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LESSONS FOR IMPROVED INTERNATIONAL SPACE SITUATIONAL AWARENESS (SSA) FROM RECENT DEVELOPMENTS IN MARITIME DOMAIN AWARENESS (MDA)

Abstract

In a paper presented at the 2012 International Astronautical Congress in Naples, Italy, authors Kate Becker and Tiffany Chow examined ways that Maritime Domain Awareness (MDA) solutions might inform space situational awareness (SSA). Specifically, the paper addressed how the international mechanism for MDA, the Maritime Safety and Security Information System, might offer lessons for greater international SSA data sharing. Building off of that work, this paper continues the attempt to extrapolate lessons learned from the field of MDA and apply them to improved international SSA. It highlights the most recent developments in MDA, specifically efforts to improve international collaboration and progress made toward using space-based Automatic Identification System (Satellite-AIS). The National Space Policy and efforts such as "Collaboration in Space for International Global Maritime Awareness" (C-SIGMA) demonstrate that efforts are underway to increase MDA capabilities through use of Satellite-AIS, often seeking increased international collaboration in space as well as in maritime operations. The valuable progress made and lessons learned in this area should not go unnoticed by those working to enhance global SSA capabilities. This paper looks for ways these developments in MDA might relate to improving international SSA.

I. INTRODUCTION

In a paper presented at the 2012 International Astronautical Congress in Naples, Italy, authors Kate Becker and Tiffany Chow examined ways that Maritime Domain Awareness (MDA) solutions might inform space situational awareness (SSA). Specifically, the paper addressed how the international mechanism for MDA, the Maritime Safety and Security Information System, might offer lessons for greater international SSA data sharing. Building off of that work, this paper continues the attempt to extrapolate lessons learned from the field of MDA and apply them to improved international SSA. It highlights some recent trends and developments in MDA, specifically efforts to improve international collaboration and progress made toward using space-based Automatic Identification System (Satellite-AIS). The National Space Policy and efforts such as "Collaboration in Space for International Global Maritime Awareness" (C-SIGMA) demonstrate that efforts are underway to increase MDA capabilities through use of Satellite-AIS, often seeking increased international collaboration in space as well as in maritime operations.[i] The lessons being learned in this area should not go unnoticed by those working to enhance global SSA capabilities. This paper looks for ways these developments in MDA might relate to improving international SSA.

Thinking about MDA and SSA together is not a new concept. In recent years especially, States around the world have identified these two areas as priorities for international and national security and as opportunities for collaboration with each other. This conceptual joining of the two areas is likely because of similarities in the types of challenges and solutions they exhibit, from natural and manmade threats to the necessity for working with partners to address these threats. As a result, there has been considerable effort in the past five to ten years to increase both SSA and MDA through more effective international cooperation and partnership, improvements in data gathering and processing technologies, and norms of responsible behavior.

While these two areas are not exactly the same, the authors believe that significant similarities exist and find it worthwhile to explore recent developments in MDA for lessons that can inform SSA, and perhaps vice versa. This paper focuses on four related lessons learned from developments in MDA and examines how they correspond to issues in SSA.

II. LESSONS LEARNED

Lesson 1: Increase Focus on Sensors

For both MDA and SSA, the ability to share data is crucial. In the realm of MDA, several efforts are underway to produce a “common operational picture” to increase the ability to share data through standards and interoperability. Through the International Convention for the Safety of Life at Sea (SOLAS), the International Maritime Organization (IMO) has since 2002 required all ships meeting certain criteria to broadcast Automatic Identification System (AIS) data.[ii] AIS is an internationally recognized data format, and through SOLAS, IMO built in a high level of international standardization to the international MDA effort.

Efforts such as the Maritime Safety and Security Information System (MSSIS) are building on this SOLAS requirement to increase the dissemination of AIS data. MSSIS is a freely -shared, unclassified, near real-time data collection and distribution network dealing primarily with Automatic Information System (AIS) data with participation from over 50 countries tracking over 6,000 ships.[iii]

While increasing the sharing of AIS data can indeed provide a higher level of MDA, AIS data is limited in several ways. It has a relatively short range, and is an active tracking system that relies on ships to operate within requirements set by SOLAS. Experts have noted the need to not only work to increase the sharing of data currently available, but to increase the amount of data gathered on the maritime domain.

In the realm of SSA, similar efforts are underway to increase standardization and interoperability. Beginning in 2007, the Joint Space Operations Center (JSpOC), part of the United States Strategic Command, began sharing its data on potential on-orbit conjunctions with all satellite owner/operators around the world. Since then, they have developed a Conjunction Summary Message, which provides consistent information on potential collisions in a standard format for all operators. In June 2013, the Consultative Committee on Space Data Standards (CCSDS), a body comprised of national space agencies, published a Recommended Standard for Conjunction Data Messages (CDMs). The CDM provides a standard format for the exchange of conjunction information between those with conjunction assessment data and satellite owner/operators.[iv] CCSDS works closely with the International Organization for Standardization (ISO), and ISO and CCSDS have created standards dealing with sharing data on upcoming satellite maneuvers and on-orbit data.

Despite these efforts in the realm of data sharing, SSA capabilities are still lacking. While objects 1-10 centimeters (cm) in diameter can cause serious damage, the U.S. Space Surveillance Network (SSN), the network of sensors that provides data to the JSpOC and currently the most comprehensive source of SSA observation, has little capability to detect objects under 10 cm. Additionally, the vast majority of SSN sensors are in the northern hemisphere, making continuous observation of an object impossible, with the potential for objects to be unobserved for several hours.[v]

Efforts to increase data sharing through standardization may be considered "low hanging fruit" that should be capitalized upon in order to increase the global MDA or SSA picture. However, it is clear that while efforts to increase sharing are occurring in both MDA and SSA realms, a complete global picture of our oceans or Earth orbit is not possible by simply providing more of the data currently available. Instead, additional data is needed in both realms to provide adequate awareness. While increased data sharing efforts are effective in their own right, and also help establish a foundation for further international cooperation in both realms, such efforts should not be accomplished at the expense of examining additional data sources. Building on the data sharing foundation, the implementation of new sensors to provide data in either realm should occur with the end result of maximum sharing of sensor data among interested parties as a primary goal.

One effort to increase the amount of data available in the MDA realm is Satellite AIS (S-AIS). While still reliant on the cooperative transmission of AIS from ships, S-AIS allows this AIS data from ships across the oceans to be received and used to increase MDA, rather than only those ships in close enough range to shore to be received by on-shore sensors. Both government and commercial entities have in the last ten years placed AIS receivers in low Earth orbit, with ground systems in place to accept and disseminate the AIS data transmitted from the satellites. Many of these entities have plans to extend their capabilities.[vi]

In addition to increasing the capacity to collect greater amounts of AIS data from ships across the oceans through S-AIS, efforts exist in the MDA realm to add non-cooperative tracking of ships to the MDA picture. In the short term this would likely mean incorporating existing Synthetic Aperture Radar (SAR) and electro-optical/infrared (EO/IR) sensors currently in orbit into an MDA system that would be able to ingest and disseminate multiple types of data.[vii] In the longer term it could mean creating a constellation of these types of sensors that could provide a global maritime picture.

In the SSA realm, additional sources of data should also be considered. As has been mentioned, sensors in the southern hemisphere would be of great value. Additionally, while MDA is working to expand from cooperative into non-cooperative tracking, SSA should look for ways to expand from a system of non-cooperative tracking sensors into cooperative tracking methods.

<u>Lesson 2: Increased Role for Private Sector</u>

While the expansion into S-AIS has been driven by both government and commercial entities, not even ten years into the use of S-AIS, the commercial sector has taken the lead in this arena. Two commercial entities, exactEarth and ORBCOMM, operate constellations of S-AIS receivers in orbit. These companies use ground capabilities to provide their customers with the AIS data transmitted by these satellites. They have found a business case that closes for providing MDA information, as customers are willing to pay for this information given the abundance of trade that takes place over the oceans and therefore depends on safe transit.

In the realm of SSA, the private sector has in recent years also found ways to participate. This has happened primarily through the Space Data Association, a non-profit association of satellite operators that allows these operators to securely share cooperative location and maneuver data for their satellites in a standard format with all SDA members. This effort was largely driven by these companies' dissatisfaction with what SSA was available to them, rather than by a promising business case. While the SDA is now playing an important role in including the private sector and cooperative data in the effort to improve the global SSA picture, the question remains as to whether there is a role for commercial entities seeking to make a profit from deploying dedicated SSA sensors or providing SSA information and analysis, as is happening in the MDA realm. There are currently private entities exploring options to sell SSA, but there is no effort to date by a commercial entity to sell SSA data from a sensor in orbit.

Even in the government realm, the role of space-based sensors is relatively new in SSA as it is in MDA. The first space-based sensor dedicated to SSA is the Space Based Space Surveillance (SBSS) satellite. However, there are efforts to put constellations of small satellites into orbit that can accomplish various types of monitoring, such as those by Skybox Imaging and Planet Labs. As small satellites have proved effective for MDA, potential SSA applications of small satellites should be considered. The business case for such small SSA satellites would need to be analyzed, including whether the primary market would be governments such as the U.S., whose current SSA efforts could be enhanced by data from such satellites, or whether commercial satellite owner/operators would see enough value in this data and analysis to purchase the products themselves.

Lesson 3: Need Multiple Sources and Contributors

As mentioned, data from SSA satellites could enhance the quality of SSA already being provided. It is clear in the MDA realm that, while S-AIS cannot completely replace ground-based AIS monitoring, it does work in tandem with ground-based AIS monitoring to enhance the global picture of MDA substantially. And just as no one type of observation can provide the complete picture needed, no one actor can provide all the observations and data needed. In the MDA realm, this realization has led to both incorporation of private sector S-AIS data and expansion beyond S-AIS data to acknowledge other assets for maritime monitoring that exist internationally. SAR satellites and high resolution EO/IR satellites have been recognized as potentially valuable contributors to a more complete global MDA picture.[viii] C-SIGMA is one effort that is working to enact a mechanism that would allow the sharing of this type of data internationally, thus encouraging the data to be incorporated into enhanced MDA systems at the national and international level. This could perhaps take the shape of an international center that collects data from multiple sources and disseminates MDA information.

Similar concepts have been proposed in the SSA realm. One possibility is to allow data from government, private, and academic systems already monitoring and analyzing orbital data to be shared between these existing entities providing SSA information to enhance each of their efforts. Such entities include the JSpOC, the SDA, and ISON, a network of optical telescopes based at Russian academic institutions. This would allow the various types of data these entities collect--observations from ground-based optical and radar telescopes, observations from space-based assets, and satellite owner/operator position and maneuver plan data to be incorporated into the analysis each of these entities is providing. Increased data sharing between existing entities would result in more reliable conjunction assessments and advanced warning of potential collisions, as each of the systems described here are currently limited in their individual capacities to provide a complete SSA picture to those satellite owner/operators who rely on them. This model would spread the burden of providing SSA data globally among these existing systems, incorporate multiple types of data from a variety of geographically dispersed locations, and enable owner/operators to not have to rely solely on one source for critical SSA data.

Lesson 4: Need to Move Beyond Bilateral Arrangements

While the robust international coordination sought by efforts such as C-SIGMA may be an ideal end state, achieving such coordination and sustaining the infrastructure needed to support it are daunting tasks in reality. Perhaps because of this, the trend in both MDA and SSA cooperation has been to focus on bilateral efforts. For example, recent high-level policy agreements between the United States and Japan have included specific agreements to coordinate in the realm of MDA. On the SSA side, the United States has signed bilateral Memoranda of Understanding with Australia, Canada, Japan, and France.

Bilateral cooperation is appealing between States with mutual interests in any realm, especially those with a security dimension where trusted allies are necessary to ensure success of the cooperation. MDA and SSA certainly both have critical security dimensions. For example, MDA has traditionally been the responsibility of Navies; while SSA, a much more recent phenomenon, has military entities leading the way in the United States, Russia, and China. Given the heavy role played by military entities in both MDA and SSA, and the technically and politically complex nature of gathering and sharing data in each realm, it could be that bilateral cooperation with allies is the most natural state. However, while these bilateral efforts certainly represent progress in the MDA and SSA realms, bilateral cooperation should not be seen as a replacement for more robust international cooperation that incorporates the most data available in each realm. As discussed above, current data sharing efforts are a good initial step to build a foundation for more robust cooperation not only in data sharing but in coordinating sensors for additional data collection. The same is true for bilateral cooperation, which should be seen as laying a strong foundation for more robust multilateral cooperation in the future.

Increased international cooperation in both realms may be facilitated by security becoming more dependent on a variety of actors. Maritime commerce is certainly a global activity, and in the space realm the number of space-active States and commercial entities continues to grow at a rapid pace. Additionally, due to the nature of Earth orbit, any actor operating with a lack of SSA data represents a risk not only to themselves and their own assets, but also to all other actors.

III. CONCLUSION

In this paper, the co-authors have continued work started in a 2012 IAC paper on the applicability of lessons learned from collaboration in MDA to enhanced collaboration for SSA. The primary lessons examined and explored here were increasing focus on sensors, finding a larger role for private sector, the need for multiple contributors and sources of data, and the need to move beyond bilateral agreements toward greater international collaboration. While MDA and SSA are not exactly the same, the recent developments in MDA collaboration have relevancy to SSA. Expanding data sources, both in terms of sensors and contributors, will only lead to a more comprehensive picture. This, in turn, underpins safety, security, and sustainability in the domain. Traditional State-to-State bilateral agreements are an effective way to pursue this enhanced sharing and cooperation, but should not be seen as a complete substitute for broader international coordination.

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[i] C-SIGMA Mission, www.c-sigma.org/mission.

[ii] "All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size shall be fitted with an automatic identification system (AIS)…" Safety of Life at Sea Convention, as amended Dec 13, 2002, Chapter V, Regulation 19.

[iii] National Maritime Domain Awareness Coordination Office Wiki: MSSIS entry, accessed at http://www.gmsa.gov/twiki/bin/view/Main/MssisInformation.

[iv] Consultative Committee on Space Data Systems, "Conjunction Data Message: Recommended Standard CCSDS 508.0-B-1 Blue Book," June 2013, public.ccsds.org/publications/archive/508x0b1.pdf.

[v] U.S. Strategic Command, "USSTRATCOM Space Control and Space Surveillance Fact Sheet," http://www.stratcom.mil/factsheets/USSTRATCOM_Space_Control_and_Space_Surveillance.

[vi] Guy Thomas, "Space-based AIS, the Game Changer."

[vii] Guy Thomas, "Collaboration in Space: The Silver Bullet for Global Maritime Awareness?" Canadian Naval Review, Volume 8, Number 2, Summer 2012.

[viii] Kimberly Coniam, "Maritime Domain Awareness", U.S. Dept of State presentation to the 17th International Space Univeristy Annual International Symposium, March 5-7, 2013.