TaMaris Project : Interpretation of detected suspect vessel events

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ABSTRACT

As we face varied unlawful activities and other threats, innovative solution shall be set up to permanently track and monitor all type of ship traffics, in vulnerable trading lanes and country border zones in order to detect abnormal vessel behaviour, to understand suspicious event and to early identify threatening situation.

TaMaris on going development is a technical capability grouping analysis tools and operational procedures, operated from state of art human machine interface (HMI), to support experts group in understanding suspicious event, early identify threat and generating argued electronic report. Reports required for keeping continuously informed decisional authority. TaMaris is built up from the following technical components to:

- Correlate series of validated alarm on detected abnormal vessel behaviours within pertinent intelligent information sources to either confirm or not hypothesis on the type of on going suspicious event.
- Supervise process (multi-hypothesis criteria) conducting to early identification of threat.
- Provide geo-collaborative tools and advanced interfaces for experts group collaborative interpretation of suspicious event and identification of the threatening situation and associated consequences.
- Elaborate electronic formatted interpretation files in order to periodically inform decisional authority on event evolution and timely decide actions.
- Provide analysis set of tools to carry out specific studies on past identified maritime events and to elaborate various target factors for dedicated vessel tracking and controls.
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- Automatically index information in the interpretation files. These indexes are further used to create right to know keys to control and filter user accesses to archived files.
- Set up a base archiving interpreted suspicious events to be used as knowledge models by experts in the process to identify new threat from detected suspicious event.

The first TaMaris prototype would be available at the end of 2009 and will exploit alarms on detected abnormal vessel behaviour issued by ScanMaris ready prototype (SCANMARIS project was presented in MAST 2007 conference).

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CONTEXT

Figure 1 shows the layered architecture of a potential end to end system solution structuring all necessary technologies to prevent and investigate threats from understanding the common traffic picture up to the analysis of detected vessel suspect. These main research technologies are:

- Interoperability of various sensors (radars, AIS, satellite imagery, etc.) and data fusion to generate common operational traffic picture of the vessel tracks over wide maritime area.
- Interoperability of information and intelligence sources, and data fusion to generate common operational intelligent traffic picture of all vessels type activities over wide maritime area.
- Common definitions of abnormal behaviours and threats, and detection of abnormal behaviours of vessel tracks and activities.
- Common definitions of suspect events and analysis of the nature of suite of abnormal behaviours occurring in different sea locations and times.

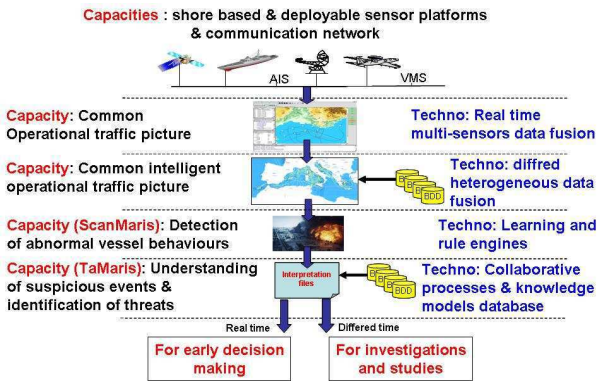

Figure 1. End to end system solution including TaMaris capacity

Main technical challenges are to fuse data acquired in real time from various sets of deployed sensors (conventional coastal radar, automatic identification system receiver, high frequency long range radar, high resolution optical cameras, satellite imagery, etc.) over a large maritime zone, and combine them with auxiliary information coming from existing on line databases (TF2000,

LLOYDS, EQUASIS, SATI, ICCAT, METEO-OCEANO, etc.) or intelligence, to built a common operational intelligent traffic picture where tracks for each detected vessel (cooperative and non cooperative) are appended with auxiliary information (name, flag, type, operator, owner, tonnage characteristics, destination, navigation conditions, etc.).

In ScanMaris capacity, both a Learning Engine built on the AMAS (Adaptive Multi Agent System) theory and a Rule Engine access the produced common operational intelligent traffic picture. The Learning Engine will process these data and assess the behaviour of each ship indicating three states: licit behaviour, abnormal behaviour and unknown. The Rule Engine uses both this assessment and the direct result of the data fusion process and analyse them using pre-defined rules established to detect abnormal vessel behaviour. For example these rules allow defining transhipping, boarding, shifting of speed/course, etc. Also, systematic coherence tests on all the acquired data are undertaken by the Rule Engine, for example, AIS code discrepancy with similar information in the on line Lloyds Register data base, etc. The Rule Engine issues alerts to an HMI. The operator manages each alert, provides a feedback to the Learning Engine, and specifies, possibly after enquiry, if the behaviour having triggered an alert is ultimately to be defined as "licit", "illicit" or "unknown".

Then, an alert (detected abnormal vessel behaviour) is immediately transmitted by the operator to the group of experts, with all the relevant data. This package is analysed, taking into account its peculiar evolution described as consecutive abnormal vessels behaviours, in order to identify if the corresponding event is suspect, and to define its illicit nature and the potential threats involved. During all this process, documented files are elaborated according to standard and procedure, and forwarded to decisional authorities to continuously follow the event status and to timely decide on appropriate actions. This is TaMaris capacity.

TAMARIS CAPACITY

Existing operational maritime surveillance systems, such as most advanced SPATIONAV (France), SIVE (Spain), MEVAT (Finland), show their limits regarding the understanding of the maritime traffic pictures. The displays are often crowded with hundreds of tracks representing ships, making the analysis of abnormal vessel behaviours complex (even not possible). Furthermore, the displays propose the ships real time positions only, and when replay is available, it is disconnected from real-time information. Most of the time, replayed and real-time information are not presented on the same tool, which does not facilitate the analysis of potentially unlawful activities. Above that, new system generation proposes to enrich the information presented to the users, with sets of alerts, contextual information, and new features to improve the quality of the analysis. This means that the users will be able to manage massive amounts of data, arranged both geographically and temporally. These data will also be mixed with contextual elements such as metrological, oceanography, economical and many other heterogeneous elements to be timely linked with the detected abnormal vessel behaviours.

Future solution proposes an innovative combination of hardware and software dedicated to the end-users, in order to answer the stakes defined by the large quantity and the heterogeneity of the maritime information to be handled. The selected hardware consists in a multi-touch and multi-user surface. Such a surface can be manipulated by several users at the same time and, with their multi-input capabilities, enable to implement efficient interactions inline with the navigation into massive quantity of heterogeneous information. This surface is also large enough to display the required quantity of data to fit the needs of maritime surveillance. As this hardware is engineered by one of the TaMaris partners, it will finally be possible to tune it, according to the ergonomic needs raised during the project by the involved Operational User Committee.

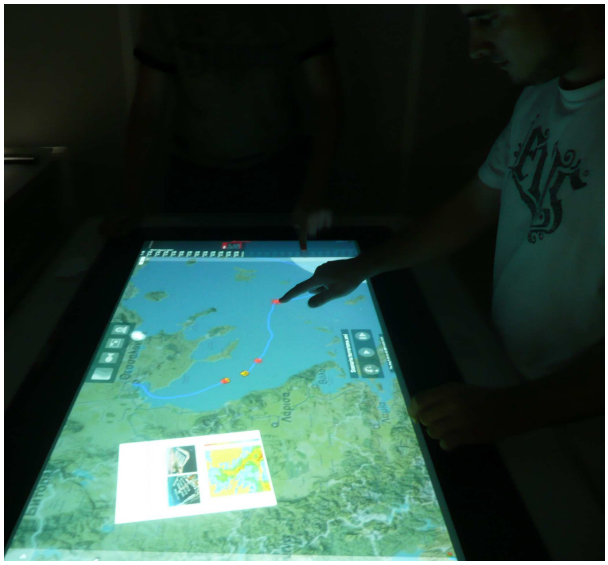

Figure 2. Multi-touch and multi-user hardware for the end-users

TaMaris capacity includes Human-Machine Interfaces software dedicated to a combined space & time navigation. The objective is to merge features of modern standardized geographical systems, which enable a quick and precise access to geographical layers and areas, with time navigation capabilities, providing an easy and integrated switch between recorded and real-time data. This software relies on a specifically adapted database structure, named What-Where-When (3W) database, which will be fed by the lower layers of end to end system solution (see figure 1). It offers specifically designed interactive components to the users on the multi-touch surface. These interactive components enable the integration of heterogeneous data seamlessly to offer multi-dimensional (space and time) localization and advanced filtering possibilities, based on the data themselves.

Finally, current systems poorly support the need for collaborative decision making, mandatory in order to propose a proper reaction to the illicit, and threat events. Current systems rely on paper procedures, email and telephone calls and informal discussions between the actors of the maritime surveillance, without any facility to support the communications or the presentation of the relevant information. The TaMaris capacity thus includes several techniques from the Computer Supported Collaborative Work (CSCW) to ease remote collaboration between different entities and co-present collaboration between operators in the same room. The collaboration is centralized in the 3W database, hence offering smart history (time) and precise location (space) of the different contributions, whoever their emitter is and whatever their nature is. This space and time contextualization has to objective of helping the progressive production of an analysis file that will be distributed between the operators and to the decisional authorities. The TaMaris HMIs also provides open communication capabilities to attach external data (pictures, documents, specific data formats such as ones generated in air patrol recognition missions, etc.) into consistent analysis folders, and to share these folders with other operators and decisional authorities. The complementarities between the distributed information system and the support for different types of media, are enable the creation of a global collaborative environment oriented toward an optimal use of the resources (humans and systems) for powerful and quick decision making.

TAMARIS CAPACITY DEVELOPPMENT METHODOLOGY

Iterative approach is retained to the development of the TaMaris HMIs, in order to fully support the participative and iterative approach. The design of the HMIs is achieved progressively starting with paper mock-ups that are easily modifiable and transportable. The paper mock-ups enable to collect the first feedback from the users and reach unambiguous agreements between the users and the project team, early in the development phase. Then, paper mock-ups are transformed in simple interactive prototypes. These early HMI prototypes also contribute to the continuity of the feedback from the users, and propose a framework for the unit tests of the different software modules. HMIs available early in the project facilitate the tests of applicative algorithmic modules with the opportunity to visualize the behaviour of these modules and thus to detect bugs or necessary improvements before the final integration phase. The HMI prototypes will be consolidated iteratively, letting the users see the progress and participate to the decisions, and providing an improved platform for the unit tests and also anticipated integration between the HMIs and the interface to ScanMaris generating documented alarms on abnormal vessel behaviours to be interpreted.

The TaMaris HMIs will mainly allow to:

- Display the common intelligent operational traffic picture with information layers and space & time navigation capabilities.
- Display and manage the ScanMaris issued documented alarms and spatiotemporal evolutions of detected abnormal vessel behaviours.
- Provide interpretation tools to understand unlawful situations, support for collaborative decision making and timely transmission of conclusions to decisional authorities.
- Provide analysis tools to perform dedicated studies on past identified maritime events and to elaborate various target factors for specific vessel tracking and controls.
- Build up knowledge models on unlawful activities and threats.

The HMI design is animated by participatory periodic design sessions during which the TaMaris project team and the users meet to design, evaluate and validate HMI functions at different stages of maturity.

COMMON INTELLIGENT OPERATIONAL TRAFFIC PICTURE

The data necessary for surveillance must come from sensors and intelligent information that are

combined into one multi layer geo-spatial picture and thereby presents a tool to the operator that allows him to do what he does best: visually integrate movements, images and texts to judge specific detected critical situation.

The following figure 3 provides common intelligent operational picture over occidental maritime Mediterranean area. The stickers are the position of detected vessel and colours give the vessel types (tanker, ferry, container, yacht, fishing vessel, etc. and unknown).

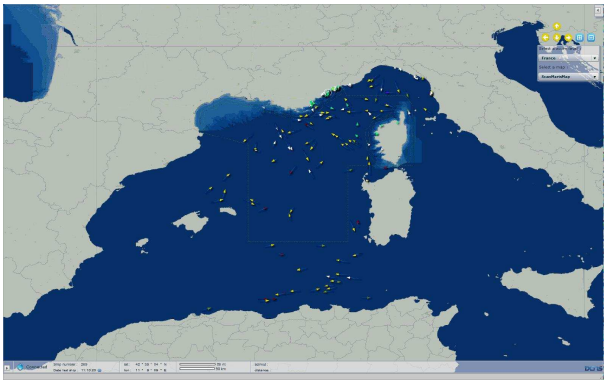

Figure 3. Common intelligent operational traffic picture

From built up and maintained data base, by directly selecting the vessel location on the screen, vessel file is displayed to the operator. This file contains vessels characteristics, destinations, set of pictures, past events such as detentions and history. Figure 4 shows one sheet of the vessel file.

General Information

Name	:	BYANOR III
IMO	:	455386709
Flag	:	Panama
Type	:	Freezer
Subtype	:	Polythermes
MMSI	:	238967455
Callsign	:	U7VX8
Operator	:	NFC (Japan)
Owner	:	NFC (Japan)
Manager	:	NFC (Japan)

Tonnage Characteristics

Deadweight tonnage	:	6437
Gross tonnage	:	7000

Engine Characteristics

Engine type	:	Motor Diesel
Engine number	:	1
Service Speed	:	16/20

Structure Characteristics

Length overall/Draft	:	65/13.53
Beam/Depth	:	20.10/6.70

Figure 4. Vessel file (picture and characteristics sheet)

Other information is available to the operator such as navigation conditions, regulated zones, bathymetry, vessel black list, etc.

ALARM ON ABNORMAL VESSEL BEHAVIOUR

Alarm is highlighted to operator when implemented rule on unlawful situation is met by set of combined information on vessel activity. As example, the figure 5 gives alarm on container propulsion failure displayed to the operator with related information.

Figure 5. Alarm on container propulsion failure with vessel location and date (red vignette), vessel type and name (white vignette) and speed history profile (black vignette)

Such vessel abnormal vessel behaviour happening on Italy and French trans-border zone, information exchange between Italian and French organisms would be useful to carefully follow the situation evolution and prepare common rescue actions to anticipated potential accident if, for instance, the sea state is becoming harmful.

REPORTING ON IDENTIFICATION OF UNLAWFUL ACTIVITIES AND THREATS

TaMaris allows expert to issue reporting to decisional authority. This report would propose, in a standard form, identification of unlawful activities and threats in a factual way with justified descriptive elements.

Such as example of reported conclusions and recommendations are illustrated here below.

The chronology and natures (stops & transhipments) of the anomalies, which were detected in the behaviour of refrigerated ship BYANOR III (Panamanian pavilion and Japanese ship-owner), present the following profile:

- *Stop in open sea during ten hours of the refrigerated ship BYANOR III of Panamanian pavilion and Japanese ship owner, near to the*

Aeolian Islands' blue fin tuna fishing zone. The BYANOR has an ICCAT licence.

- *Stop in open sea of BYANOR III during approximately five hours, near to the blue fin tuna's fishing zone between Malta and Benghazi (Libya).*
- *Probable transhipment of capture of the seiner St Antoine-Pierre (French pavilion, ship owner /La Sétoise) who was fishing the previous day in the blue fin tuna fishing zone, close to the BYANOR III which had stopped.*
- *Observations of 2 (with Libyan pavilion) of the five fishing vessels, successively transhipping captures onboard BYANOR III.*

The following elements of fishing's regulation violation were noted:

- *Transhipments of capture in a zone not priory defined by ICCAT as an authorized zone under monitoring.*
- *The ship owner of the seiner St Antoine-Pierre did not deposit nor obtained from ICCAT any authorization of transhipment of capture at sea.*
- *Libya does not have any «quota» of blue fin tuna's fishing in the Mediterranean.*

Recommendations:

- *Inscription to the ICCAT black list of the refrigerated ship BYANOR III as well as the seiner St Antoine-Pierre.*
- *Carrying out a complete control of the seiner St Antoine-Pierre as soon as its next stopover at Sète with a report sent to the SATI database.*
- *Carrying out a control of the refrigerated ship BYANOR III, as soon as its next either exit or entry to the Mediterranean through the Suez canal.*
- *Reporting and asking for clarifications to the Japanese and Libyan authorities regarding the transhipment events which were noticed.*

Annotations / Decisional Authority:

- *Accepted Recommandations.*
- *Need to constitute a preliminary file about the current year's fishing campaigns as well as the previous ones of the seiner St Antoine-Pierre.*

CONCLUSION

TaMaris capacity would enhance future generation of maritime surveillance system to report on understanding of detected abnormal vessel behaviour and early provides to decisional authority identification of illegal activities at sea and threats.

TaMaris capacity would provide set of tools to either analyse past identification reports on specific types of suspect events to perform statistical studies or traffic pictures to carry our target factors assessments to track and control dedicated vessel fleet.
Integrated ScanMaris (detection of abnormal vessel behaviour) and TaMaris (identification of illegal activities and threats) will be the core capacities of the next intelligent maritime surveillance system. They pave the way for collaboration between multinational sea border surveillance systems to make maritime traffic more save and secure.

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