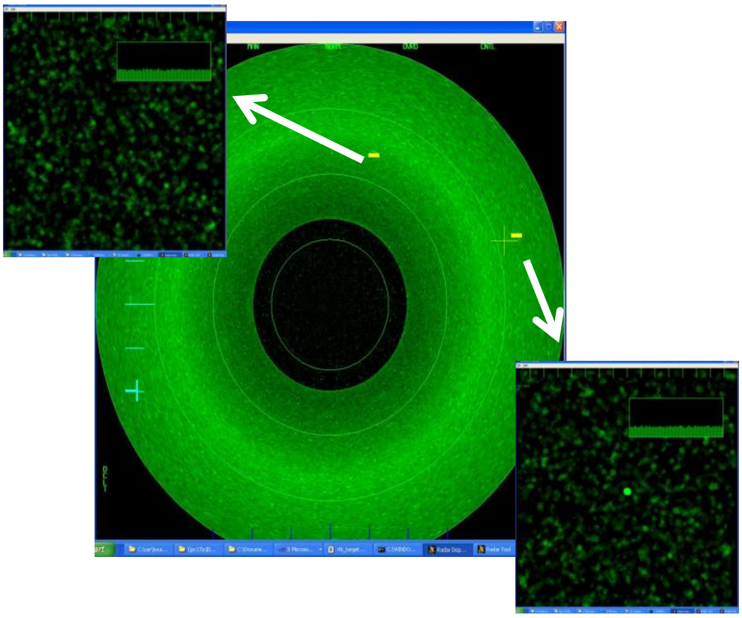
Maritime airborne surveillance will greatly benefit from the introduction of Medium Altitude Long Endurance Unmanned Air Systems (MALE UAS). The MALE UAS is composed of a flying component, the Unmanned Air Vehicle (RPAS), and the ground based Control Station (GCS).

Figure 6: MALE UAS GCS

MALE UAS provide improved Persistence and Area Coverage capabilities such to increase the probability to detect, recognize and track the specific target boats, additionally they offer a very flexible means to collect the necessary imaging (pictures or videos) for the different maritime surveillance needs. The SeaBILLA airborne segment capabilities have been demonstrated in the Mediterranean scenario using Vignettes 3.1 (Sardinia – irregular immigration) and 3.2 (Sicily – drug smuggling).

A site visit at Alenia Aermacchi plant in Turin has been performed in July 2013 to present the simulation of the MALE UAS based on the Mediterranean SeaBILLA drug trafficking vignette and the relevant mission effectiveness analysis results. The mission effectiveness analysis results have been presented in the deliverable D22.2, including the additional Ionian Sea vignette requested by End Users at the 2nd SeaBILLA Workshop.
High fidelity simulations of Maritime Radars and Electro Optical / Infra Red (EO/IR) sensors have been used to evaluate and provide evidence of the quality level of the surveillance images and videos that can be collected with state-of-art sensors.

Maritime Radar SeaSearch and Inverse Synthetic Aperture Radar (ISAR) modes typical presentations are shown in the figures below.



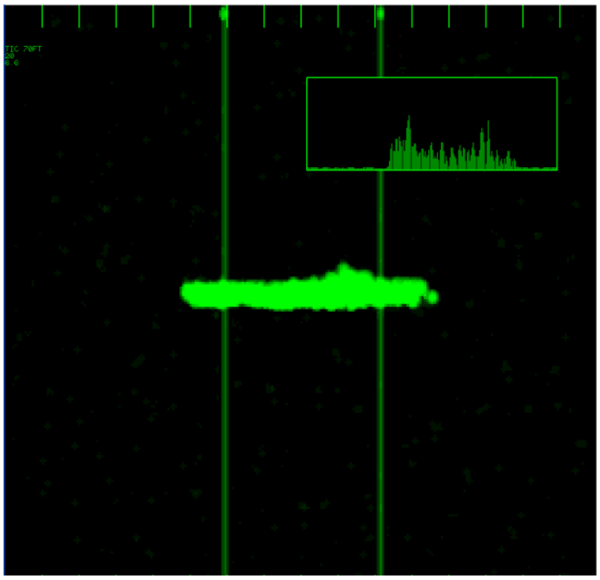


Figure 7: Radar SeaSearch mode for boat detection and Radar ISAR mode for boat classification

The following figures provide the evidence of the possibility to investigate the people and the equipment on-board and the nature of the activities which are taking place

Figure 8: Investigation of people, equipment and activities on the boat

Satellite segment - ELINT

Thales Alenia Space Italia provided an off-line simulation of a possible future spaceborne ELINT system to explain main concepts behind this idea and show how this asset can contribute to the maritime picture awareness improvement. This idea for such kind of system is derived by the prototypal mission ELISA that is a demonstration project sponsored by the French Defense procurements agency (DGA) and Centre National d'Etudes Spatiales (CNES). Its mission is to prepare the ground for the future operational program ROEM (Elint) for mapping the positions of radar determining their technical characteristics. Once the measurements of the spacecraft are combined, it is possible to locate and characterize the source of each signal. The idea is to apply the same concept exploited by ELISA for retrieval of ground based radar location to the maritime environment and the location of ship equipped by navigation radar.

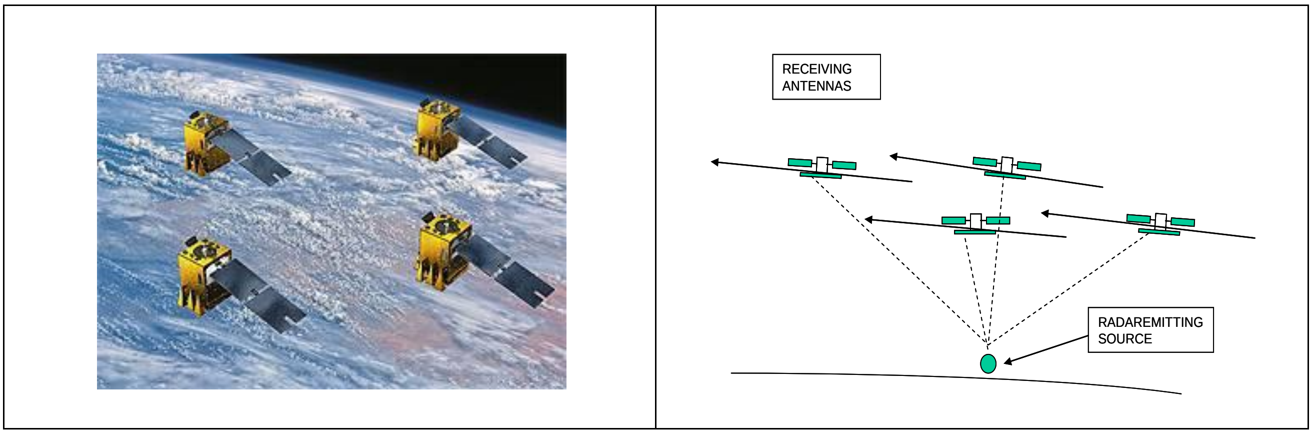


Figure 9: Satellite ELINT principle

This kind of information (location of ship equipped with navigation RADAR) can be then fused with data coming from other assets as EO Satellites - e.g. COSMO SkyMED during the Demo AIS and SAT-AIS systems bringing to an improvement of the maritime picture awareness, in other terms to a reduction of the number of suspect ship (boat used for illegal immigration are usually not equipped with navigation radar).

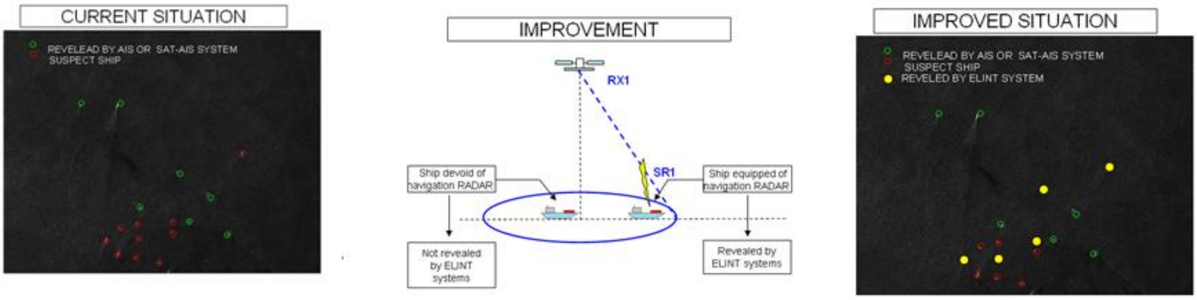


Figure 10: Satellite ELINT improving maritime situation

Satellite segment - SATCOM Communication Simulator

To evaluate the employment of a Ka band communication Thales Alenia Space Italia provided a SATCOM Communication Unit Simulator (SCUS) in Ka-band to simulate a Beyond Line-of-sight Datalink between RPAS sensor nodes and a "National Situational Picture“ central node (COP) collecting/fusing data on a given Area of Interest to improve the activities of Sea Border surveillance. The use of real-time video-streaming provided by the RPAS and transmitted to a control centre via a beyond line of sight satellite data link permits to provide early-warning patrolling remote area; Increase situation awareness relaying on RPAS data collected in real-time.

In Figure 11 a screenshot of the SATCOM Communication Unit Simulator is represented in the case of heavy atmospheric losses which reflects high impairments on the RPAS video streaming quality from the optical payloads such as those represented in Figure 12.

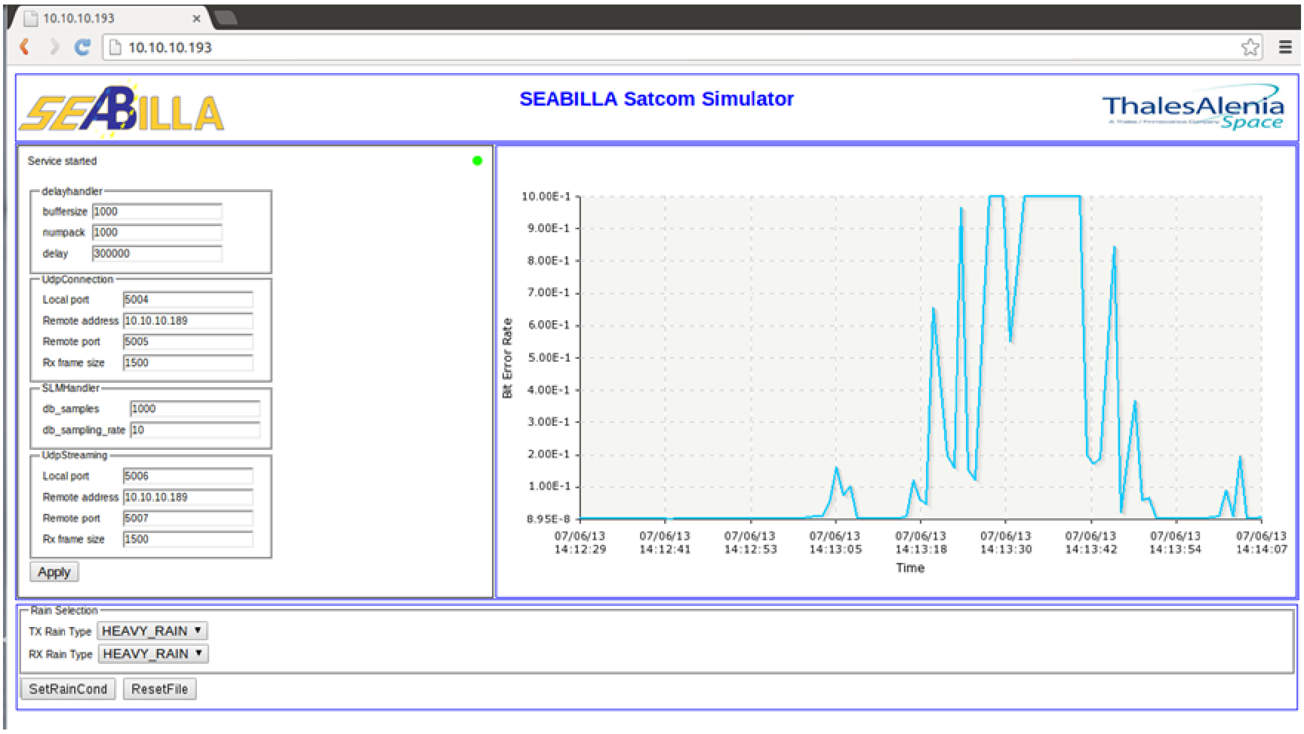


Figure 11: BER Dynamics in heavy rain

Figure 12: RPAS video streaming SATCOM datalink in heavy rain

Cooperative traffic

CNIT and SELEX ES have investigated the idea to assimilate the radar tracks provided by the navigation radar into the Command and Control post to expand the situational awareness in areas beyond the coastal surveillance systems where no other data are available. Such data can be transferred to the ground using VHF channel or dedicated SATComms; to explore the potential of this approach a simulation have been performed to analyse the Sardinia Channel coverage exploiting the presence of the high density route between Gibraltar and Suez. Assuming a journey of a small boat from Algeria to Sardina and a crossing of the commercial ship corridor, encouraging results have been achieved with many detection (in the order of 300 hits) in the deep sea area near the African coastline. This proofs the high potential of such approach well received from the end user community

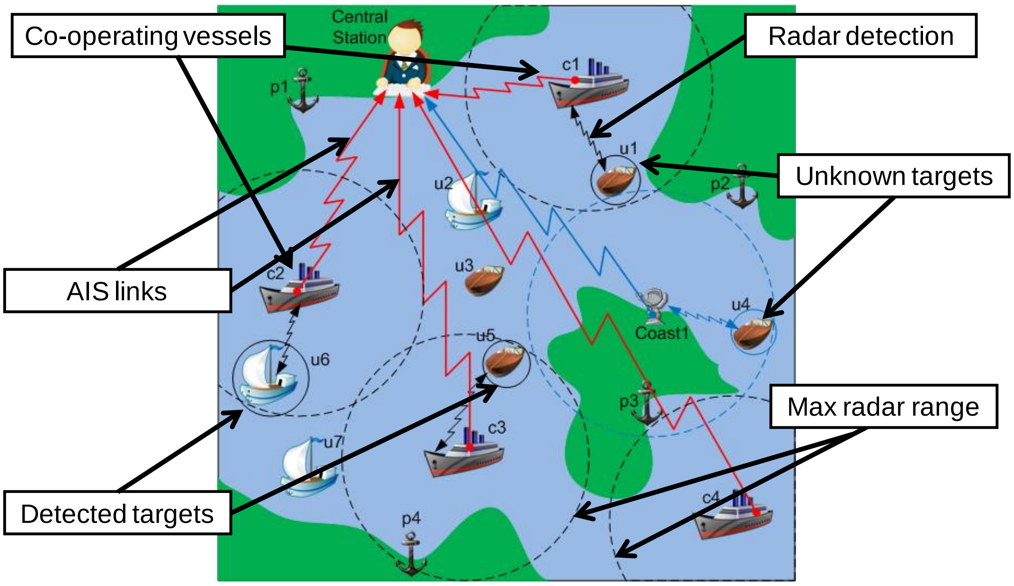


Figure 13: Commercial ship navigation radar concept

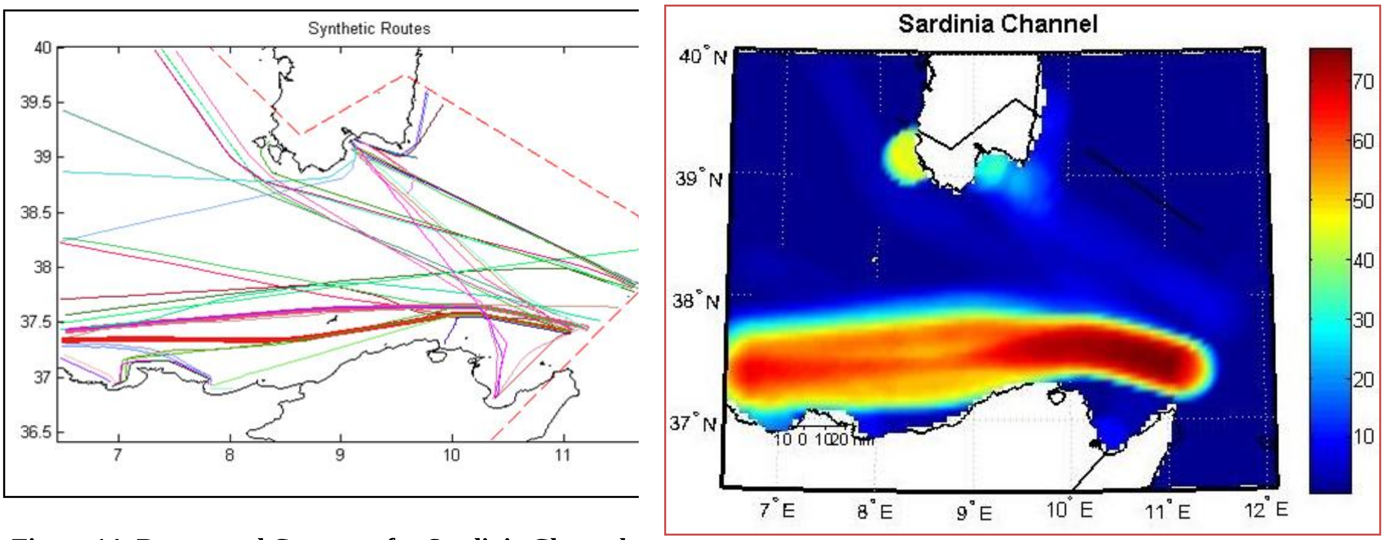


Figure 14: Routes and Coverage for Sardinia Channel

Conclusion about Mediterranean

Research and investigation on the way to improve the awareness at Sea in the Central Mediterranean have demonstrated that this objective can be achieved by combining a number of different solutions while providing the necessary glue to allow sensor cueing and coordination.

In the next table a summary of the results is shown

Sardinia	HR Radar	RPAS	AIR PATROL	COOP Traffic	EO SATELLITE	COVERAGE	TRACKING CONT.
SUC 3.1.1_A	1	1	NO	YES	YES	60%	60%
SUC 3.1.1_B	1	1	NO	NO	YES	17%	9%
Sicily							
SUC 3.2.1_A	1	1	NO	YES	NO	83%	32%
SUC 3.2.1_B	1	1	NO	NO	NO	32%	16%
SUC 3.2.2_B	1	1	1	NO	NO	35%	17%

Table 2: Mains Mediterranean metrics results

ATLANTIC SCENARIO

About the Atlantic most of the focus was put on the satellite capabilities, RPAS and behavioural analysis. The Baseline Situation before SEABILLA's SUC for the Atlantic is depicted in the following picture; the current coverage includes SIVE Radar, Basic radar stripe measures related to AIS stations near the covered area in the coastal stripe. On the right the resulted SUCs coverage is reported

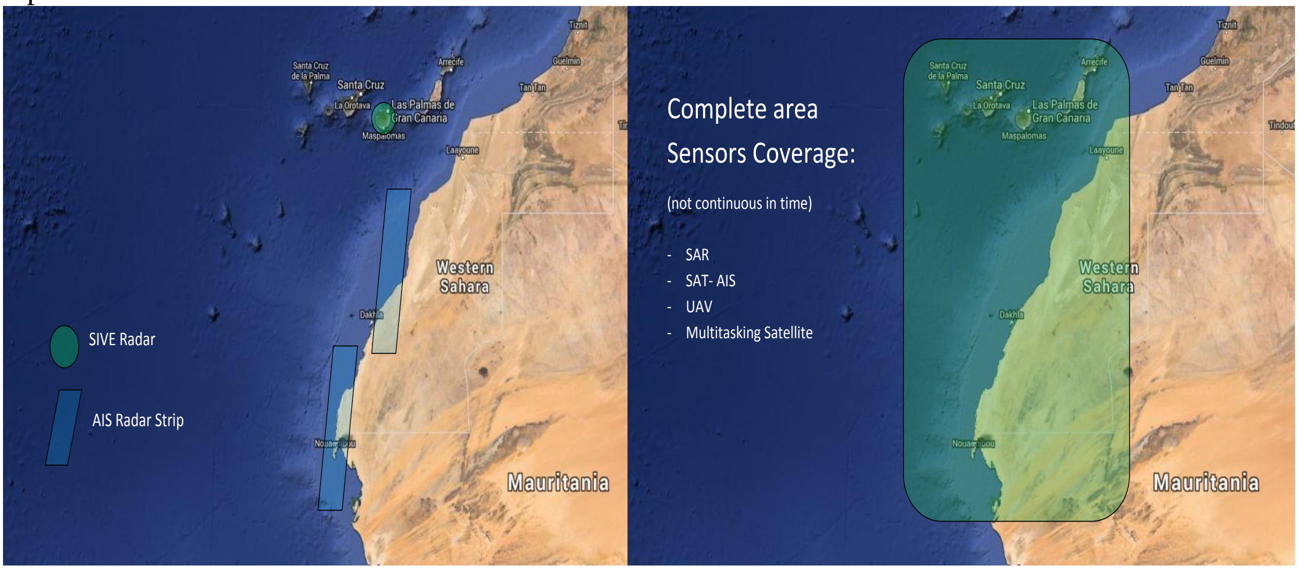


Figure 15: The Atlantic Scenario Baseline sensor coverage/After the Seabilla improvements

The Seabilla's pyramid for the Atlantic is shown in the next picture

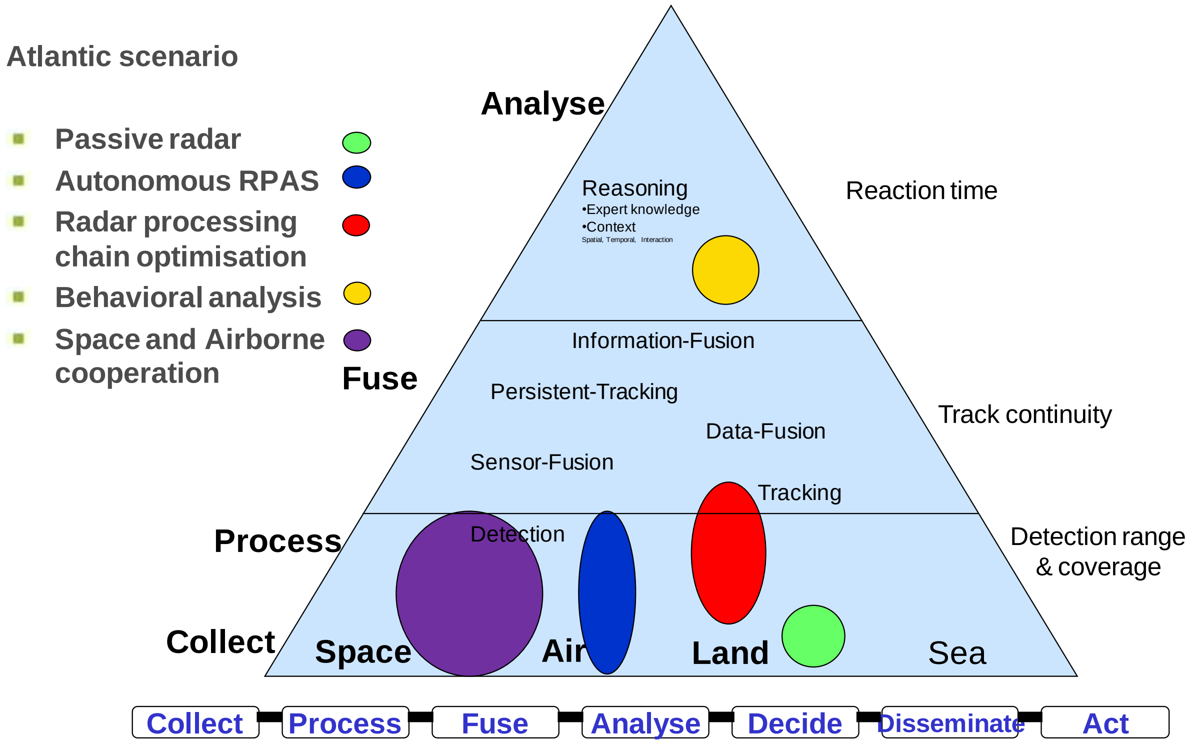


Figure 16: The SeaBilla's Pyramid – The Atlantic Scenario

For **SAR enhancement** the activity carried out by Edisoft focused the increase of detection rate in SAR images overcoming the limit of the the standard algorithm based on the correlation window that is very robust to detect medium and big ships with medium/high SCR, while it is less suitable to detect small ships with low SCR. The tests performed with such new algorithms have proofed the ability to detect small and fast boat.

About the **RPAS**, Sagem developed through simulation an valuable analysis of the surveying capabilitiesd Data transmission and operator workload; the main conclusions concerning the performance of the autonomous RPAS are the following:

- The surveyed area per mission is about 270000 km2. The important factors contributing to area coverage are the maritime radar detection range and the RPAS speed. For missions requiring important area coverage (Atlantic scenarios), medium/high speed RPAS are better adapted. For missions requiring smaller area coverage (English Channel scenarios), low/medium speed RPASs can be used.
- The time for being on zone (for coastal areas) is less than 1 hour (from initial order to ship detection). Additionally, the image reports are transmitted in just a few minutes (snapshot sequence duration) providing the ground operator with detailed information. Hence, RPASs provide a flexible means for detecting, identifying and recording evidence of illicit activities.
- The detection probability decreases significantly for small and fast boats. These targets are more difficult to detect due to their small dimensions and their high speed can enable them to escape detection in case of large areas of surveillance. In this case, the use of several RPASs with a smaller area of interest enables to get a higher detection probability.
- The imagery chain bandwidth requirement is much less than 1 Mbps, even considering large image reports (several dozens of images). This bandwidth requirement is low because only images are transmitted instead of continuous video. Additionally, recorded video snippets replay can of course be requested by the operator if necessary.
- The operator workload is reduced to a few minutes per target. With the proposed solution, the role of the ground operator is changing from “detector” to “analyst”. The operator is relieved from the need to continuously watch the video stream. He is alerted whenever a new information is available (new detection, new image report). The simulations performed in different scenarios with varying traffic density show that the operator workload is significantly reduced in low traffic density areas (e.g. Atlantic). In this case, the system brings a high benefit as the operator is relieved from long periods of inactive observation. In high traffic areas (e.g. English Channel), the RPAS is constantly detecting/tracking targets and is constantly alerting the operator.

About the **SAT AIS**, TASF developed through simulation an analysis on future needs for this technology applied in a so wide geographical context. The Atlantic scenario has illustrated the detection performances of a given “voyage” with different SAT-AIS system (Medium Performance or High Performance satellites, varying number of satellites) and different environment (fleet model in 2013 or fleet model forecast in 2022). SAT-AIS, 2 families of metrics have been considered:

- Ships tracking metrics (can the satellite receive and track the AIS signal signals transmitted by ships?)

- AIS switch-Off detection metrics (can the satellite detect when a ship stops emitting AIS?)

The conclusions are that today SAT-AIS systems (medium performance system) work well in low density maritime area (as shown in Atlantic scenario, with 2013 fleet), but does not give satisfactory results in more dense areas (like Atlantic scenario, with 2022 fleet).On the other hand, High performance SAT-AIS systems offer satisfactory results, including in dense areas. The various metrics highlight clearly significant efficiency improvement of detection capabilities between MP (Medium Performance) SAT-AIS system and HP (High Performance) SAT-AIS system.

About the **MultiSAT**, INDRA developed through simulation an analysis of the benefits of the availability of multiple passage on the same area of differents EO satellites. Dynamic multi-sat tasking analysis consists in the evaluation of the approach for combining different Earth Observation satellite's orbit, sensor field of view geometry, shape and location of a user-defined area of interest (AOI), determining the exact times when multiple satellites would be capable of observing the specified area, with the aim to quantify the revisit time parameter which is a one of the key factors for spaced-based maritime surveillance.

Dynamic multi-sat tasking analysis has been accomplished with satellite mission planning tools for satellite constellations to identify optimal image acquisitions to be used in the survey. In addition, this theoretical analysis has been used for tasking acquisitions and purchase images from commercial satellite providers. Finally, image analysis carried out on these purchased images allowed measurements on the rest improvements factors as defined in D13.1 document.

ENGLISH CHANNEL SCENARIO

The English scenario dealt with irregular immigration, illegal trafficking of goods and terrorism. The context is characterized by short distance and high ship density. Some application as the terroristic attacks requires fast reaction capabilities. The Seabilla's pyramid for this scenario is shown in the next picture.

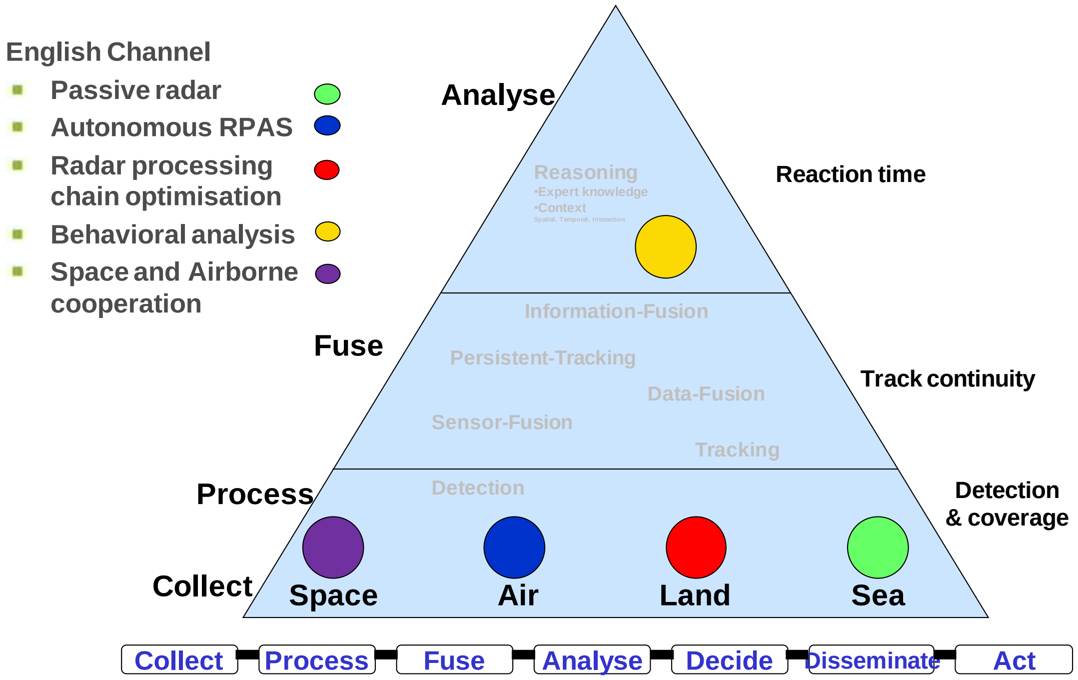


Figure 17: The SeaBilla's Pyramid – The English channel Scenario

Improvements brought by Seabilla on the English Channel mainly refers to improved detection and coverage

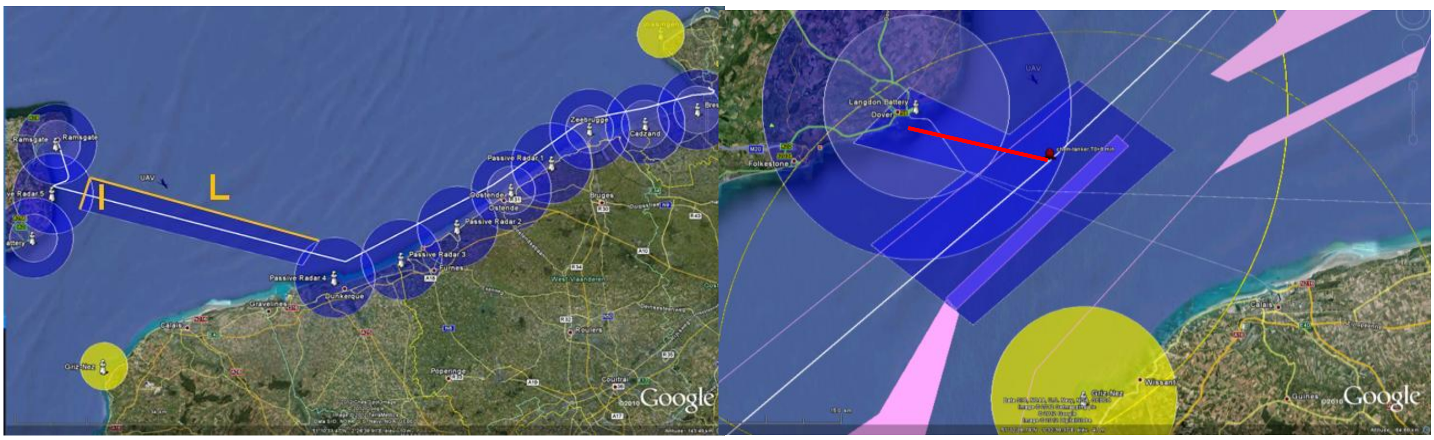


Figure 18: The English channel Scenario - Examples on improvements in terms of coverage for the irregular immigration and antiterrorism vignettes

The following main results have been achieved for the English Channel vignettes.

Techno	Drug trafficking	Irregular immigration	Terrorism
Passive Radar	0	5	0
Autonomous RPAS	1	1	1
Radar processing chain optimisation	0	6	1
Behaviour analysis	1	1	1
Detection & tracking	0	0	1
Satellite and airborne cooperation	1	0	0

Table 3: Involved techno in English Channel

Vignettes	Detection	Coverage	Tracking continuity	Available time to decide
Drug trafficking	140%	120%	180%	
Irregular immigration	50%	70%	80%	
Terrorism				300%

Table 4: MoE in English Channel

English Channel physical and synthetic trials

Thales Passive radar (PLC)

Dedicated Seabilla PCL experiments for English Channel demonstration were conducted between the 23th and the 27th of September 2013 in Saint Cast-le-Guildo (Brittany), near Saint Malo. Tests were organized with the much appreciated support of both French Maritime Surveillance authorities (authorisations, site access, and traffic coordination) and Gendarmerie Maritime (instrumented target evolutions). The PCL was located on the premise of a French Maritime Surveillance semaphore overlooking the port of Saint Cast-Le-Guildo, thus providing a clear field of view of coastal waters from North-West to South-East.

Figure 19: PCL deployment (inshore view with semaphore in the background)

Two types of cooperative targets were provided and operated by the Gendarmerie Maritime, representative of medium size (about 20 m) and small boat (few meters) both equipped with GPS

Quantitative analysis for instrumented targets demonstrated that:

- For medium size boat (Vedette), the best DVB-T channel enabled excellent detection rate under 10km, and very good performance up to 20km except for trajectory legs presenting very small Doppler effect. Detection is still possible between 20km and 30km, though performance logically decreases, as signal to noise ratio drops, and the target nears its radio horizon.

- For a very small target (small inflatable rubber boat), detection is quite difficult, due to both its small radar cross section, and its position very near the sea surface level. Except in one run (best DVB-T channel, best weather) where it can be followed in the first two kilometers, it is rarely detected in a continuous way, but rather appears to be detectable during brief periods of time in the 1km to 10km range.

this demonstration confirms that DVB-T PCL may indeed act as a gap filler for coastal surveillance especially in mobile application to improve and reinforce the existing coverage whatever the vessel by an adapted deployment taking into account the real PCL performances (like for the very small boats with few metallic parts located low on the water), though some peculiarities due to bi-static configuration would not guarantee the same overall coverage as traditional radars. These issues may be somewhat offset by the fact that DVB-T PCL should be easier to maintain, as well as better accepted by local citizens concerned by radiation emission.

VTS radar processing chain optimizaton

Demonstration of the VTS radar processing chain optimisation was off line on raw VTS radar data recorded during WP2.3 data acquisition campaign 4th of July 2012. In this data acquisition campaign The Netherlands Coast Guard sailed with the “Visarend” patrol vessel and a RHIB instructed patterns. The raw VTS radar of the “Lange Jaap” was made available for off line processing optimisation. The results of the processing chain optimisation were shown in movies as the vessels and the environment are dynamic. In this document relevant screenshots of the movies are presented to show the radar processing chain optimisation results. The optimisation result is presented each time after the baseline ‘traditional’ VTS radar processing. In the radar processing chain optimisation all steps in clutter reduction, target detection, false alarm reduction and tracking are integrally taken into account.

Figure 20: Tracks and Vessel and Rhib used during the test

The movies of the VTS radar data with baseline ‘traditional’ radar processing and the optimised radar processing chain showed the End Users during the demonstrated the benefits of optimised processing chain during challenging conditions and that the track quality allows automatic detection of events with small non reporting boats.

Behavioural analysis

The Complex Event Processing (CEP) system has been developed by **TNO** to process in real-time vessel track data. For the initial research and development of this system in WP3.4 the GPS data set (tracks) with instructed vessels recorded by BAES was used.

Further real-time development has been done on simulated SeaLION tracks and live feed of IVEF tracks of the NLD Coast Guard. The IVEF tracks are fused tracks of VTS radar and AIS receivers along the Netherlands coast. The real-time implementation is based on Esper CEP engine in combination with Postgress/Postgis database system for scalable Behavioral Analysis module with spatio-temporal processing capability. The rule based End User events are presented on Google Maps user interface (see next picture)

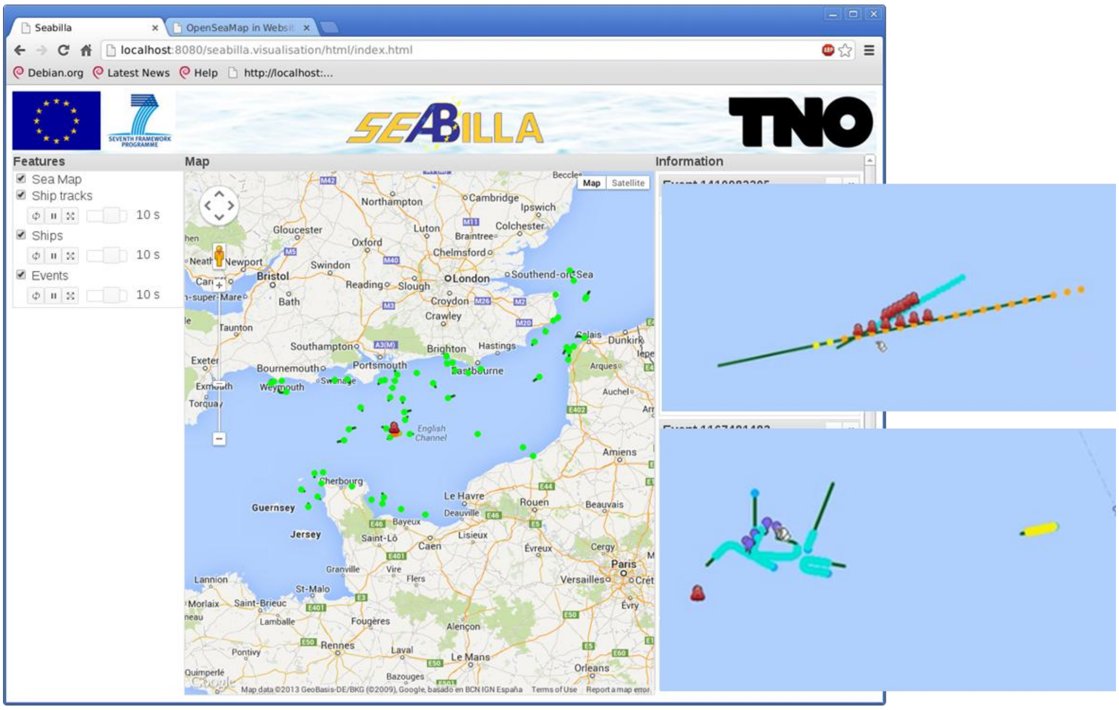


Figure 21: Screenshot of Behavioural Analysis GUI

The above screenshot shows the Behavioural Analysis GUI with English Channel drugs smuggling vignette. Right top zoomed moment chemical tanker is crossed by smuggle vessel. Right bottom small smuggle boats picking up drugs dropped overboard by the chemical tanker. The testing of the algorithm had been performed using AIS data collected from three main data sources: 1) Open source data (from 400 different web sites, 2) SAT-AIS data – provided by LuxSpace and SAT-AIS data – provided by excectEarth

Other behavioural analysis engines tested were:

The **Correlation Systems'** algorithm is a combination of diverse modules. First of all, there is an advanced tracker module which converts positioning vessel data coming from disparate sources (radar, AIS, GPS ..) into most-likely trajectories. This module is already capable to spot out cinematic alerts. Then the behavioural analysis engine, which is based on Bayesian network, will work on the trajectories and will identify individual as well as interactive suspicious patterns.

The **UMU** behaviour analysis algorithm has been developed on the basis of CEP-traj, a Complex Event Processing framework to process moving device trajectories.

The **BAES** behaviour analysis algorithm was based on learned Gaussian Process models to detect anomalies in marine traffic data streams. Gaussian Processes can be used as a highly-flexible regression technique for learning. As processes define sets of functions which conform to some observed data, these are of great use when the generating function is unknown, complex, or of secondary interest. The technique allows to learn a normal set of (multi-modal) behaviours and test for anomaly without needing to know the subtleties of the underlying behaviour. It is based on a stream of data (e.g. tracks, GPS locations, AIS streams), and points or tracks which are not internally consistent are highlighted. It has the advantage over more parametric methods (e.g. Bayesian Networks) in that no detailed model of normal or abnormal behaviour needs be built.

The FOI algorithm aim is to to detect hand-over of illegal goods or immigrants between two ships which pass by the same sea area during two different time periods with the goods left floating in the water during the time between. CEP with the Esper tool has been used to find approximate time and position for a potential pick-up of goods potentially dropped into the water at an earlier passage of another ship. Position reports from each ship in a scenario (typically several hundreds of ships) are assumed to be delivered each 5 minutes (like from AIS). For all pairs of reports from ships where a (pick-up) ship position is within a certain distance to at least one position of the "wake" of another (dropping) ship (say, 1 km) within a certain time (say, one hour), the position pair is saved for further analysis. What is referred to as the "wake" here is simply the earlier reports from the dropping ship. If, furthermore, the pick-up ship has at least three position reports close enough in space-time (according to the limits given above) to the wake, and also reduces its speed (to be able to do the pick-up) from more than 10 m/s to less than 5 m/s between the first and the second compared to the second and the third, report, this behaviour pattern will be reported as a potential pick-up situation at the time of the third report. The reported position – sent as an alert from the CEP system - will be the interpolated position on the wake closest to the pick-up ship. Pick-up situations are only reported once – the first time detected - from the same pair of "dropper / pick-upper".

Enhanced classification

The Semantic Classifier is an RDF/SPARQL based classification engine, capable of applying a set of classification rules, each associated to an entry in a taxonomy hierarchy.The enhanced classification using the semantic classifier will be shown within the Mondeca ITM tool. The classification request comes from the SeaBilla knowledge manager module. It consists of the URI of a given Vessel. The results of the classification process are maritime class which the vessel belongs to. The next picture shows the different components of the classification service.

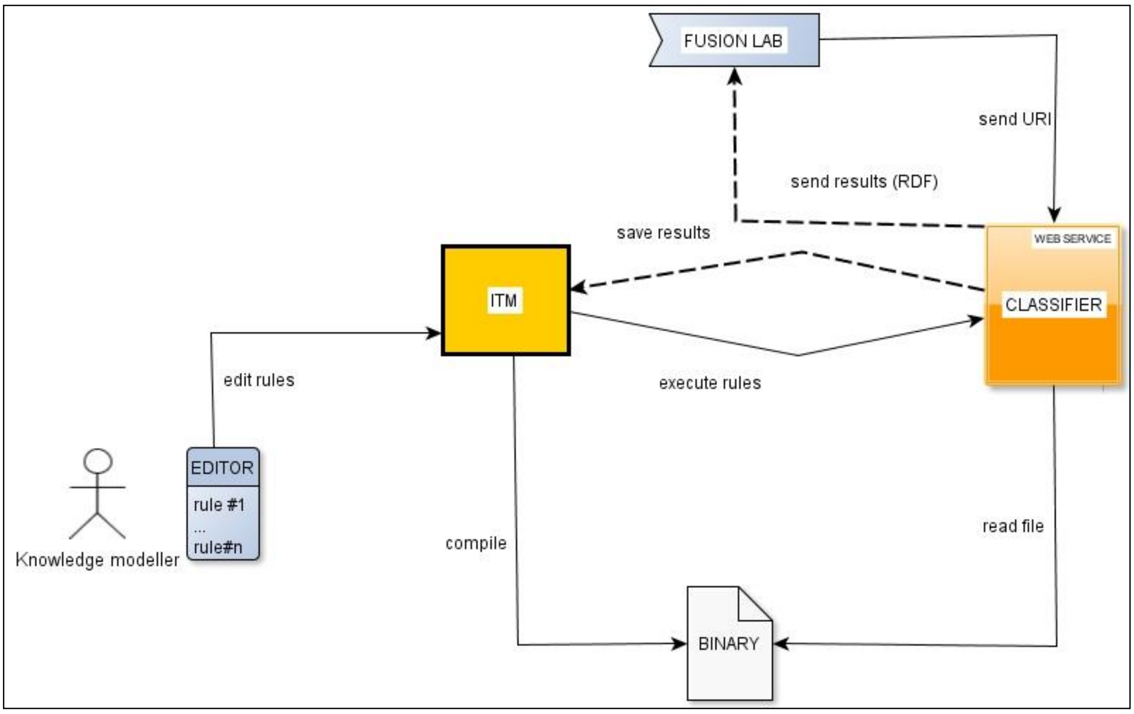


Figure 22: SeaBilla classification service architecture.

The potential impact, the main dissemination activities and exploitation of results

The SEABILLA project has developed new concepts in the project area 2 (SP2) “Surveillance segments improvements”, project area 3 (SP3) “Sensors networking and information fusion” and project Area 4 (SP4) – Trials, demonstrations and validation. The exploitation of the capabilities developed and demonstrated within the SeaBilla program is based on a multi-level strategy to be the widest possible. The mechanism for the exploitation of the capabilities developed and demonstrated within the SeaBilla program is through the Industrial and SME partners within the consortium. These partners are related to sectors within the Homeland Protection market within which the results of SeaBilla may be exploited.

This exploitation plan is created using the contributions of all participating parties taking into account:

- maturity and performance assessments of the integrated solutions and of the different components
- identification of applicable standards and further standardisation that would foster implementation (WP5.4)
- identification of the legal framework and of relevant legal issues (including privacy), from WP1.4 Legal study
- results from User Workshops (WP5.2)

From the Seabilla’s perspective surveillance goals are to save lives at sea, decrease irregular migration and trafficking, and improve Search and Rescue operations: to reach these goals, maritime surveillance involve different technologies which can be implemented in three different zones according to the technology. These zones are: Territorial Zone, EEZ, High sea zone, and Third country zone.

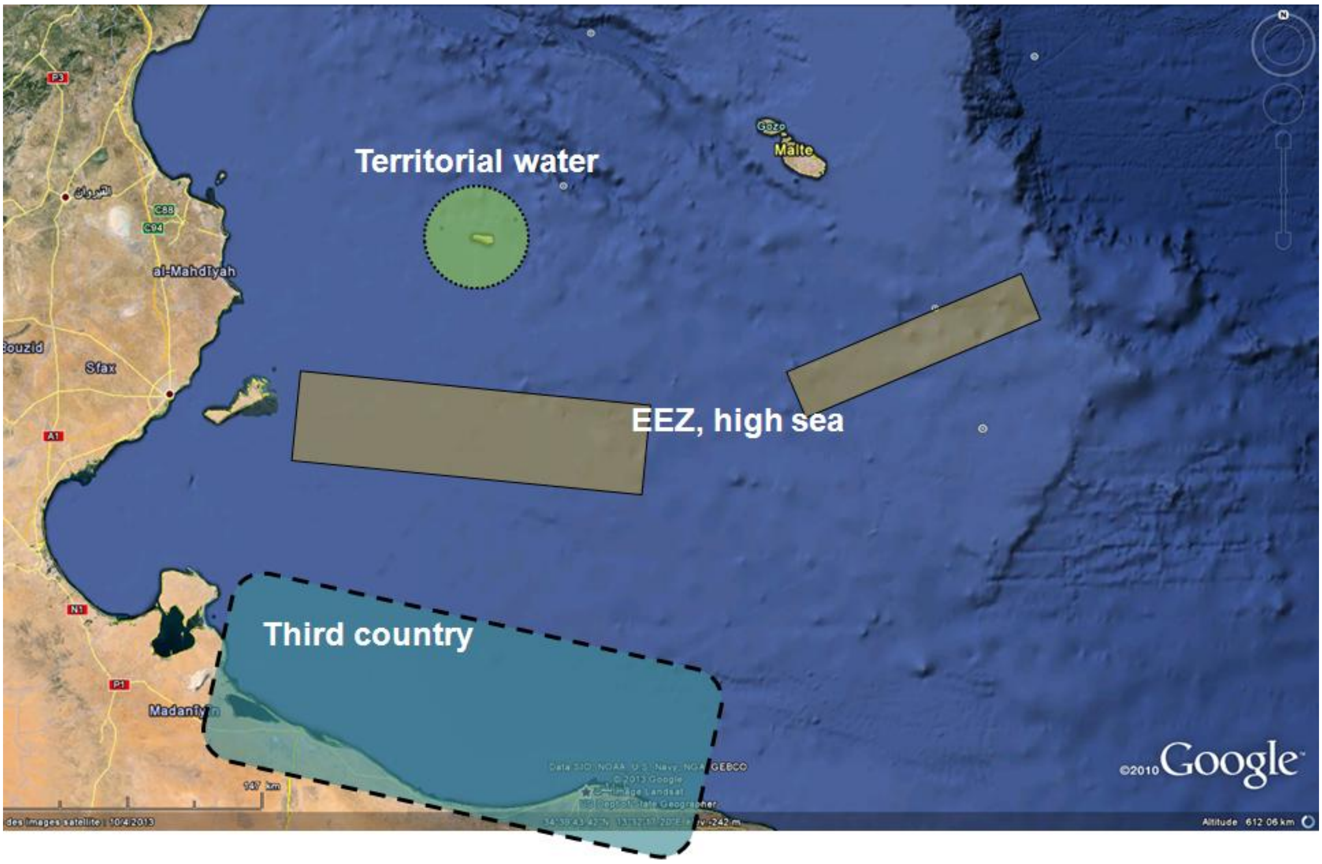


Figure 23 : 3 main areas

According to the above zones, technologies that can be implemented are:

In the Territorial Zone, existing means for maritime surveillance such as radars or Electoptical systems can be improved with

- Implementation of clutter reduction algorithms to improve the detection of small boat on existing coastal Radar,
- Implementation of behavior analysis for operator help,
- High resolution Active and Passive radar to detect all boats and especially improve the detection of the smaller one
- RPAS for tracking on designated target coming, directing the patrol ship to intervene,
- Creation of a Common Maritime Picture built from local, regional, national and European inputs.

In the EEZ, High sea Zone, several technologies can be involved to detect and follow the suspicious vessels

- Satellite SAR imagery,
- Multi satellite tasking,
- Satellite AIS,
- RPAS/MPA for the Surveillance on large area,
- RPAS for tracking on designated target coming from satellite detection or intelligence,
- Radar Network of Co-operative Vessels.

In the third country zone, the goal is to provide early warning information about the suspicious ships which are leaving coast towards maritime zone object of the surveillance

- To reach these requirements the technologies which can be used are:
- Satellite SAR imagery,
- Multi satellite tasking,
- Satellite AIS,
- Intelligence means.

SEABILLA ROADMAP

Once the concept of Maritime Surveillance is defined, the suggested roadmap for SeaBilla implementation can be a bottom up approach implementing technologies from the existing surveillance capabilities in the coastal zones to the High sea zones and at the end to the distant coastal zones. Taking into account the implementation of technologies in existing systems for coastal surveillance and also the maturities of each technology, the suggested philosophy is to complete with improved or new technologies for territorial zones and gradually implement new technologies in EEZ and high sea zones and further for third country zones as described in the following figure.

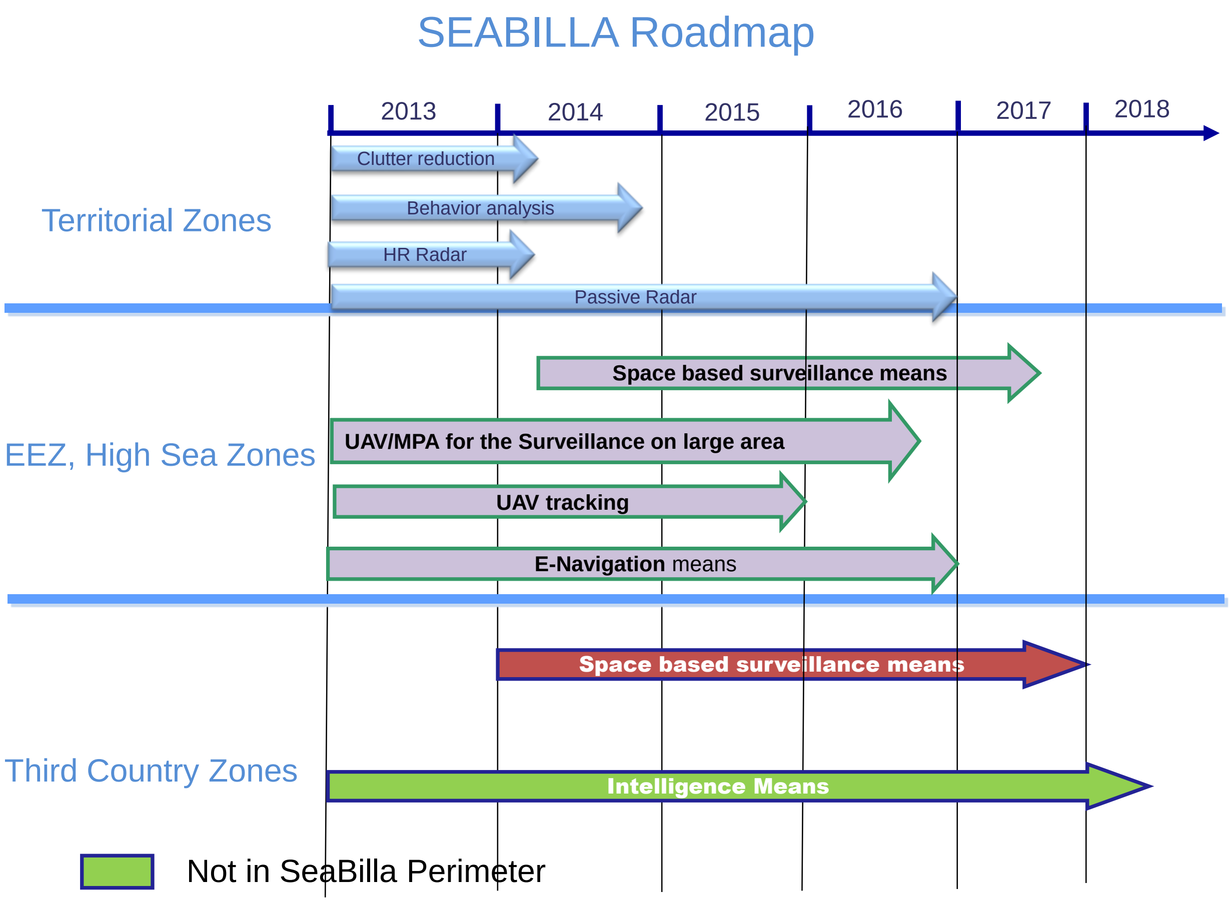


Figure 24 : SeaBilla Roadmap

Dissemination activites

The main mechanisms adopted to disseminate the Seabilla results during the project lifetime were:

- Meeting with regional end user carried out by the demonstration scenario leaders (Edisoft, Indra, Selex, Thales)
- European wide dissemination in the three end user workshops
- Participation of Selex and Thales to the Marborsur informal implementation group which was the channel to dialog with Frontex and DG Home
- Seabilla Web site
- Demonstrations (live and simulated at simulation facilities provided by the partners)
- International event in the maritime sector (Frontex days, European Maritime days, workshops)

In regards of the post end activities the various Seabilla partners can exploit results in:

- Leverage on individual dissemination plan
- Push follow up in the incoming opportunities at EU RD level (Horizon 2020, POV Closeye)

Exploitation activites

The exploitation potential of the industrial and SME partners is extensive and covers large segments of the security market. The SeaBILLA consortium has full coverage of relevant capabilities and good complementarities among the partners.

The IPR environment defined in this program also enables the open collaboration between partners to maximize the potential for collaboration on the exploitation of results. Especially for SME, Research Centers and Universities, the project has been an invaluable opportunity to expose themselves to the context of large Security Systems and will offer a vast visibility of their products and activities to the End Users community.

The main drivers of the exploitation are:

- The user-oriented approach favours the integration of several technological components and solution bricks rather than a unique Sea Border Surveillance System. Thus the outputs of the project will be available for use at several levels: at the equipment level (e.g. sensors), at the subsystem level (e.g. platforms) and at the system level (integrated surveillance system).

- Technology insertion into end-products will then be possible not only for the system integrators which participate to the project but also to companies that provide components. A number of SeaBILLA solution bricks can be applied to existing sensors and information systems, allowing progressive performance enhancements through retrofits. This property is expected to be a multiplier of opportunities to bring SeaBILLA results to the market.

- Blue border surveillance is an emerging and rapidly expanding market where the variety of customer requirements and national agencies (currently in the stage of European coordination through organizations like FRONTEX) allow for a large possibility of system solutions, involving ground facilities, airborne platforms and satellite use. Therefore the exploitation of SeaBILLA achievements will be done at several levels, ranging from upgrade of existing systems (e.g. information management systems) and exploitation of existing platforms (satellites), that can provide solutions to customer in the near-term, to the brand new development of system solutions or components that will be introduced later to the market according to its own development schedule.

- Another characteristic of the project is its combination of solutions that are at different stages of maturity, according to their Technology Readiness Level but also to the regulatory framework status: for example the UAS domain is still in search of technical and regulatory improvements that will allow the insertion of RPASs into non-segregated airspace, whereas manned platforms offers immediate solutions for maritime surveillance. Therefore the exploitation of SeaBILLA results is expected to be spread over a large timescale.

Example of Seabilla Exploitable achievements

In the following a short description of exploitation path for significant achievements is the space, air and land and sea based segments is given.

SPACE BASED SURVEILLANCE

The contribution of Space based Surveillance to the European platform for the Border Maritime Surveillance comprises several topics that will be shown in this chapter and that have proven its usefulness by its high level of compliance with the requirements in line with the SeaBilla objectives. The main explitable results are:

- Radar imaging and SAR processing techniques
- Spaced based-AIS
- Space data fusion
- Dynamic multi-satellite analysis and Optical satellites image processing

Seabilla partner involved: E-geos, Indra, Edisoft, TASI, TASF

In the context of SeaBilla project, different algorithms for SAT Image processing were compared and the advantages/limitations were deduced. The improvement possibilities considered for the near future are the following:

- An advanced analysis of the area to process should be done, to set dynamically the threshold of the used algorithm.
- The limitation of the velocity estimation should be overpass (or, anyway, be reduced) analyzing new filtering techniques that are able to increase the visibility of the wakes and to improve the target spectrum reconstruction.

- The implementation of super resolution filters for the ship signature reconstruction in high resolution images could provide very useful information in the context of border surveillance activities.
- The ingestion of new SAR systems, as TerraSAR-X, CosmoSkyMed and Sentinel-1, is foreseen.
- The use of the polarimetry for ship classification purposes is also considered very important in the next months.

The fusion of relevant data was demonstrated by the developed algorithms where all the cooperative data used were correlated with the detected ships in the SAR images. Automatic information extraction was also demonstrated when the correlator provides information about the non-correlated ships, that are detected in the SAR images but do not transmit cooperative signals. Multisensor multimission data fusion is a key part of such potential

As exploitable results derived from these analysis on optical images a set of end user product/services may be already delivered such as automated reporting for ship/small boats detection, change monitoring maps on hot spot areas (eg: harbours) or on-shore illegal activities mapping. The following table summarized a roadmap of the availabilities of these techniques. It's based on the internal strategy of each partner which may change depending on the industrial priority and the market.

Space based surveillance	Date of availability
Radar imaging and SAR processing techniques	2014
Spaced based-AIS:	2013
Medium perfo Satellite	existing
High performance Satellite- 1st element	2017
Overall hybrid performance Satellite- final system	2024
Space data fusion	2014
Dynamic multi-satellite analysis and Optical satellites image processing:	2013
Change monitoring maps on hot spot areas (eg:harbours)	existing
Validation assessments maps (on-shore illegal activities mapping)	existing
Automated reporting for ship/small boats detection (Basic)	existing
Automated reporting for ship/small boats detection (Improved)	2015

AIR BASED SURVEILLANCE

In the future the newly available sensors to carry on board of RPAS will provide:

- higher resolution (for both Radar and EO/IR)
- enhanced multi-spectral and hyper-spectral imaging
- improved stand-off range and haze penetration (e.g. with Enhanced Local Area Processing technology)
- improved stabilization
- image intensification and edge enhancement techniques (for better IR images)
- reduced weight and size

As the above improvements will be adopted, they will contribute to an even better operational capability of the MALE RPAS (e.g in terms of surveillance data quality and higher flexibility for flight profiles and mission planning) and reduced costs and maintenance time. Current communications systems are adeguate to disseminate surveillance data and therefore also this technology area can be therefore mature for operational use.

In the future the newly available communication systems will provide:

- more integrated equipment; e.g. with Software Defined Radio (SDR)
- wider bandwidth satellite communications
- reduced weight and size

as the above improvements will be adopted, they will allow to communication of larger size surveillance data, such as those generated by higher resolution sensors or by a larger number of sensors on-board of the RPAS.

Given the maturity of the key technological aspects for the airborne maritime surveillance, the major issue preventing today the use of RPAS in the maritime surveillance operations is the limitation to operate in non-segregated airspace. In June 2013, the “Roadmap for the integration of civil Remotely-Piloted Aircraft System into the European Aviation System” Final Report has been issued from the European RPAS Steering Group. The document defines the path to be followed by R&D and regulatory activities in order to authorize civil RPAs to enter non-segregated airspace (possibly with some limitation) in 2018.

The following table establishes the currently expected availability dates for the key items presented above.

Key Item	**Availability date**
Radar & EO/IR Sensors	2013
Communications	2013

RPAS Autonomy	2013-2018
RPAS Integration in EU Aviation System	2018

LAND and SEA BASED SURVEILLANCE

The land and sea based surveillance includes at least for SeaBilla four different techniques:

- Radar processing chain optimization,
- High Resolution Radar,
- Passive Coherent Location,
- Cooperative naval Radar tracks.

The detection of the small sea surface targets like small boats, using current civilian radar systems is difficult due to the small radar cross-section and, in some cases, low speed of these targets and the presence of strong radar clutter from the surrounding sea surface.

In order to obtain an overview of the parts of a civilian (VTS) radar system that can be adapted for detection of small sea-surface targets, a generic processing chain has been tested. The Radar processing chain optimization is an innovative clutter reduction techniques. However to fully exploit the capabilities of novel clutter reduction techniques, it may be necessary to adapt the target detection and false-alarm reduction steps as well (at least the parameter settings).

Critical conditions for this kind of systems are: affordability of technology, vessel size, vessel location, coastal terrain, sea state, weather, vessel traffic density, EMI, spoofing, cooperative/non-cooperative targets, and vessel signatures (IR, RCS, visual, etc.), vessel tracking (Heading/Speed). All of these conditions should be taken into account when system assessments are made.

The availability of High Performance Coastal Radar (HPCR) can improve the surveillance performance by optimizing the number of patrol ship necessary to cover a specified area, mitigate the risk of undertaking naval mission and reduce the overall costs. The merit of such a system is usually gauged in terms of ability to detect and track small boat e.g. boats with small RCS (typically few square meters). This class of radars refers to specific technologies, often derived by military systems, which differs (in terms of improved performance and cost) from typical costal radar usually designed for Vessel Traffic Control.

HPCR combines synergic effect of high altitude of installation sites (a pre-requisite to get long distance coverage), duct effect and specific technologies. In particular the duct effect can significantly enhance the radar energy beam to illuminate small target at long distance (about 50KM). This situation leads to the so-called Over the Horizon capability. The radar coverage depends on the height of installation: a radar installed at 1000 meters above the sea level has an optical horizon of about 70 Nautical miles.

Moreover the duct effect is quite common in Mediterranean waters. It determines an anomalous propagation of the radar emitted radiation and its travel beyond the optical horizon. The additional advantage is the modest losses of the radiation which is channelled into the duct allowing to get a target with significant value of energy.

Although dedicated active radars are very effective at detecting and locating maritime traffic, they are subject to gaps in their coverage, especially along the coasts. Such gaps are bound to be recognized as vulnerabilities by malefactors and may be used for covert movements. As it would be quite expensive and impractical to multiply active radars for gap filling, it should be beneficial to study alternate approaches such as passive radar (passive coherent locator) which alleviate the need for active radar emission, combining reduced costs in their design, no constraints in spectrum management, low frequencies yielding good bi-static radar-cross sections and inherent operational stealth.

Passive radar is a misleading term as it implies no electromagnetic emission. In fact, passive radars would be best described as multi-static radars with non-cooperative emitters: in order to avoid confusion, this class of equipment is described as Passive Coherent Locator. Such non-cooperative transmitters are readily available along coasts, including FM and TV transmitters that project sufficient RF power to be of interest.

In SEABILLA, the study focussed on terrestrial Digital Video Broadcast (DVB-T) transmitters as this standard has now become very popular (analog TV is disappearing) and on the FM radio.

The following table establishes a roadmap of the availabilities of these techniques. It’s based on the internal strategy of each partner which may change depending on the industrial priority and the market.

Land and sea based surveillance	Date of availability
Radar processing chain optimization	2015
High Resolution Radar	2013
Passive Coherent Location	2015
Cooperative naval Radar track	2016

Detection and Tracking

Five detection and tracking algorithms have been tested within WP3.2 tasks. Algorithms from BAES (2), Selex Galileo and UCL have been tested with real datasets, while TAS-F algorithm has been tested with simulated datasets. In very general terms, the 2 standard approaches evaluated by the different BAE Systems groups at ATC and Warton struggled to track the targets, while the 2 novel algorithms evaluated by Selex and UCL performed reasonably well. Although this is a very encouraging outcome, more evaluations are required before claims about improvements can be made. This way, the roadmap for the exploitation of those technologies include the following milestones:

Milestone	Date of availability
Perform more evaluations of the algorithms both on synthetic and real datasets	2014
Include algorithms in commercial products	>2015

Identification and classification

The several identification and classification architecture implementations have been tested mainly with simulated datasets. Also, only individual components have been tested, not the complete system integrating all the components, so the work done within WP3.2 can be considered only as preliminary testing. The complete component integration and testing is being done during WP4 activities. As a general conclusion, it can be stated that some improvements are required before implementing the methods tested in this WP into commercial products. The next steps in the roadmap for the exploitation of those technologies deal with those improvements, that are listed below:

Milestone	Date of availability
Write better rules with the help of maritime surveillance expert, in order to improve the performance	2014
Build and integrate a complete platform with all the components working together	>2015
Meanwhile, the platform developed within SeaBilla can be reused for future tests to demonstrate its real power.	>2014

For the imagery chain management significant increased performances of the autonomous function are expected in the coming years (3 to 5 years' timeframe) thanks of combined use of additional sensors and future platforms.

For the abnormal behaviour analysis is a support function to operators helping them to assess and understand the situation in the maritime COP (Common Operational Picture). Non-profit Governmental agencies (e.g. FOI and TNO) might not have any commercialisation roadmaps of their own but will use the results from the SeaBilla project further in upcoming research projects and they will test the technologies in their public environments and support commercialisation in their industrial contacts and cooperation’s. TNO has currently a behaviour analysis system running on a trial bases with the Dutch Coast Guard operational environment. Commercially, these types of systems are now emerging on the markets, both in Europe and globally. Products are being developed and marked right now but the maturity of these products are difficult to assess. Some partners in the SeaBilla consortium have announced activities on the market already, on their own or in partnership with third party companies. Application areas are:

- Maritime small bot tracking
- Maritime constabulary operations
- Urban ISTAR
- Cyber defence and security

The market value for this type of products must be regarded as “considerably high”, especially taking into account the added value to customers selecting new sea surveillance systems. Since the market for these types of technologies are not limited to just sea surveillance but also including the security arena in general the market value is even higher.

Specific marketing roadmaps or other commercial plans are not available from partners but all have announced a high activity level in the field. Below an estimate of the market development in a short table form is given. One can especially note that there is an urgent need in change of the operational rules for sea transportation. If behaviour analysis techniques are going to become real efficient rules must be similar to ones used for air transportation with e.g. mandatory flight plans etc.

Behavioural Analysis	Date of availability
Early products emerging	2013
Operational testing and evaluation	2013 – 2016
Second generation products	2017
New rules for sea transport	20xx

The address of the project public website and relevant contact details

The Seabilla WEB site is reachable at www.seabilla.eu

The list of relevant contacts are reported below:

WP1.1	JRC	Guido.ferraro@jrc.ec.europa.eu
WP1.2	BAES	John.S.Anderson@baesystems.com
WP1.3	TCF	Philippe.roucoulet@thalesgroup.com
WP1.4	JRC	Guido.ferraro@jrc.ec.europa.eu
WP2.1	TASI	Fulvia.Verzegnassi@thalesaleniaspace.com
WP2.2	Alenia	fbruni@alenia.it
WP2.3	Selex	Agostino.longo@selex-es.com
WP3.1	Baes	John.S.Anderson@baesystems.com
WP3.2	EADS	philippe.chrobocinski@cassidian.com
WP3.3	Sagem	nicolas.massenet@sagem.com
WP3.4	Indra	lherasmu@indra.es
WP4.1	Indra	lherasmu@indra.es
WP4.2	Indra	lherasmu@indra.es
WP4.3	EADS	philippe.chrobocinski@cassidian.com
WP4.4	EADS	philippe.chrobocinski@cassidian.com
WP4.5	TCF	Philippe.roucoulet@thalesgroup.com
WP5.1	CNIT	luca.facheris@unifi.it
WP5.2	TNO	Eric.denBreejen@tno.nl
WP5.3	TCF	Philippe.roucoulet@thalesgroup.com
WP5.4	FOI	bjorn.larsson@foi.se
WP6.1	Selex	stefano.andorno@selex-es.com
WP6.2	Selex	stefano.andorno@selex-es.com

4.1 Use and dissemination of foreground

A plan for use and dissemination of foreground (including socio-economic impact and target groups for the results of the research) shall be established at the end of the project. It should, where appropriate, be an update of the initial plan in Annex I for use and dissemination of foreground and be consistent with the report on societal implications on the use and dissemination of foreground (section 4.3 – H).

The plan should consist of:

- Section A

This section should describe the dissemination measures, including any scientific publications relating to foreground. **Its content will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

- Section B

This section should specify the exploitable foreground and provide the plans for exploitation. All these data can be public or confidential; the report must clearly mark non-publishable (confidential) parts that will be treated as such by the Commission. Information under Section B that is not marked as confidential **will be made available in the public domain** thus demonstrating the added-value and positive impact of the project on the European Union.

Section A (public)

This section includes two templates

- Template A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- Template A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

These tables are cumulative, which means that they should always show all publications and activities from the beginning until after the end of the project. Updates are possible at any time.

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES

NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[2] (if available)	Is/Will open access[3] provided to this publication?
1	*Synthetic Aperture Radar Raw Data Simulator for Sea Environment Dedicated to Moving Ship Detection*	*Andrea Radius*	*Sensor Signal Processing for Defence*	*25-27 Sept. 2012*	*IEEE*	*London*	*2012*			*No*

[2] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

[3] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

			(SSPD 2012)							
2	*Advanced Ship Detection for Spaceborne based Maritime Awareness*	*Andrea Radius*	*European Space Agency Living Planet Symposium*	*09-13 September 2013*	*European Space Agency*	*Edinburgh*	*2013*			*No*
3	*An Application of a Fuzzy Classifier Extracted from Data for Collision voidance Support in Road Vehicles*	*Mercedes Valdes-Vela*	*Engineering Applications of Artificial Intelligence*	*No. 26, Vol 1, 2013*	*Elsevier*	*United States*	*2013*	*pp. 173-183*	*http://dx.doi.org/10.1016/j.engappai.2012.02.018*	*no*
3		*Jana Ries, Alessio Ishizaka*	*Proceedings of IEEE 2nd International Conference on Communications, Computing and Control Applications*	*December 2012*	*IEEE*	*Marseille, France*	*2012*	*pp. 1-4*	http://ieeexplore.ieee.org/ *xpls/abs_all.jsp?arnumber =6417853&tag=1*	no
4	*Ship Detection and Segmentation using Image Correlation*	*Alexander Kadyrov, Hui Yu, Honghai Liu*	*Proceedings of IEEE International Conference on Systems, Man and Cybernetics (SMC)*	*October 2013*	*IEEE*	*UK*	*2013*	*pp. 1 - 8*	*http://arxiv.org/abs/1310.5542*	*yes*

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities[4]	Main leader	Title	Date/Period	Place	Type of audience[5]	Size of audience	Countries addressed
1	*Workshops*	*EDI*	*Visit of IESM - GENERAL PROMOTION COURSE*	*16 November 2011*	*Lazarim (Edisoft), Portugal*	*Policy makers*	*30*	*Portugal, Africa*
2	*International conference in operations research*	*Jana Ries*	*Towards a decision support system for aerial vehicle routing problems*	*31 August 2011*	*Zurich*	*researchers and practitioners in Operations research*	*50*	*International*
3	*Conference*	*FOI*	*Combined sensor system for small vessel detection and tracking for maritime domain awareness*	*19-20 Oct 2011*	*Linköping TAMSEC 2011*	*researchers and practitioners in Operations research*	*100*	*International*
4	*Conference*	*EDI*	*Presentation in Geographical*	*07 December 2011*	*Geographical Society of Lisbon,*	*members and institutional*	*[100,500]*	*Europe*

[4] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[5] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

			Society of Lisbon		*Portugal*	*guests*		
5	*Workshops*	*EDI*	*Visit of the Secretary of Defence of the Democratic Republic of Timor Leste*	*05 January 2012*	*Lazarim (Edisoft), Portugal*	*Policy makers*	*< 20*	*Portugal, Timor Leste*
6	*Workshops*	*EDI*	*Visit of the Foreign Affairs Ministry/Diplomatic Institute*	*12 June 2013*	*Oeiras, Portugal*	*Policy makers*	*< 20*	*Portugal*
7	*Conference*	*EDI*	*III Congress 'Mares da Lusofonia'*	*23 May 2013*	*Rio de Janeiro, Brasil*	*Policy makers*	*[100,500]*	*CPLP (*http://www.cplp.org/*)*
8	*Workshops*	*EDI*	*Visit of the Delegation of the National Defense College of Índia*	*22 May 2013*	*Lazarim (Edisoft), Portugal*	*Policy makers*	*< 20*	*India, Portugal*
9	*Conference*	*EDI*	*TechNet International 2013*	*24 October 2013*	*Congress Center in Lisbon, Portugal*	*Civil Society*	*[100,500]*	*Europe*
10	*Workshop*	*SES*	*Marborsur Meeting*	*15 October 2010*	*Brussels EC*	*Frontex, Dg Home and maritime end user reps.*	*[20]*	*Europe*
11	*Workshop*	*SES*	*Marborsur Meeting*	*20 March 2011*	*Brussels EC*	*Frontex, Dg Home and maritime end user reps.*	*[20]*	*Europe*
12	*Workshop*	*SES*	*Frontex Event*	*April 2011*	*Warsaw*	*Frontex, Dg Home and maritime end user reps.*	*[20]*	*Europe*
13	*Workshop*	*SES*	*Marborsur Meeting*	*15 June 2011*	*Brussels EC*	*Frontex, Dg Home and maritime end user reps.*	*[20]*	*Europe*

14	Workshop	SES	Marborsur Meeting	19 July 2011	Brussels EC	Frontex, Dg Home and maritime end user reps.	[20]	Europe
15	Workshop	SES	Marborsur Meeting	01 March 2012	Brussels EC	Frontex, Dg Home and maritime end user reps.	[20]	Europe
16	Workshop	SES	Marborsur Meeting	31 May 2012	Warsaw Frontex	Frontex, Dg Home and maritime end user reps.	[20]	Europe
17	Workshop	AleniaAermacchi	Cost efficent and operationally effective solution for aerial border surveillance	24 25 July 2012	Almeria Spain	Frontex Guardia Civil	[50]	Europe
18	Poster	AleniaAermacchi	8th Future Security – Security Research Conference	17 ÷ 19 September 2013	Berlin (GE)	Scientific Community, Industry, Civil Society, Policy makers	150	Germany, Austria, Greece, the Netherland, Czech Republic, Italy, Sweden, Belgium, United Kingdom, France, Finland, Spain, Poland, Norway, United States
19	Meeting	SES	VIP Day Organization	21 Sept 2013	Brussels EC	DG Entr	[15]	Europe
20	Conference	TASI/EGEOS	Copernicus: Working Towards Safer Seas	22 May 2013	Malta (La Valletta)	Potential Users	30	Europe
21	Conference (International Radar Symposium 2013)	CNIT	A Maritime Radar Network for Surface Traffic Control Based on Service Vessels	19-21 June 2013	Dresden,Germany	Scientific Community/Industry	50	International

22	Conference (European Microwave Week 2013)	CNIT	Analysis of the radar coverage provided by a maritime Radar Network of Co-operative Vessels based on real AIS data	6-11 October 2013	Nuremberg,Germany	Scientific Community/Industry	50	International
23	Conference	SES	European Maritime Day	22 May2012	Malta	Policy makers	30	Europe
24	Demonstration	EdiSoft	Atlantic Demonstration	19 September 2013	Lisbon	End users, Industry	20 to 30	Portugal, Spain
25	Demonstration	Thales	English Channel Demonstration	26 September 2013	Paris	End users, Industry	20 to 30	France, UK, Netherlands
26	Demonstration	SES	Mediterranean Demonstration	5 November 2013	Rome	End users, Industry, Frontex, EC	50	Italy, Spain, Portugal,
27	Demonstration	TNO	Third end user WS – Final Conference	14 January 2014	Brussels	End users, Industry, Frontex, EC	50	Europe

Section B (Confidential[6] or public: confidential information to be marked clearly)
Part B1

The applications for patents, trademarks, registered designs, etc. shall be listed according to the template B1 provided hereafter.

The list should, specify at least one unique identifier e.g. European Patent application reference. For patent applications, only if applicable, contributions to standards should be specified. This table is cumulative, which means that it should always show all applications from the beginning until after the end of the project.

TEMPLATE B1: LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC.					
Type of IP Rights[7]:	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant (s) (as on the application)

[6] Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

[7] A drop down list allows choosing the type of IP rights: Patents, Trademarks, Registered designs, Utility models, Others.

Part B2

Please complete the table hereafter:

Type of Exploitable Foreground[8]	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application[9]	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved

In addition to the table, please provide a text to explain the exploitable foreground, in particular:

- Its purpose
- How the foreground might be exploited, when and by whom
- IPR exploitable measures taken or intended
- Further research necessary, if any
- Potential/expected impact (quantify where possible)

[19] A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

[9] A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html