

SECURING THE SEAS



The Logic of
Maritime Domain Awareness

FINDING IN BRIEF

The United States and its allies face a diverse array of security problems in the emerging global landscape, ranging from terrorism and insurgency to arms trafficking and illegal migration. Many of these problems have a maritime dimension that typically is manifested in littoral areas near shipping lanes and population centers. In the aftermath of the 9-11 attacks, the federal government decided that it needed to greatly improve U.S. monitoring and understanding of potentially dangerous developments at sea. The phrase it uses to describe this emerging mission is Maritime Domain Awareness.

A “National Plan to Achieve Maritime Domain Awareness” was published in October, 2005. The plan stated that, “the primary method for information sharing, situational awareness, and collaborative planning will be the national maritime common operating picture.” The common operating picture is described as a detailed and timely depiction of all security-related developments at sea. Continuously generating such a picture will require close cooperation among federal organizations with relevant skills and assets, especially military services and intelligence agencies. It will also probably require the cooperation of foreign governments and private shippers.

The two federal agencies most likely to lead this effort are the Navy and the Coast Guard. Ideally, they would like to track all vessels, passengers, crew and cargo in maritime transit and

monitor the status of relevant facilities ashore. No framework for conducting such surveillance of a global basis currently exists, but proponents of improved maritime awareness often point to the worldwide air traffic control system as a model of what might be achieved. Early efforts to fashion a maritime awareness system are likely to focus on the ocean approaches to national territory, key shipping lanes, and areas of frequent terrorist activity such as the Arabian Gulf.

Achieving maritime domain awareness on a global scale would require extensive collection, networking and analysis activity. Much of the necessary work is already being done by government agencies and private companies, but the results are so balkanized that information often fails to reach users in a timely fashion or usable form. Major changes will be required to break down organizational barriers to cooperation, and to fill gaps in collection and analysis capability. Such changes are unlikely to occur unless an organization such as the Navy or Coast Guard is given the power and resources to press for implementation of new practices.

This report was written by Dr. Loren Thompson of the Lexington Institute staff in consultation with members of the Naval Strike Forum and other maritime security experts. The report is one in a series of Lexington Institute studies intended to illuminate solutions to emerging global security challenges that are both innovative and affordable.

MANKIND'S LONG VOYAGE

Scientists believe that the first humans, homo sapiens, emerged somewhere in Africa over 100,000 years ago. Most of the time between then and now was spent struggling to survive in the wilderness, but about 10,000 years ago permanent villages and sophisticated tools began to appear in what is now the Middle East. The entire history of mankind since those early signs of civilization can be described as an ascent to ever greater awareness and skill at manipulating the physical world. The most recent phase of mankind's long voyage began with the Enlightenment of the 17th and 18th Centuries, an unprecedented surge of scientific knowledge and rationalism that was accompanied by the founding of the Republic. Since that time, the ascent of human civilization has greatly accelerated.

The spread of human commerce and culture has not unfolded smoothly. Periods of integration such as the rise of the Roman Empire have been followed by centuries of contraction and decay. War has been commonplace even in the most peaceful and progressive eras. Over time, though, the diverse communities that comprise the human race have gradually become more integrated. Technology has played a central role in this process, and — accompanied by the vital ingredients of market economics and democratic values — may now be on the verge of producing the first truly global civilization.

But every period of progress confronts obstacles and opponents that threaten to block change or divert its course to destructive ends. During the last century, enemies of progress typically took the form of oppressive states propounding violent ideologies such as fascism and communism. Today the dangers are more diverse and elusive, but still combine retrograde ideas with new technologies to retard the ascent of civilization. Terrorists, insurgents, and traffickers in the tools of mass murder all share that same basic character — what President George W. Bush once called “the unconventional and invisible threats of new technologies and old hatreds.”

This study is about the role that the Navy and other sea services play in countering such challenges. In particular, it is about creating the global awareness of maritime developments necessary to defeat emerging threats. With two-thirds of the world's surface covered by water and most human beings living near the sea, it is impossible to fashion an effective security posture unless there is adequate understanding of what transpires in the maritime domain. Indeed, failure to build better mechanisms for sustaining such awareness will encourage the migration of terrorism and other threats to the myriad archipelagoes and sea lanes that cover the globe. This is a task that the Navy and Coast Guard cannot accomplish by themselves — the oceans are too big — so much of the report is devoted to describing a framework in which all users of the sea, public and private, naval and commercial, can collaborate to build comprehensive awareness for the common good.

MARITIME DANGERS



EMERGING MARITIME CHALLENGES

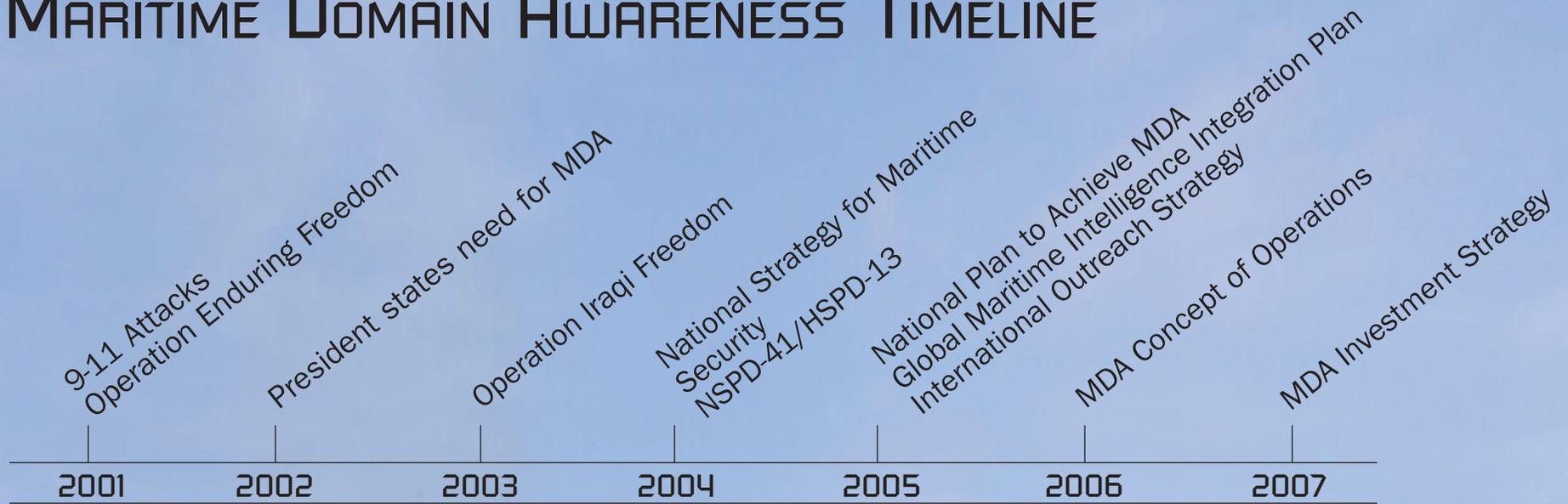
The federal government refers to efforts aimed at improving understanding of events at sea and in coastal areas as “Maritime Domain Awareness,” or MDA. In a sense, maritime awareness is the oldest and most fundamental mission of both the Navy and the Coast Guard, because without some understanding of what is transpiring at sea the services would have great difficulty accomplishing their other missions. However, Maritime Domain Awareness has taken on more focused and precise meaning for the military establishment since the terrorist attacks of 9-11, because those attacks were viewed as emblematic of broader changes in the global security environment — changes with profound implications for maritime operations.

The basic shift now unfolding is that a global security environment dominated by competition between state-based conventional and nuclear forces during the 20th Century is giving way to a far more complex landscape of ambiguous, elusive, unconventional dangers. State-based threats have not disappeared because the impulses that give rise to them are always present in the human condition. But those traditional threats are now being supplemented and in some measure eclipsed by an array of challenges such as terrorism, trafficking in illicit weapons technology, trade disruptions, resource rivalries, human migrations and environmental problems. Some of these emergent issues, such as drug smuggling and piracy, aren’t really new, but they assume greater importance as state-based threats recede and globalization empowers previously disenfranchised groups.

All of the emergent dangers have a maritime dimension. The sea is often the easiest medium through which to launch terrorist attacks, transport weapons of mass destruction, move illegal migrants, or otherwise disrupt the fabric of civilization. Even when the maritime domain is a difficult venue for conducting aggression or criminal activity, the success of security measures on land will inevitably lead enemies of civilization to cast their eyes at the sea as an arena in which to continue the struggle. Thus, detailed, timely awareness of maritime developments is both an operational requirement for dealing with emergent security challenges, and a potential deterrent against the migration of dangerous activities from land to sea.

The federal government has only recently begun to think through how it will accomplish its goals for Maritime Domain Awareness. The geographical scope of the mission, the range of threats that must be understood, and the precision of the information required suggest a task of unprecedented complexity. Somehow, the nation’s security establishment must construct a framework for providing global maritime awareness that does not undercut the performance of other missions and is affordable within projected budgets. Even with the optimum alignment of federal agencies and assets in pursuit of MDA, it is likely that the cooperation of foreign governments and private shippers will be required to make the system work. Thus, Maritime Domain Awareness might reasonably be described as an early step in the creation of a global security regime, a worldwide collaborative undertaking to protect the economic and political gains that mankind has made from the dangers of the present era.

MARITIME DOMAIN AWARENESS TIMELINE



ORIGINS OF THE MARITIME AWARENESS MISSION

As the world's preeminent trading nation and naval power, the United States has a clear interest in understanding developments in the maritime domain. Nine-tenths of U.S. trade moves by sea, and national territory is bounded mainly by oceans rather than other countries. Any party that impairs free transit of sea lanes, endangers maritime access to foreign markets, or uses the sea as a sanctuary from which to harm America's homeland and overseas interests must be countered. More broadly, any trend that threatens to diminish the value of the maritime domain as a shared resource of mankind must be understood. These principles have always been grasped within the Navy and Coast Guard, but they took on renewed importance for the nation in the aftermath of 9-11.

President Bush cited the need for enhanced Maritime Domain Awareness only months after the 9-11 attacks, stating that the heart of any such effort should be "accurate information, intelligence, surveillance and reconnaissance of all vessels, cargo and people extending well beyond our traditional maritime boundaries." That need was formalized in 2004, when Bush signed two presidential directives describing U.S. maritime security policy and establishing a Maritime Security Policy Coordinating Committee. The interagency body was charged with developing a National Strategy for Maritime Security that would be supported by implementation plans in eight areas, including MDA, maritime intelligence integration, operational threat responses, transportation security, and outreach to prospective international partners.

The National Plan to Achieve Maritime Domain Awareness was published in October 2005, setting forth an ambitious agenda for integrating the efforts of federal agencies, overseas allies and private industry in improving surveillance of the world's oceans. The plan stated that, "the primary method for information sharing, situational awareness, and collaborative planning will be the national maritime common operating picture," described as a "near-real time, dynamically tailorable, network-centric virtual information grid shared by all U.S. federal, state and local agencies with maritime interests and responsibilities." More recently, the government has completed work on an MDA concept of operations that seeks to engage all relevant agencies in a unified effort.

The final step in posturing the nation for improved Maritime Domain Awareness prior to actual implementation is to publish an investment strategy. Because the MDA mission area involves federal agencies in activities that overlap with their existing functions, the hope is that new investment requirements will be relatively modest. It may be feasible to meet key goals for enhanced maritime awareness by realigning and networking existing assets rather than buying new ones. However, some additional outlays of funding will probably be required to fill gaps in existing capabilities, and to extend the MDA framework to overseas partners not currently participating in the global surveillance network.

MDA MISSION OBJECTIVES

OBSERVABLES	COLLECT	FUSE	ANALYZE	DISSEMINATE	DECIDE/ACT
Vessels	Sensor networks	Tracks with tracks	Anomaly detection	Communication networks	Strategic
People	Military operators	Data with tracks	Pattern recognition	Common operating picture	Operational
Facilities	Intelligence agencies	Tracks with data	Comparison with rules	Command centers	Tactical
Cargo	Open sources				
Infrastructure	Commercial data				
Sea lanes	Law enforcement				
Threats	Foreign governments				
Friendly forces					
Weather					

SITUATIONAL AWARENESS & PREDICTIVE INTELLIGENCE



GOALS OF MARITIME DOMAIN AWARENESS

The National Plan to Achieve Maritime Domain Awareness states three overarching goals. First, MDA efforts must “enhance transparency in the maritime domain to detect, deter and defeat threats as early and distant from U.S. interests as possible.” Second, MDA must “enable accurate, dynamic, and confident decisions and responses to the full spectrum of maritime threats.” Third, MDA must “sustain the full application of the law to ensure freedom of navigation and the efficient flow of commerce.”

Translating these goals into practical objectives, the plan says that the United States and its allies should be able to “persistently monitor” vessels, cargoes, crews, and passengers traversing the world’s oceans; access and maintain detailed data about ships, facilities and infrastructure; and “collect, fuse, analyze, and disseminate information to decision makers to facilitate effective understanding.” No system for accomplishing these objectives on a global basis presently exists. Participants in the MDA planning process often use the analogy of the global air travel system to describe what they would like to achieve in the maritime domain — a collaborative network of sensors, command centers and databases that continuously monitors all traffic flows, precisely identifying the characteristics, travel plans and operators of each object tracked.

The 2005 MDA plan emphasizes the need for unity of effort and sharing of information in building a global surveillance effort. However, fashioning a truly integrated global network from the current, fragmented collection of assets and actors will be difficult.

Within the United States, relevant capabilities are scattered across the federal government among agencies that often compete for resources, and fostering unity of effort will be further complicated by the need to involve state and local authorities with a role in maritime affairs. Maritime activities are similarly balkanized in other countries whose cooperation will be necessary, and relations between key countries are often characterized by friction and ambivalence. While there are technical solutions to the challenge of integrating diverse reconnaissance capabilities and databases, it may be that the most important ingredient missing from the current maritime surveillance regime is simple trust.

The U.S. Navy uses the concept of a “thousand-ship navy” to explain the need for closer cooperation in global maritime security, arguing that by sharing information and assets, the navies of diverse nations can achieve goals no single navy could hope to accomplish. Deputy Chief of Naval Operations Adm. John G. Morgan, Jr. has described the thousand-ship vision as a “navy of navies,” similar to the networking concept of a “system of systems,” to highlight the greater degree of integration made possible by the seamless meshing of many different pieces. Vice Admiral Morgan contends that this navy-of-navies concept is well suited to the demands of global Maritime Domain Awareness. The concept is almost infinitely extensible, potentially engaging not only navies and coast guards, but also the world’s many private shippers.

MDA FUNCTIONAL AREAS

MDA = SITUATIONAL AWARENESS
PLUS INTELLIGENCE

INFORMATION COLLECTION

domestic & foreign,
sensitive & open
source

INFORMATION ANALYSIS

fusion,
pattern recognition
& anomaly detection

INFORMATION SHARING

networking &
dissemination



AN ARCHITECTURE FOR AWARENESS

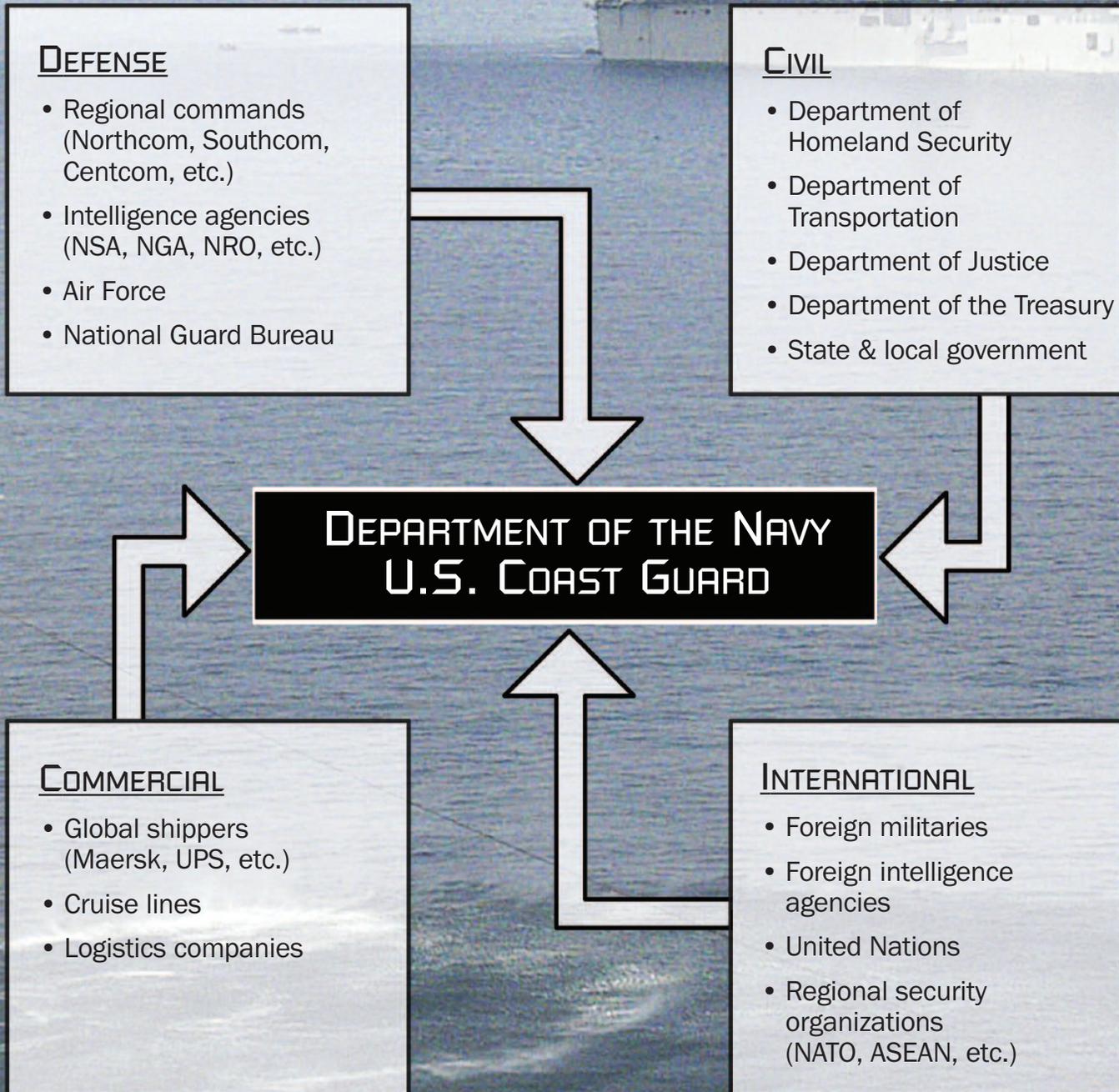
Regardless of whether U.S. Maritime Domain Awareness efforts engage a handful of agencies and allies or the entire global maritime community, they will still need to accomplish the same basic functions. First, detailed information will need to be collected and archived from a range of maritime “observables” — ships, cargoes, crews, facilities and so on. Second, the collected information will need to be moved quickly among participating organizations in a global network that reconciles easy access with the need to protect sensitive intelligence. Third, the network will need to contain nodes where information is fused and analyzed to identify patterns or anomalies before it is made available to end-users worldwide. Collectively, these three functional areas define the architecture of a global maritime surveillance system, a “nervous system” for the international maritime community.

The collection function is already performed by a vast array of orbital, airborne and other sensors operated by the world’s governments. Some of these assets are so highly classified that the operating governments do not even acknowledge their existence, while others (such as weather satellites) routinely provide information to the general public. Many governments also operate spy networks and diplomatic corps that can glean vital information about maritime developments. Additional information on traffic flows, cargo contents, passenger rosters and the like is continuously generated by commercial sources. No framework currently exists for integrating all the information collected about maritime activities, and therefore it is not clear how adequate existing collection resources are for meeting MDA goals.

The networking function is an essential feature of any integrated collection architecture. Without sufficiently capable and accessible networks, information cannot be conveyed in a timely fashion to analysts and command authorities, and warnings based upon the interpretation of that information cannot be disseminated to those who must respond or act to avoid risk. The United States is developing a “global information grid” to serve the needs of military users worldwide, but foreign governments and private shippers typically do not have access to that grid. A comprehensive architecture for Maritime Domain Awareness would need to provide affordable communications links, interface standards, and terminals enabling all participating organizations to share detailed and diverse information instantaneously.

The fusion and analysis function is required to integrate huge volumes of information from many sources into the common operating picture that gives end-users actionable insight. So much data is available from so many collectors that without some mechanism for merging and interpreting it, users would be overwhelmed by extraneous detail. The core of the fusion and analysis function would be an ability to quickly detect patterns and discontinuities hidden in the data, employing some combination of database searches, mathematical rules, and experienced human judgments. Once a coherent picture is generated from the mosaic of available information, the architecture must then allow that knowledge to be made available to users in a readily-grasped form, presumably using some system based on internet protocols.

MAJOR PARTICIPANTS IN MDA



IMPLEMENTATION CHALLENGES

Persistent surveillance and understanding of the world's oceans is a huge undertaking — so huge that it has never really been attempted. Past efforts at Maritime Domain Awareness have focused on collecting a limited range of information about specific categories of vessels transiting well-defined areas. Monitoring everything all the time was not considered to be a feasible goal, and it may not be feasible even now. But because emerging threats to maritime security are thought to appear most readily in places where surveillance is light and enforcement lax, the U.S. and its allies must pursue a more comprehensive approach to maritime awareness. Aside from the usual funding constraints, there are three basic challenges to implementing such a regime.

The first challenge is geographical. Two-thirds of the earth's surface is covered with water, and no means currently exist for monitoring traffic over such a vast expanse. While reconnaissance satellites in higher orbits can survey much of the earth's surface from a few vantage points, detail typically declines with distance. Satellites in lower orbits move so fast relative to the earth's surface that a very large number are needed to maintain tracks, and even then the quality of information obtained may be relatively poor. Any collector operating within the atmosphere or on the seabed will be limited in its reach due to the curvature of the earth and various obscurants. These fundamental physical constraints dictate that MDA efforts focus initially on areas of greatest concern — maritime approaches to U.S. territory, key chokepoints, areas with recurrent terrorist activity, and the like. Finding the optimum geographical focus for the initial stage of implementation will be driven in large part by the availability of funding, the maturity of surveillance technologies, and the receptivity of other nations to participation.

The second challenge is organizational. Within the United States, implementation of a Maritime Domain Awareness program will require horizontal integration of activities scattered across the federal government, and vertical integration of federal, state and local government efforts. A further dimension of integration will be required to engage private-sector shippers such as UPS and FedEx. Beyond U.S. borders, additional cooperative mechanisms would be needed to engage foreign navies, intelligence agencies and private maritime interests. These organizational complexities are so daunting that they could divert planners from the real goals of MDA into endless interagency wrangling. To avoid paralysis, the federal government will need to designate some agency — presumably a military service — as the leader for MDA implementation. One approach might be to vest the Coast Guard with responsibility for littoral awareness near national territory, and the Navy with responsibility for more distant surveillance. Whatever course is taken, though, the removal of bureaucratic obstacles to success is likely to be a major challenge.

The third challenge is technological. Modern information and networking technologies can mitigate many of the problems associated with geographical reach and organizational integration, but finding the right technical architecture will be difficult. The most important technological issue is developing a way of fusing information from scores of collection systems that were not designed to be interoperable. There must be some system for integrating information from sensors, spies and other sources scattered around the globe, otherwise it will not be possible to create the common operating picture that lies at the heart of Maritime Domain Awareness. The challenge of implementing such an architecture is made even harder by the need to protect sensitive sources while still maximizing access for all prospective users.

MARITIME CHALLENGES IN SOUTHEAST ASIA



AN EXAMPLE: SOUTHEAST ASIA

One region where arrangements for enhancing Maritime Domain Awareness have progressed rapidly in recent years is Southeast Asia. The vast archipelago of islands stretching from Indochina to Australia reflects both the promise and the peril of economic globalization. A third of the world's sea-borne commerce and half of its oil moves through the Strait of Malacca and the Singapore Strait each year, making those passages critical chokepoints in the global economy. As Singapore's defense minister Teo Chee Hean observed at a recent regional security conference, a consumer product in transit through his country's ports might be made of raw materials from Indonesia, components manufactured in Vietnam, and software coded in India, that is destined for final assembly in China using Japanese production equipment financed with American capital.

Because this intricate supply network depends on the timely movement of container ships and tankers traversing lightly policed sea lanes, it is highly vulnerable to disruption. Unfortunately, the region has more than its share of problems that might lead to such disruptions, including territorial disputes, separatist insurgencies, religiously-inspired terrorism, piracy and smuggling of everything from weapons to illegal migrants. Some analysts have also suggested that as Islamic terrorists currently operating in Southwest Asia are gradually defeated, they may shift their operations to Indonesia, the world's most populous Muslim state. Recognizing the numerous local threats to transit and trade, the countries of Southeast Asia have begun cooperating more closely to monitor maritime developments in their area.

In 2004, Indonesia, Malaysia and Singapore bolstered existing bilateral security agreements by agreeing to coordinate the use of their navies in patrolling the Strait of Malacca. The following year, they added joint air patrols to their maritime surveillance activities. More broadly, they have participated in a series of regional security initiatives such as the Five Power Defense Arrangements and the Western Pacific Naval Symposium aimed at building trust and cooperation among regional military forces. During 2005, nineteen navies from countries participating in the Western Pacific Naval Symposium took part in a joint military exercise that illuminated ways of improving information sharing and interoperability.

These efforts demonstrate how the shared economic and security concerns of nations can support initiatives such as the "thousand-ship navy" concept advanced by the U.S. Navy. But there is much more that can be done in places like Southeast Asia to improve Maritime Domain Awareness, and some of the most challenging needs can only be met with U.S. assistance. For example, the United States is the only country with a constellation of satellites for tracking maritime traffic, and its submarines far surpass the intelligence-gathering capacity of any other country's undersea fleet. Furthermore, it is the only country operating large numbers of carrier-based surveillance planes and building a robust global communications grid for the rapid transmission of military information. It thus has the opportunity to be a key player in developing Southeast Asian maritime awareness capabilities, possibly participating in the creation of a comprehensive surveillance regime that can be gradually extended outward to encompass much of the Western Pacific and Indian Ocean.



FRAMING AN INVESTMENT STRATEGY

Given the other missions and funding commitments impinging on military budgets, policymakers would prefer to achieve national goals for Maritime Domain Awareness through realignment and reorganization rather than new investment. There is some justification for believing that can work, because unlike in other emerging mission areas such as missile defense, the federal government has already made heavy investments in assets and personnel relevant to maritime awareness. Moreover, commercial interests have an incentive to collect much of the information MDA planners are seeking because of on-going business requirements. So it may be feasible to follow the same investment approach in Maritime Domain Awareness that the Navy has applied in its ForceNet initiative — to focus initially on using existing systems better rather than buying new ones.

However, some new investment outlays will eventually be required. First of all, there are major gaps in the existing surveillance regime for items such as nuclear contraband. Second, few tools currently exist for accomplishing multi-source correlation and fusion of data on the scale contemplated. Third, many foreign navies will be unable to participate at the level of intensity required without some form of financial assistance. Fourth, commercial shippers will balk at any awareness scheme that significantly raises the cost of doing business, and some shippers (especially smaller ones) will actively seek to evade participation in a system that requires them to comply with burdensome regulations. Spending money is the main way that the government is likely to overcome all of these obstacles to success.

As with any investment plan, the MDA investment strategy will need to begin with a precise set of operational goals and a review

of the assets currently in existence or in prospect for meeting those goals. The strategy will probably call for increasing the geographical reach and operational intensity of the maritime awareness system over time, beginning with a handful of locations (such as Southeast Asia) where the need for better monitoring of events is already recognized to be a high priority. These high-priority areas will in effect become testbeds for assessing how readily existing assets and organizations can collaborate in improving domain awareness, and also will offer insight into how gaps in the existing surveillance regime can be closed. For example, planners may choose to develop hardware for tracking non-cooperating shippers, or seek to strengthen enforcement regimes to a point where non-cooperation become more burdensome than complying, or simply subsidize shippers to carry necessary identification and tracking gear.

In terms of integrating the activities of participating federal agencies, the Government Accountability Office recommends establishing milestones and metrics for tracking the success of an investment strategy. But such measures can only be applied effectively if operational goals are precisely stated, there is a real concept of operations, and the managers implementing the program have sufficient authority to demand results. These requirements argue strongly for putting one of the military services in charge of the overall effort. The Navy is a logical candidate given its competencies, resources and reach. On the other hand, the Coast Guard may be better postured to interact with foreign navies. One thing is clear: Without a suitable management structure for driving progress in the emerging mission, investment outlays are unlikely to produce the necessary gain in maritime awareness.



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