Collaborative Space-based Maritime Situational Awareness (CSMSA) - Pathway to Global Maritime Cooperation for Security, Safety, Environmental Protection, and Resource Conservation

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ABSTRACT

Collaborative Space-based Maritime Situational Awareness (CSMSA), also known as C-SIGMA, "Collaboration in Space for International Global Maritime Awareness " envisions a global collaboration of all space-faring nations linking together existing and planned unclassified space system capabilities to form a worldwide collaborative network. This effort would be coordinated via regional centers to create international global maritime awareness, available to all nations of good will. It would be a huge step toward global maritime security but it would also provide substantially improved safety, environmental protection, resource conservation, as well as disaster mitigation and recovery. This paper also discusses both the need for C-SIGMA and what its components should include. These components include the software to know which sensing satellite to task when, the utility of five different satellite types, and the dynamic data analysis tools to build knowledge and understanding from the derived information and other maritime related data sources. The questions of governance are not specifically addressed as those answers are in the political realm, but suggestions are provided.

Keywords: Satellites, maritime security, maritime situational awareness, maritime domain awareness, space systems, S-AIS, SARsats, C-SIGMA

1. INTRODUCTION

"Maritime Security has different dimensions, including but not limited to Maritime Situational Awareness (MSA), Law enforcement, maritime safety, maritime environment, maritime science & technology, maritime trade & economy, maritime law and public health. Therefore, in national terms, Maritime Security can only be achieved by a "whole of government" approach. If we succeed in applying this approach together with like-minded countries in a multi-national environment, we can attain our common Maritime Security objectives"

"There can be no Maritime Security without Maritime Situational Awareness."

Figure 1. Satellite AIS (S-AIS) Tracks now define the Maritime Domain

2. BACKGROUND

In the 21st century it is well known that the cyber world has expanded exponentially but unnoticed by many, since 2004 and increasing steadily since then, there has also been an on-going revolution in space-based Earth observation systems and, led by space-based AIS, their utility over the world's waterways has increased dramatically. These capabilities not only support safety and security at sea but can also significantly assist in economic and environmental stewardship and resource protection, as well as disaster mitigation and recovery. This is especially true of the remote areas of the world such as the Arctic, and the resource rich areas in the underdeveloped world such as the Gulf of Guinea, the South China Sea, Micronesia, and the Indian Ocean. The potential contributions of space-based Earth observation systems to maritime awareness is of growing interest to the world's naval and law enforcement forces, as well as to environmental preservationists, governmental transport, commerce, maritime, environmental protection, and disaster preparedness ministries, in addition to ship brokers, and others with an interest in the marine domain, its environment, and the protection of its resources, but coordination to maximize these capabilities is lacking.

Ongoing research started just after 9/11 (September 2001) shows that no single country or international organization has the ability and resources to fully support the safe, secure and efficient use of the maritime domain as well as the conservation and protection of the marine environment with its finite resources of fish, minerals and oil, as well as to substantially assist oceanic commerce. In that no one country has sufficient resources, including space craft, substantial international collaboration is essential to achieving these objectives in a balanced manner. Indeed, this effort may need to be managed by an agency of the United Nations. Among the greatest needs, as well as the greatest opportunities for international collaboration are presented by the multiple national and regional efforts to develop the doctrine and concept of operations to coordinate the use of the space technologies now available for detecting, identifying and tracking vessels well offshore, on a global scale. These systems are especially suited in areas with shared international interests such as the Arctic, or in pirate infested waters, or in areas known to support smuggling or resource theft of all types such as the Gulf of Guinea.

As of mid-2019 there is a virtual tidal wave of new space-systems with earth observations capabilities being planned and built. This includes a robust number of satellites (175+) equipped to collect the United Nations' International Maritime Organization (IMO) mandated Automatic Identification Systems shipboard anti-collision beacon. There are also several dozen of synthetic aperture radar satellites now being built. These are the two most critical part of space-based maritime awareness. C-SIGMA would not be possible without S-AIS as it reports the position of every legal ship many times a day, often with less than a two-minute delay between position reports, and SARsats are very useful because of their all-weather, day/night imaging capabilities.

Additionally, as indicated above, the cyber world is also enjoying a similar expansion, with artificial intelligence and machine learning leading the way. The time to take advantage of these significant opportunities that are on the horizon and rapidly bearing down on the world is now, as this tide of technology rises. Catch the wave! Seize the moment!

3. SYSTEM DESCRIPTION

There are eight elements that must be integrated for effective results. (Five in space, two on the ground.)

Two of the six different satellites types employ passive sensors:

1. Automatic Identification System (AIS), an automated short message system designed for collision avoidance and traffic control in congested waters but is now also used globally as a primary ship identification and tracking system. It is the key component of this concept.

2. Unclassified Signals Intelligence satellites (SIGINTSats) (New Capability as of 2019)

Another three of the six different satellites types employ imaging sensors:

3. Synthetic aperture radar satellites (SARsats)

4. Electro-optical (EO) imaging satellites

5. Video optical satellites

The sixth element are the communications satellites

6. M2M communication satellites. Individual transponders sending short formatted status reports to communications satellites

The last two elements deal with the tasking of the satellites and analysis of their collected data plus information from other sources.

7. The ground infrastructure, (terminals), software tools and licenses to allow users of the system to determine which spacecraft to task when to obtain the desired results, and to so act.

8. The software tools to correlate, fuse and analyze the information generated by the space systems, including S-AIS track data, the basis for all analysis, along with all other pertinent data resident in all reachable data sources such as port, financial, shipping and broker records.

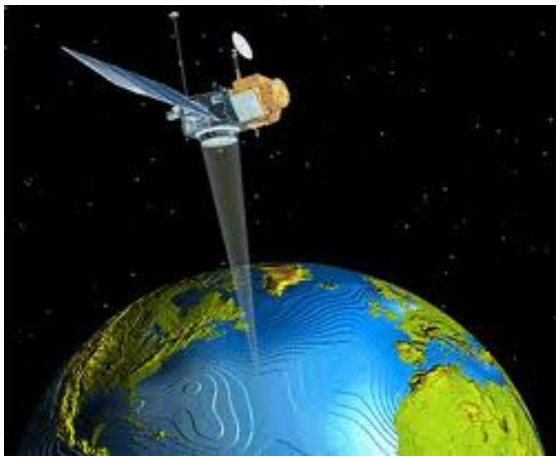

Figure 2: Many Satellites now Watch the Seas

4. OPERATIONAL CONCEPT

Tracking the reports from S-AIS is now revealing the "Pattern of Life" of the maritime world on a global scale. This pattern has been recorded for more than the past 10 years and offers great insights into normal and abnormal behavior in the maritime domain. Optical, video and especially SAR radar images of many sea areas have also greatly increased our understanding of what is abnormal. Unclassified signals intelligence exploitation of the emissions in the maritime domain are offering yet another source of highly useful data. Ships also use both text messages and machine-to-machine data communications, the technological heart of the "internet of things" (IoT), to report the state of many things onboard the ships and in the waiting ports. Those data items include the status of engines, the temperature and pressure inside containers, fuel levels, oil pressure in the engines and critical bearings, and a myriad of other things. Information technologists have also been gathering shipping and ship broker records as well and have been analyzing all of the above data using artificial intelligence and machine learning to the problem of dynamic data analysis for at least the last 15 years. (Yes, five years before the first S-AIS receivers reached space but the job became much easier when they did start collecting AIS from all over the globe.) The lessons learned have been very fruitful, and it will only get better. This is especially true as more and more people share more and more data.

The IT capacity now exits to analyze all of this myriad data. ICG Solutions alone reports it ingests and analysis several billion discreet data points per day. The collaboration of all of this data on a worldwide scale would allow watch centers in each region of the world to gain a much better understanding of what is happening in their area of responsibility and

where it fits in the global picture. To be sure, much of the information will be regional specific, but a great deal of it will be directly affected by what is happening elsewhere in the world.

Space systems will not replace terrestrial systems, but they will make the terrestrial systems much more effective. Instead of sending a maritime patrol aircraft or a law enforcement cutter on an area patrol, they will be sent to search where abnormal activity is known to be.

There are already as least two organizations employing unclassified space-based systems for enhanced maritime situational awareness. They are both based and focused on Europe. They are the European Maritime Safety Agency and FRONTEX, the Border Guard and Coast Guard of the European Union. France and India have recently announced they are going to jointly build a space-based maritime security system for the Indian Ocean. There are several other organizations which are now also using Space as means to increase their maritime security. The proposal here is not that we replace theses entities, but rather that we bring them all together to enhance the sharing of resources and allow for their use in a more effective and efficient manner. It would allow for the more well-developed nations of the world to assist those that are not so developed, for the betterment and benefit of all.

5. BONUS ROUND

While C-SIGMA/CSMSA would go a long way toward satisfying many of the world's varied needs for maritime situational awareness, it would also have the added benefit of providing a focal point for the creation of the global maritime security system envisioned in "A Cooperative Strategy for 21st Century Seapower," the current major policy statement of the US military maritime services. The coordination needed to implement C-SIGMA would provide a focus for the efforts to achieve a common goal of protecting the maritime environment as stated in that document and would go far in bringing the lawlessness of such places as the Gulf of Guinea under control. Space-based earth observation does not replace terrestrial systems but does make them substantially more effective and is a significant start to fulfilling the core need of knowing who is where on the world's waterways.

C-SIGMA/CSMSA also directly supports of the US Presidential Policy Directive Four (PPD-4), US National Space Policy (NSP), 28 June 2010, and could be the international mechanism to satisfy its Implementation Task #1, quoted below. PPD-4 emphasizes U.S. leadership in space and directs international collaboration on mutually beneficial space activities for the purpose of broadening and extending the benefits of space to all mankind. PPD-4, which is unclassified, has a classified Implementation Directive. However, Task Directive #1 is unclassified and states:

> "(U) Working through the National Maritime Domain Awareness Coordination structure, the Secretaries of Defense, Homeland Security, Transportation, State and Commerce, will develop an unclassified, international available program to foster international collaboration using civil and commercial space systems to enhance global maritime domain awareness to provide: enhanced safety of life at sea; increased mutual security of all users of the maritime domain, improved protection of the maritime environment and the resources of the sea; improved flow of commerce; and better monitoring of the condition and performance of the Marine Transportation System."[iii]

The implementation of that directive has been held in abeyance for some unknown reason but implementing C-SIGMA/CSMSA could well be the key to building the envisioned, truly global, maritime security system, and would substantially assist in many tasks including detection of illegal smuggling of all types, of goods, arms, drugs, and people; much improved maritime pollution control and resource protection, such as illegal fishing and stealing of oil, as well as dramatically assisting humanitarian assistance and disaster recovery operations. Remote ocean surveillance in such areas as the Arctic, the southern oceans, and the western Pacific would clearly immediately benefit many people both in and out of those regions.

6. WHERE NEXT?

Implementing C-SIGMA/CSMSA in the Arctic and a few other locales such as the Gulf of Guinea and the western Pacific could be the needed stepping-stone to the implementation of Global Maritime Awareness for the betterment of the entire world.

Since April 2005 C-SIGMA has held 11 highly successful international conferences at locals all over the world including two in Italy, one in Japan, Ireland, England, And Portugal plus Canada and the US. These conferences have been attended by all the major Earth observation and AIS satellite builders and operators, and most if not all, of the builders of dynamic data analysis software focused on Earth observation. Many users of this data from all corners of the globe have also participated. Many, if not all attendees, agree we must do something like what is described above, but the question remains "How?" Both NATO and the Multinational Maritime Security Center of Excellence have expressed an interest, not nothing specific has materialized yet. Money and manpower seem to be the stumbling blocks. Given the high potential payoff, it should not be.

REFERENCES

i Multinational Maritime Security Centre of Excellence Concept of Operations, pg 1
ii Ibid
iii Classified Annex, US Presidential Policy Directive 4, 28 June 2010
iv The first four conferences were called TEXAS (Technical EXchange on Ais via Satellite)