An Advanced Integrated Total Ship Safety, Security, Surveillance, Survivability (TS^5) System Incorporating Incident Management System For Effective Situational Awareness

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Abstract

Ensuring safety and security of Naval ships, at port and at sea, against external threats is of paramount importance. Equally so, increased survivability based on improved recoverability from major incidents is of concern. The above gives rise to continued improvements in the designs of various advanced technologies that collectively cater for Situational Awareness and Battle Damage Control System (BDCS). Furthermore, effective maritime operations require the integration of reliable technologies into a seamless system in order to fully support the operational missions. To best detect and react to potential external threats and onboard incidents, requires the integration of suitable technologies that can cover a wider range of operations, from offshore platform protection, to forced protection at port, to amphibious, sovereignty, law enforcement, fishery protection, search & rescue operations, normal operations, operation in dangerous waters and in combat. This is a complex challenge given that threats at Port, as an example, or threats in littoral waters, are different from the threats at sea. None of the conventional OEM solutions deployed on existing naval ships provides Modular Integrated Situational Awareness System (MISAS) capability that can manage combined onboard & external threats as well as provide for optimal management of unplanned incidents in an efficient way. Conventional approach is based on solutions that are standalone with limited systems integration, some requiring standalone data acquisition hardware and software, computers, consoles and data communication network that have less commonality with other systems deployed onboard a target vessel. This paper provides an optimum solution for a comprehensive MISAS capability for fast identification and tracking of undesired threats and for improved management of unforeseen incidents. It combines leading edge technologies to manage both threats and incidents through an Advanced Incident Management System empowered TS^5 system.

I. Introduction

This technical paper is intended to introduce an effective method for integrating lead technologies based on improved data fusion from various sensors and systems in order to achieve a most optimum configuration for a modern modular based Situational Awareness system empowered by an Advanced Incident Management System. Through modularity, the end-user will be able to select desired functions according to the target ship's Class and Mission, in order to increase interoperability and commonality across fleet. It addresses lead technologies for integration with the TS^5 system to safeguard a naval ship at port, in littoral waters, at sea, and in special operations involving pirates, Search & Rescue operations, protection of offshore assets, as well as, for combating threats in normal & combat operations.

Based on the integration of TS^5 related system with L3 MAPPS modern BDCS, ship security against threats, as well as, damages against unforeseen incidents would be seamlessly managed. The Integrated Platform Management System (IPMS)'s Multi Function Consoles (MFCs), Data Acquisition Units (DAUs) and the IPMS/BDCS Human Machine Interface (HMI) core software to be deployed as an integral part of the TS^5 system will further improve commonality across ship systems, ease of operation for the ship crew located at Combat, Communication, Bridge, MCR and other desired locations. At each location, access to systems information could be controlled by the TS^5 Station In Control (SIC) feature.

To best identify commonality of the desired technologies that could result in a most effective modular TS^5 system solution, necessitated review of the available technologies based on ships mission, operational situations and threats. Due consideration was given to the following:

- Ship stationed at port, involving forced protection. This applies to any ship in general, but the level of systems sophistication and the investment level vary with Class and Mission of the target ship.

- Ship operating in littoral waters engaged in law enforcement operations, fisheries protection, surveillance and sovereignty protection, offshore platform, littoral warfare operations. This generally applies to Coastguard vessels, Fast Attack boats, Mine sweepers/layers, MCMVs, OPVs and Corvettes, although it could also include other resources.

- Ship at sea involved in normal operations, joint naval operations, operations in dangerous waters or in combat. Operations at Sea could involve situations where the use of Rigid Hull Inflatable Boats (RHIBs) is unavoidable, such as when combating pirates or when involved is Search and Rescue operations. This generally applies to a wider range of mission critical ocean going vessels such as Frigates, Destroyers, Aircraft carriers and Submarines.

Throughout the rest of this paper, the concept of Modular Integrated Situational Awareness System (MISAS), and various technologies that could be considered for integration with a MISAS based TS^5 system are addressed.

II. MISAS Approach

At present, various standalone technologies are deployed onboard mission critical naval ships that may require integration with onboard and shore based systems. As an example, it may be desired for a ship to communicate with Harbor Maritime Security Operation Center, RHIBs, ships own video surveillance and security system, harbor security system and special coastal surveillance Radar, onboard Searchlight, and vision systems etc. However, most of the applicable situational awareness technologies utilized for the above, are standalone systems with less hardware and software commonality that may involve embedded data communication network and little interconnectivity.

The use of standalone systems creates extra installation work, adds to Life Cycle Costs, can result in less effective use of available information during special operations, and less efficient management of threats & incidents.

The MISAS approach involves the integration Searchlight and desired cameras, vision systems with image processing capability, with other Situational Awareness related technologies as an integral part of a TS^5 system. The above integrated solution would also interface with various ship systems, such as the BDCS, Integrated Bridge System (IBS), Combat and Communication systems and equipment in the MCR location for machinery control.

A modern solution approach should be modular in nature, reduce the use of standalone systems, to the extent possible remove embedded networks, and above all, it should maximize commonality of applicable software/hardware across the systems deployed onboard the ship.

The above improves situational awareness and allows the ship crew to efficiently collaborate in real time with other nodes (onboard, other ships and shore based systems) in order to better understand threats, collect threat related data from external resources and databases and to react faster to disaster or security threats while at Port, in Littoral waters or at Sea.

In the following sections, appropriate technologies for integration with a TS^5 system enabled with an Advanced Incident Management are addressed. The identified commonalities give rise to an optimum implementation of a Modular Integrated Situational Awareness System (MISAS). Based on the target naval ship, its mission, and the end user's preferences, the desired technologies will be integrated with the TS^5 system.

II.1 At Port

While at Port, a Naval ship's situational awareness system provides real-time monitoring to protect the ship and its crew against unforeseen threats. It may become necessary to deploy or to coordinate effort with RHIBs for force protection. This necessitates appropriate technologies to maintain On-The-Move video links with these RHIBs or with land based surveillance and security systems.

By utilizing video analytics technologies, capability can be provided to better protect a ship against threats by alerting the crew to emergencies or potentially threatening situations based on processing

of images obtained from various camera sources.

While at Port, the TS^5 system could integrate the following technologies to achieve the intent of MISAS:

a)- Consideration for Radar system - The Radar for at Port operations is different from Radar deployed at sea. Generally, the desired Radar is for small target close range detection and can include redundancy for mission critical vessels.

The TS^5 system could interface with selected data from Radar, such as for obtaining information on range, bearing, altitude and speed of target. This will ensure improved data fusion with other Situational Awareness related subsystems for improved data access and advisory.

b)- Consideration for Radio – When at port, it may become necessary to communicate with a number of nodes . This can include communication with law enforcement authorities (border/shore/port security, fishery protection) as part of ship forced protection and Maritime Security and Interdiction operations. It is necessary to select appropriate Radio that can cater for operational requirements at Port, in Littoral waters and at Sea.

The operation at Port could also involve communication between the mothership and the boarding party on RHIBs. This includes the use of effective Radio and video/voice communication. The TS^5 system enabled with an Advanced L-3 MAPPS Incident Management System could interface with the Ultra TCS ORION multi-mission Radio to achieve the desired capabilities.

Figure 1: Ultra TCS ORION, video, data and voice communications

c)- Consideration for camera and searchlight systems – Various camera and vision systems with different capabilities are generally deployed onboard naval vessels. These can include conventional CCTV, infrared, thermal, laser, head mounted cameras and searchlight. It is common to find separate standalone systems for the above, some even requiring their own embedded data communication network, console and computer system, resulting in less commonality with other onboard systems.

The TS^5 system could provide cost effective integration of the above technologies while minimizing the use of embedded networks.

d)- Consideration for Sonar – While at Port, Sonar data, including Diver Detection Sonar, have to be integrated with other Situational Awareness subsystems. Various cameras could be used for tracking the identified threat in the Real-Time.

The L-3 ELAC's Vanguard sonar provides superior capability. When the ship is at port or anchoring, the above could be utilized at 30 kHz Omni-directional mode. In addition a passive mode is available (e.g. for speed boat detection or when active transmissions are not permitted).

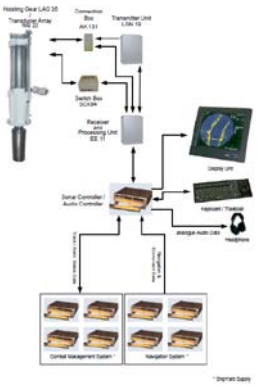


Figure 2: L-3 ELAC Sonar

Similar to Radar, selected data from Sonar could be interfaced with the TS^5 system to augment other situational awareness information, such as from the cameras and from Radar Automatic Target Tracking (ATT). Such sensor and information data fusion will better assist the crew during threat assessment and threat response processes.

For harbor security, offshore platforms and naval base security, where provision of security and higher survivability against unforeseen threats is of paramount importance, L-3's Harborguard Early Warning Detection and Security system provides

enhanced functionality. The key technology that L-3 offers is the small target detection capability of the Radar system. The above could be deployed on a moving platform (ship) and on fixed platforms (shore based, oil platforms). When augmented by L-3 MAPPS TS^5 system enabled with Incident Management System, it could provide additional features, including access to machinery and auxiliary systems, access to IPMS functions, Incident Record and Replay, Killcards, Searchlight, Radio connectivity and video imagery products for RHIB related operations and data exchange as previously addressed. The above added values provide a most comprehensive MISAS based TS^5 system.

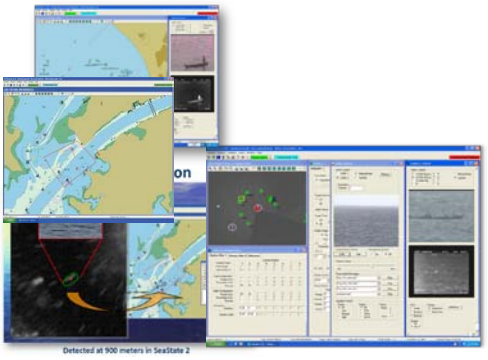


Figure 3: L-3 Harborguard

The above solution interfaces with AIS, various vision systems and Radar. The target positions are compared with configurable warning and alarm zones to trigger automatic positioning of the cameras to facilitate threat analysis and support target challenges through the integrated acoustic hailing device. The L-3 radar processor is able to utilize various advanced target extraction algorithms and techniques to identify very small targets in the sea clutter. The system can also use radar track data to slew-cue the cameras and/or non-lethal deterrent devices such as acoustic hailer device (AHD), laser dazzler or water cannon around to a selected target. The Shipboard Perimeter Protection System (SPPS) is a derivative system designed specifically for near-vessel perimeter security (out to 1500m) utilizing a special radar system. This enables L-3 to offer a portable system for temporary installation when anchored or docked in an unsecured location.

The technologies addressed in this section could be interfaced with TS^5 system enabled with an Advanced Incident Management System. The above results in the provision of a single platform for situational awareness related technologies. As an added value, the TS^5 system would take advantage of L-3 MAPPS Advanced BDCS capabilities such as Incident Management System, Incident Record and Replay functions, smart vision system for fire and smoke detection, as well as, autonomic control system for Chilled Water (CWS) that increases weapon and communication systems survivability under CWS damaged condition. The above can result in higher ship and ship systems survivability under unforeseen threats and incidents.

II.2 Littoral Waters

When a naval ship operates in littoral waters for surveillance and sovereignty operations, security of an offshore platform or fishery protection, or when a ship is engaged in operations involving pirates or Search and Rescue, it becomes necessity to use some resources as addressed in the previous section, augmented with other subsystems to best protect the ship against external threats. L-3 can also provide its Vigilis product for security of multiple nodes.

Figure 4: L-3 Vigilis product

Similar to the case at Port, modular integration of applicable situational awareness technologies with TS^5 system would result in improvements in survivability, commonality, systems integration and Life Cycle Costs; particularly when the modular solution is applied to all Classes of naval ships at enterprise level.

A most effective approach is sensor data fusion into a single MISAS based TS^5 system. The integration of the following with the TS^5 system will improve management of threats and incidents in Littoral Waters:

a)- Radar and ATT system – based on data collected from Radar, the cameras/search light will zoom on the target.

b)- Through interfaces with appropriate technologies, TS^5 could provide information on coordinates of the target, type of target and the threat/threat level. The TS^5 could provide images from cameras, with capability for pan/zoom/tilt. TS^5 could also provide access to navigation and communication charts as desired. As a result, the crew will have access to all desired information through a single TS^5 console.

c)- Selected information from other systems such as Sonar and Sonar sound recorder could be made available for advisory purposes and decision making through the TS^5 system. The L-3 ELAC Vanguard 70 kHz forward looking mode capability caters for cruising in shallow waters where smaller beams are desired. When integrated with TS^5, it would be possible to use the Sonar information on a target's bearing and distance from mothership, for determining the input for onboard cameras and other vision systems. Via the TS^5 Incident Management System tools, the crew will be able to exchange text messages to desired workstations, to record and replay operations, threats and incidents, and send instructions to key personnel and workstations located onboard the ship and on the RHIBs.

d)- For operations in littoral waters, it may become necessary to utilize RHIB. In this case, there is a need for effective radios with ability to stream images to/from the RHIB and for data/voice communication between the mothership and the RHIB as well as other nodes (ships, shore based system).

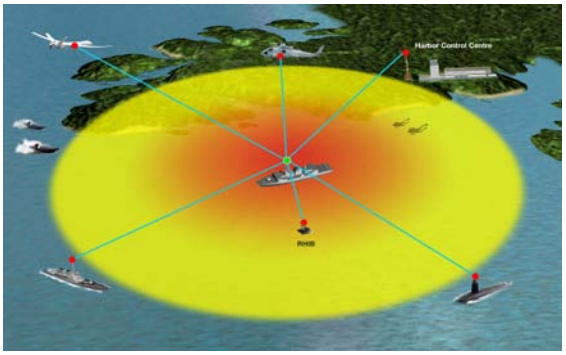


Figure 5: Threats & Interoperability in Littoral Waters

Through integration with the Radio solution from Ultra TCS, the TS^5 system would enable the crew in the mothership to efficiently monitor threats, manage operation by boarding parties, perform ship-to-ship and ship-to-shore communication, including provision of tool where temporary interoperability is desired with a foreign naval or a commercial vessel.

The latter could be achieved through spare portable multimedia capable Radio kit that temporarily could be offered to another ship.

II.3 At Sea for Oceangoing Vessels

For Oceangoing vessels, the situational awareness technologies are an extension of those utilized while at Port or when operating in Littoral waters.

Depending on the specified threat zones sanctioned by the Navy and the doctrine to be adopted for actions related to each threat zone, an advisory system is required to best assess the input from various devices, sensors and software systems, in order to alert the crew of potential threats and to direct them to take remedial actions to counter potential threats.

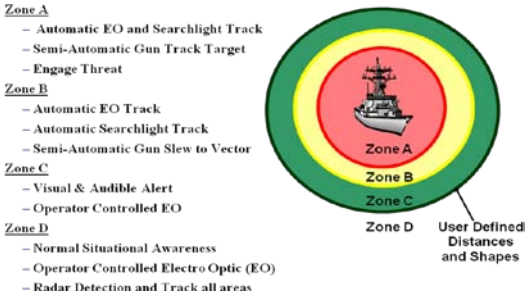


Figure 6: User Defined Ship Protection Zones

The TS^5 system enabled with L-3 MAPPS Advanced Incident Management System Killcards can provide an effective method for predefining the steps needed to be taken by the concerned crew according to the threat levels. The Killcards would also provide access to applicable operational procedures & recommendations for handling different threats and/or incidents in order to alleviate confusion or panic that could arise during major events.

For each threat zone, appropriate killcards could be defined to automate the order in which actions must be executed, and check lists that must be completed by the concerned crew in order to best manage threats and incidents. The killcards can be executed in automatic mode, or in semi automatic mode or in manual mode as desired by the crew. All actions by

the crew could be recorded and reviewed later as required. This can include pages accessed, data entered and actions executed through the TS^5 related mimic pages.

The MISAS based TS5 system could integrate the following:

a)- Images and intelligence from UAVs could be made available by the TS^5 system to the concerned crew for advisory purposes and decision making via the TS^5 system Advanced Threat & Incident Management System HMI.

b)- Integration with an encrypted Warship AIS (W-AIS) system to support identification of secure "blue force" assets and voluntary emitters utilizing the TS^5 system Advanced Threat & Incident Management System HMI.

c)- Integration with a Voyage Data Recorder as an integral part of the TS^5 system.

d)- Integration with the L-3 ELAC's Vanguard Sonar will provide the desired security at Sea. For cruising in deep water where reverberation is not a problem the 30 kHz mode can be used to achieve a greater detection range. It is possible to cover only a sector instead of using the Omni-directional beam pattern. Once a target is assigned the Automatic Target Tracking (ATT) will follow the target and calculate speed and course.

Sonar measures distance and bearing of the target as well as the signal level of the echo and calculates course and speed of the target. This data could be interfaced with the TS^5 system for provision of input data to underwater and other cameras controllers. Sonar information, such as bearing, range, speed, course, signal level, augments TS^5 system's Situational Awareness capability. The crew will be able to define a surveillance area via dedicated HMI. When a target enters this area an alarm will be triggered and designated cameras will provide vision alert for the concerned crew. The TS^5 system would collect, correlate and display target tracks acquired by different subsystems on Electronic Chart systems.
e)- The ship ability to transmit or receive broadband information allows it to access all sensors and data bases relevant to a given target of interest. In a typical chain of event, the ship could receive a night image that first identifies a suspicious vessel. UAV or helicopter video feeds received could be redirected in real time to an RHIB on an interception course. The RHIB crew access to these UAV or helicopter video feeds is critical to the safety and efficiency of the mission as it allows them to see what is happening on the deck of the target ship. In turn, the RHIB crew could remotely access intelligence data bases located on the mothership as more information becomes available on persons or cargos of interest.

Currently, most available situational awareness solutions are standalone. The proposed TS^5 system provides a most effective method of data fusion with Ultra TCS Radio products and vision system to best manage situations where RHIBs are deployed at sea.

II.3 The TS^5 System Configuration

The TS^5 system enabled with New Generation Threat & Incident Management System caters for modular integration of leading edge situational awareness technologies for a wide range of Naval Ship Classes to increase their survivability, security, surveillance capabilities and operational effectiveness under damaged conditions and incidents. The above can be achieved through optimum sensor and information data fusion for improved management of threats and incidents.

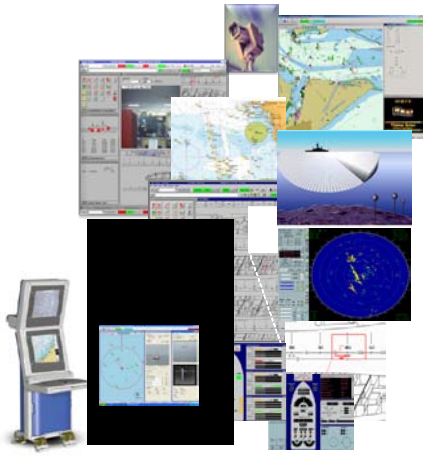


Figure 7: TS5 Console for Threat & Incident Management

Based on the location where the TS^5 system consoles are installed onboard the target ship, different levels of systems security, data access, control and monitoring capability will be provided. Therefore, when the TS^5 system Threat & Incident Management console is accessed at the combat centre, Communication, Bridge or Machinery Control Room, only selected data will be presented to the

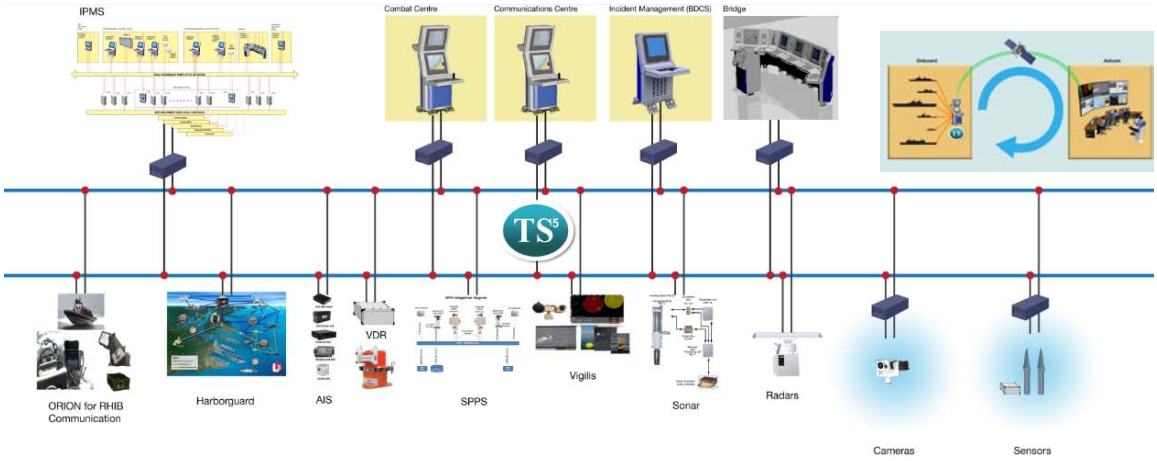
crew in these locations and the crew in these locations will have limited access to control operations as desired by the end user for each position.

Above and beyond integrating a modern Incident Management System with situational awareness related technologies, automatic killcards, commonalty of HMI look and feel, extended hardware commonality, improved integration of camera and vision systems; the presented TS^5 solution removes various embedded data communication networks. The proposed MISAS based TS^5 Architecture is shown in the below.

Depending on the ship Class, ship Mission, and situational awareness desired capability, the MISAS based TS^5 system allows the end user to select its preferred technologies. The TS^5 system can interface with any desired OEM supplied equipment.

result the following added values can be achieved:

- Removal of some embedded networks
- Effective sensor data fusion that could be distributed across multiple platforms
- Common visualization and information overlay on applicable charts to better assess data, interpret threats and manage incidents
- Provision of a common user interface software development tool and, to the extent possible, common workstation platform for ease of operation based on same look and feel across all applicable technologies
- Integration with Incident Management and killcards for automation when threats are identified & for improved damage control
- Modular open system design, providing flexibility and choice for the end- user based on ship mission
- Seamless TS^5 technology interfaces for Ship-to-ship and ship-to-shore connections.



III. Conclusion

The presented MISAS based TS^5 system incorporating Threat & Incident Management Systems could cater for modular integration of situational awareness related technologies based on improved sensor data fusion. TS^5 could provide relevant Situational Awareness information for effective threat & incident management on a single platform that could be placed at desired Combat, Communication, Bridge and MCR locations. Access to monitoring and control functions will be limited through Station In Control (SIC) assignment. As a

IV. References

Products and presentations from L3 MAPPS, L3 Klein, L3 Oceania, L3 ELAC and Ultra Electronics TCS.