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Research Report

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Maritime Domain Awareness Market and Capability Assessments for the Department of Homeland Security

Pursuant to its statutory authorities in the Homeland Security Act of 2002 (Public Law 107-296, 2002) and other provisions, including U.S. Code, Title 14, Section 522 and the Trade Facilitation and Trade Enforcement Act of 2015 (Public Law 114-125, 2016), the U.S. Department of Homeland Security protects the country from threats and enforces laws in the maritime domain.[1] Understanding the maritime domain is necessary to effectively and efficiently protect the country. This understanding is typically called *maritime domain awareness* (MDA), which DHS defines as the "effective understanding of information, threats, and anything associated with the global maritime domain that could impact the security, safety, economy, or environment of the United States" (Instruction Manual 262-12-001-01, 2017).

There are two main DHS missions in the *DHS Strategic Plan for Fiscal Years 2023–2027* (DHS, 2024) that benefit from or require MDA: (1) counter terrorism and prevent threats and (2) secure and manage the borders. Within and across these missions are several operations that DHS components carry out that need and use MDA between ports of entry:

- migrant operations
- counter-fentanyl operations
- illegal, unreported, and unregulated (IUU) fishing
- counterdrug operations[2]
- sanction-enforcement operations
- intelligence-collection operations
- Homeland Security Investigations (HSI) investigations

U.S. Customs and Border Protection (CBP)/Air and Marine Operations (AMO), the U.S. Coast Guard (USCG), and Immigration and Customs Enforcement (ICE)/HSI are the primary DHS compo-

KEY FINDINGS

Multiple components in the U.S. Department of Homeland Security (DHS), including the U.S. Coast Guard, Customs and Border Protection/Air and Marine Operations, and Immigration and Customs Enforcement/Homeland Security Investigations, need maritime domain awareness (MDA) between ports of entry. They need MDA to identify, locate, and thwart threats to national security and to stop illicit activities. However, DHS faces MDA capability gaps. To help DHS improve MDA, we assessed the state of the commercial market for MDA technologies, the existing state of DHS MDA capabilities, the use of artificial intelligence for achieving improved MDA, and what actions DHS can take to optimize existing and potential MDA capabilities.

Our key findings relate primarily to the lack of maritime domain data, especially where they are needed most, and DHS's inability to suitably process and interact with all the necessary data to make the most-informed decisions. These findings led us to the following recommendations for DHS:

- Improve maritime domain data-sharing, integration, and maintenance between and across components and partners
- Invest in automation capabilities for maritime domain data
- Enhance coordination and governance of MDA
- Improve the coverage area of maritime domain sensors to capture better data
- Enhance capabilities for processing maritime domain data
- Ensure that operators can view MDA results efficiently on as few screens as possible.

nents that undertake these operations and activities. The accuracy and timeliness of MDA is important for active situations, especially in the aforementioned areas. These missions work to thwart different threat actors—including, but not limited to, terrorist groups, lone actors, careless individuals, illegal fishers, illegal migrants, smugglers, transnational criminal organizations, and local criminal organizations—who might use vessels (surface, semisubmersible, and submersible) and sometimes low-flying aircraft to undermine the country's security between ports of entry. Additionally, vessels can also create hazards in the maritime domain, such as through intentional or unintentional collisions, allisions, groundings, spills, and accidents.

Complete MDA would make it relatively simple to know (1) all vessels' locations (on the surface and below the surface of all bodies of water), (2) what people and cargo are on board those vessels, and (3) the vessels' intent.[3] However, for DHS, MDA would be necessary in both the exclusive economic zone (EEZ), extending 200 nmi from shore, (where the United States has regulatory control)[4] and beyond the EEZ (where threats and vessels conducting illicit activities might originate). Yet monitoring every subsurface and surface vessel (from a single-person kayak to the largest cargo ship) would require an enormous number of sensors operating all day, every day, in all bodies of water. Even if monitoring at that scale were deployed, it would be a significant analytic task to assess a vessel's intent from a sensor, locate specific threats, and understand any underwater system. However, what can be done is to observe many vessels, determine typical routes and actions (often called *patterns of life*), and identify atypical actions. Similarly, information—such as intelligence about smuggling, trafficking, and IUU fishing—can be assessed and combined with other observations.

Within this operating environment, DHS components need to understand where vessels are and what they are doing to protect the maritime domain. Determining a vessel's activity in a given area of responsibility can be done using a variety of methods. Information can be collected using several technologies and sensor platforms (including satellites, buoys, beacons, planes, aerostats, drones, ships, offshore facilities, offshore observers, and onshore data centers) and through software and analysis systems. Typically, radar and imagery (optical and infra-

red) from ships, land, aircraft, and space are used to identify and classify vessels. Covering an entire area of responsibility is an enormous task for DHS given the size of the maritime domain (25,000 miles of inland waterways [U.S. Army Corps of Engineers, 2000] and more than 95,000 miles of shoreline for the United States and its territories [National Oceanic and Atmospheric Administration, undated]), the need to cover an area out to 200 nmi from the U.S. shoreline (see Figure 1), and the need to detect, track, classify, and identify vessels and to determine each vessel's intent. DHS, across all its components and locations, collects considerable amounts of information about what is happening in the maritime domain; yet, it does not have a complete picture, even when it operates in joint settings and shares information with other agencies.

Comprehensive MDA requires significant amounts of data and processing power, including human interactions and decisions. Artificial intelligence (AI)[5] and machine learning (ML)[6] can reduce the labor required to monitor and identify suspicious patterns when there are sufficient data to train or teach the algorithms. Applying contemporary information tools to DHS MDA monitoring processes would significantly contribute to DHS components' abilities to fulfill their missions. Toward that end, Congress, in an explanatory statement, provided funds to the DHS Management Directorate for such a platform to use across all of DHS:

> Enterprise-Wide Maritime Domain Platform.—The agreement provides $6,000,000 above the request to provide an enterprise-wide applied artificial intelligence maritime domain capability to identify, enable, and target maritime activities, utilizing dark activity and other deceptive shipping practices, to counter fentanyl and precursor chemicals, enforce sanction violations, and enhance law enforcement missions across the Department. (Granger, 2024, p. H1089)

As we will show in this report, our analysis supports the need Congress has identified.

Abbreviations

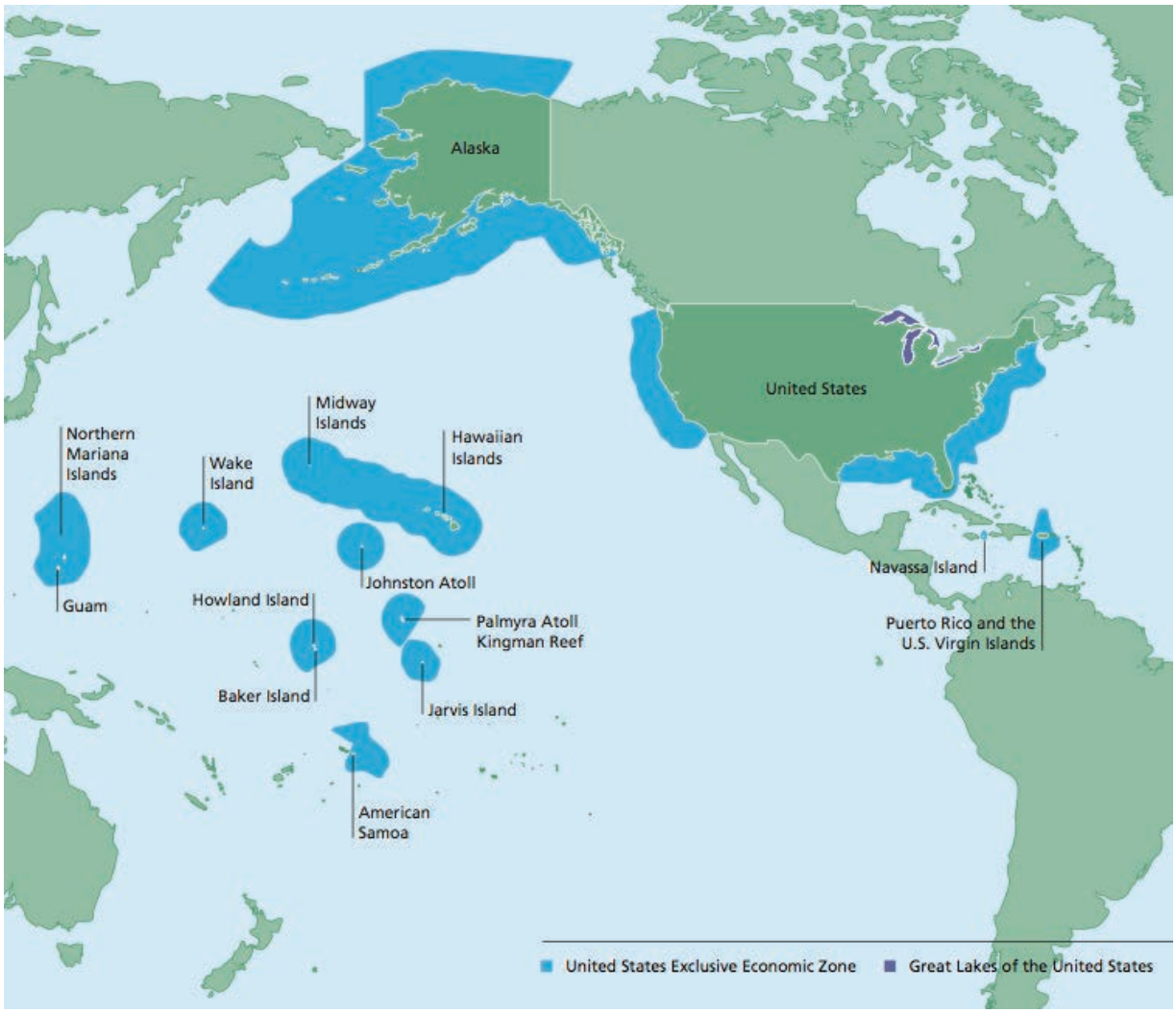
AI	artificial intelligence
AIS	automatic identification system
AMO	air and marine operations
BEST	Border Enforcement Security Task Force
C2	command and control
CBP	U.S. Customs and Border Protection
COP	common operating picture
DHS	U.S. Department of Homeland Security
EEZ	exclusive economic zone
EO/IR	electro-optical and infrared
HSI	Homeland Security Investigations
ICE	Immigration and Customs Enforcement
IUU	illegal, unreported, and unregulated
MDA	maritime domain awareness
ML	machine learning
USCG	U.S. Coast Guard
VMS	vessel monitoring system

Approach

For our assessment, we analyzed the existing state of MDA technology—particularly whether there is the potential for using AI to augment that technology—and we conducted a capability analysis. For this assessment, we conducted a preliminary review of DHS organizational structures, mission tasks, and system inventories to determine which components, programs, and technologies were within the scope of our work. We also reviewed government documents (including laws, policies, relevant strategies, and acquisition documents for MDA-adjacent systems). We also held more than 30 discussions with subject-matter experts, and we participated in site visits at MDA centers and DHS components locations in Riverside, California; San Diego, California; Miami, Florida; and Sterling, Virginia, to understand the existing state of MDA from practitioners' perspectives, including what is working well, what could be improved, and how AI automation might prove useful. Finally, we examined the commercial marketplace to understand products that DHS could purchase off the shelf to fill gaps in detection or monitoring capabilities.

FIGURE 1

U.S. Exclusive Economic Zones Needing U.S. Department of Homeland Security Protection



SOURCE: Reproduced from Pacific Coastal and Marine Science Center, undated.
NOTE: The expanse of the EEZ is very large. For example, it is nearly 4,000 miles between Guam and Hawai'i.

Using this analysis, we then determined the necessary capabilities, the current capabilities, and the resulting gaps to understand DHS's need to achieve the seven MDA-related missions listed previously and then to develop solution approaches. Our assessment and analysis was limited to needs between the ports of entry. We recognize that there are similar needs and capabilities at the ports of entry and for cargo and other vessels en route to ports of entry, especially for CBP Office of Field Operations.

Existing Systems of, Approaches to, and Capabilities for Maritime Domain Awareness

The Maritime Domain Awareness Challenge

As mentioned previously, knowing the location and nature of all vessels in or on the water is the purpose of MDA, which ultimately helps ensure national security and thwart known threats and illicit activi-

ties. Some vessels, which we call *cooperative vessels*, are those that provide signals with their location and intent information. Other vessels are referred to as noncooperative vessels or dark vessels. *Dark vessels* are vessels not transmitting automatic identification system (AIS) signals (Gambler, 2017; Stringer, 2020).[7] *Noncooperative vessels*, which include dark vessels, are those not transmitting AIS or other identifying signals (e.g., Vessel Monitoring System [VMS] signals). Not all vessels are required to transmit AIS or VMS. For example, noncommercial vessels, commercial vessels under 65 feet in length, vessels not traveling internationally, and vessels used for recreation and noncommercial fishing do not need to transmit AIS (Code of Federal Regulations, Title 33, Part 164, Section 46). For those required to transmit AIS or VMS, some vessel operators choose not to transmit, and some vessels might have malfunctioning AIS equipment. Those vessels that should be transmitting identifying signals and are purposely not doing so are likely turning themselves dark or becoming noncooperative to avoid detection, identification, classification, and tracking. Some vessels might appear to be cooperative, but they have altered their transmission in some way (e.g., their location or identification information has been altered).

The ability to know the location and destination of *cooperative* vessels that provide these tracking signals is well covered by available monitoring systems. Unsurprisingly, the *dark* or *noncooperative* vessels that are not willingly transmitting their locations (including legitimate users of vessels for legal activities and those trying to smuggle contraband or people or fish inappropriately) are not well covered by the current capabilities. The main reasons for not being able to detect, track, classify, and identify the noncooperative vessels are the lack of sensor data, lack of related data processing, and lack of alerting capabilities (which prevents any understanding of vessels' intent). These are the challenges that DHS or any entity attempting MDA must face.

Necessary and Current Maritime Domain Awareness Capabilities

Sensing Systems

Historically, organizations have relied on several techniques to monitor maritime activities. The prevailing approaches include electro-optical and infrared (EO/IR) sensors, radar-based monitoring and tracking of vessels, and monitoring and tracking radio frequency transmissions intended to promote safe navigation between vessels (such as with AIS) or to monitor commercial fishing activity (through VMS).

Monitoring techniques can be classified by particular physical phenomena, such as line-of-sight electromagnetic frequency reflections (used for radar) or the radio frequency transmissions by cooperative vessels (used for AIS and VMS). In addition to radar and AIS or VMS, there are other phenomena that can be and are used to monitor activities in the maritime domain. There are a variety of means through which sensors are deployed and monitored. For example, there are organizations at all levels of the government (federal, state, and local) that operate sensor networks and monitoring platforms. There are also a variety of private companies that operate sensor networks and monitoring platforms for a fee. However, there are advantages and disadvantages for each monitoring system.

Through our market analysis, we found that each DHS component involved in MDA-related missions and operations leverages a tailored set of systems to meet its specific mission requirements. We identified a total of 67 disparate systems of sensors, assets, and data centers, either commercial or government-owned, that contribute to MDA or *could* contribute to MDA.[8] Although many systems are developed for internal component or agency use, other systems are designed for cross-agency collaboration or to integrate external data feeds.

CBP/AMO operates aerostats as persistent surveillance installations that provide maritime radar coverage in South Florida and Puerto Rico (Long, 2025). Although aerostats are not the only radar coverage that DHS components have access to, they are likely the largest and most comprehensive systems under DHS control. Other, smaller MDA systems include maritime approaches surveillance towers, the Northern Border Remote Video Surveillance System, and the USCG's Vessel Traffic Service.

Data-Sharing and Display

There is a paucity of persistent sensor coverage in all locations in the maritime domain that need monitoring. Although operators and analysts often have access to radar data from state, local, or private sources, access is inconsistent, plagued by bandwidth issues, and not easily integrated across MDA software platforms. This might be because of issues with data quality and irregularity that come from collecting data in different formats, for different geographic locations, and in different quantities by source. The issues might also be because of a lack of sharing agreements among federal, state, local, tribal, and nongovernmental entities. Without persistent sensor coverage of the maritime domain, there is little that automated processing, AI, or ML can help with, and, perhaps more importantly, there are scant data for AI and ML applications to train on to improve alerting capabilities and general MDA.

Subject-matter experts noted that DHS operators face challenges because of the many different command and control (C2) and common operating picture (COP) systems in use,[9] and each system displays data and alerts differently. Operators often need multiple screens to monitor one area, making it harder to work efficiently and see all important information. Preferences for specific systems vary across and within operations centers, reflecting differences in missions and tools.[10] Although using one single C2 or COP system for all DHS components is unlikely, improving user interfaces and reducing the number of systems that operators must manage could make decisionmaking faster and more effective.

We also found that existing sensor networks are not widely shared across components or organizations for a variety of reasons. Existing platforms are often siloed within organizations or regions and offer duplicative and redundant functionality. Operators, analysts, and developers in different DHS components and in local and state agencies are often solving the same problems multiple times (in parallel and in silos) and, thus far, have not been able to pool their efforts in a significant way to make a broader impact and reduce duplicative efforts.

Maritime Domain Awareness Gaps

We compared DHS's necessary and current MDA capabilities to determine any capability gaps. We found that the DHS components' capabilities are lacking in the following ways:

- It is difficult or impossible to detect, identify, classify, and track noncooperative or dark vessels, especially smaller vessels and vessels in areas with little or no sensor coverage.
- Maritime sensor data coverage along U.S. coastlines is not consistent in terms of the miles covered, the distance out to sea, the types of sensor data available, and the sensor frequency and resolution in both space and time. This lack of consistency affects the ability to find and follow vessels, determine their intent, predict where threats might be or are heading, respond to threats, and complete other aspects of components' missions. We also found that
  - satellite imaging can reach farther from shore, but the data's frequency and resolution in both space and time are often insufficient for identifying, classifying, and tracking vessels in a timely manner, especially small dark vessels
  - sensors on DHS aircraft or vessels cover a small area while on patrol, but they can provide data with good resolution
  - fixed sensors, such as towers and tethered aerostats, typically cover larger areas than moving platforms and generally have good frequency and resolution, but they are still limited in their coverage area.

- Other non-DHS federal and nonfederal sensor systems collect maritime data, but the ability to share the data is hindered by such factors as data formats, permissions, and classifications.
- Determining a vessel's intent, which aids the decision to have a DHS component interdict or not, is very difficult without timely, detailed information (e.g., tips, investigations, and intelligence).
- If sensor data were collected 24 hours per day, 365 days per year, from the shoreline to the EEZ boundary—or even if existing sensor data collection were increased significantly—the quantity of data would likely overwhelm the ability of existing processing systems to render sensor data into an actionable form. Such processing would need automation, AI, and ML augmentation, but the AI or ML algorithms would need historical data to train on, including data on how to identify real threats.
- Using an AI or ML system that was based on sparse data (the existing situation) would likely lead to results with a significant number of false-positive and false-negative identifications and classifications and thus be unreliable for effective use.

Artificial Intelligence in Existing Maritime Domain Awareness Systems

The integration of AI into MDA systems has expanded significantly, driven by the growing complexity of maritime operations and the sheer volume of data that must be processed (Pohontu and Ermolai, 2024). The definition of *AI* in this assessment is quite broad: It encompasses nearly any kind of task automation that humans previously performed. By leveraging ML algorithms, natural-language processing, and advanced analytics, DHS might be able to use AI to enhance its components' ability to detect anomalies and patterns of behavior, combine sensor and other data inputs, and classify maritime threats with greater speed and precision. The data gathered could be used to make predictions about threats (and other adversarial behaviors) and potential transnational criminal organizations. AI-powered MDA systems can identify patterns and anomalies that might indicate illicit activities, providing actionable intelligence to decisionmakers. The goal is not to replace human operators but to augment their decisionmaking by automating routine data analysis, finding patterns, predicting behavior, and highlighting high-priority threats for further investigation. AI systems can increase efficiency because such systems can typically process data faster than humans given the vast amounts of data required for sufficient MDA.

AI-powered MDA systems can identify patterns and anomalies that might indicate illicit activities, providing actionable intelligence to decisionmakers.

DHS's AI Use Case Inventory gives accounts of real-world AI use by DHS components (DHS, 2026a). There are multiple MDA-related systems on this list, including Kestrel (which monitors air and maritime activity and flags unusual behavior [DHS, 2026b]) and Autonomous Surveillance Towers (which uses an algorithm classifier that assigns a vessel type to the collected image [Anduril Industries, undated]). Discussions with subject-matter experts clarified that DHS components use other commercial tools that include AI, including the following:

- Evidence.com, a cloud-based digital evidence-management system, developed by Axon, to store case information and aid in investigations
- Global Fishing Watch, a nongovernmental platform that leverages AI to detect IUU

fishing by using ML models that combine AIS tracks, satellite imagery, and behavioral analytics to identify such dark vessel activity as AIS spoofing or loitering in restricted zones (Global Fishing Watch, 2025)
- SeaVision, a Department of Transportation– and Department of War–sponsored international maritime domain information-sharing platform that incorporates AI-based tools for vessel-pattern analysis and route-deviation detection (SeaVision, undated).[11]

Existing Limitations to Applying Artificial Intelligence for Maritime Domain Awareness

Despite the proposed benefits of AI, its use in MDA systems remains an evolving capability rather than a fully mature solution. Component-level operators emphasized several limitations during our discussions:

- **Data-quality challenges and coverage gaps.** AI models are limited by the comprehensiveness and quality of the data they ingest. Deliberate AIS spoofing, inconsistent radar coverage, and unreliable crew and cargo manifest data can limit AI systems' ability to provide accurate insights. Additionally, adversaries often exploit blind spots or manipulate data streams, which further undermine a system's predictive accuracy.
- **Over-reliance on historical patterns.** Many AI systems rely heavily on historical information. When malicious actors change their tactics or try new approaches, these systems often miss the signs because they are still looking for old patterns. As malicious actors' approaches continue to evolve, AI systems become increasingly out of step with reality, missing more threats or taking longer to spot them.
- **Human trust in and oversight of AI.** Analysts and operators remain cautious about relying on AI outputs without a clear understanding of how the systems or algorithms reach their conclusions. This lack of understanding limits trust and, therefore, limits the degree of automation that operators have accepted when making critical operational decisions.

The Potential of Artificial Intelligence Applications for Enhanced Maritime Domain Awareness

Looking forward, stakeholders revealed how they anticipate that AI will play a transformative role in enhancing MDA. In our discussions, they said that AI could

- expand automated data fusion from disparate sources across DHS and partner agency systems and provide the ability to process different data formats to create a truly unified maritime operational picture
- improve predictive threat modeling by using complex adversarial behavioral baselines to anticipate illicit activity; predictive modeling is a proactive effort that prepares maritime operators who can arrive on scene before an adversary can make landfall in the United States
- enhance natural language processing for automated intelligence reporting and correlating information about malicious actor networks from different countries[12]
- support real-time decisionmaking in which the AI system recommends detection and optimal interdiction tactics.

Existing Cooperative Arrangements and Policy Enable the Use of Artificial Intelligence

Multiple cooperative arrangements—through groups, task forces, and other mechanisms—help ensure MDA. These efforts generally include federal, state, local, tribal, territorial, international, and private partnerships that support the shared approach to maritime security and are critical to information-sharing. Some of the groups cooperate to ensure MDA and require coordination among DHS components, as well as with other federal agencies and international organizations. We have compiled a list of groups that is not exhaustive, but it represents

the variety of groups and goals that contribute to MDA. As of September 2025, very little information is publicly available on how these groups do or do not incorporate AI into their efforts. However, new policies are being created to aid in implementing AI, which we also list. The organizations are as follows:

- **DHS Law Enforcement Information Sharing Initiative (LEISI).** Through this initiative, authority was designated to ICE/HSI to be the lead for law enforcement information-sharing (ICE, 2025a; DHS, 2019). LEISI's mandate spans domestic and international information-sharing, encompassing partners at federal, state, local, tribal, and territorial levels.
- **Caribbean Border Interagency Group (CBP, USCG, and ICE, 2012).** This group brings together CBP, ICE, USCG, and Department of Justice components to focus on the High Intensity Drug Trafficking Areas program, which is run by the U.S. Drug Enforcement Administration (U.S. Drug Enforcement Administration, undated).
- **Border Enforcement Security Task Force (BEST).** This is an ICE/HSI program that was signed into law in 2012 (ICE, 2026). The task force maintains an extensive operational footprint of 31 locations across the United States and Mexico and 69 BEST teams overall as of 2019.
- **Regional coordinating mechanisms.** Interagency collaborative mechanisms have been established through DHS to aid MDA that enable collaboration and coordination with regional partners to specifically focus on safety, security, and law enforcement.

In addition to those general information-sharing mechanisms, several specialized programs maintain dedicated intelligence functions addressing particular threat vectors. The programs, which implement sharing agreements focused on specific security challenges rather than broad-spectrum information exchange, are as follows:

- **Intellectual Property Rights Coordination Center.** The center integrates 25 federal and international agencies under unified leadership to combat illicit trade, among other goals (National Intellectual Property Rights Coordination Center, undated).
- **HSI Counter-Proliferation Investigations program (ICE, 2025b).** This program focuses on preventing adversaries from acquiring sensitive military equipment and strategic technologies to protect defense capabilities, secure the homeland, and preserve legitimate trade channels.

Despite the proposed benefits of AI, its use in MDA systems remains an evolving capability rather than a fully mature solution.

To supplement the effectiveness of groups focused on MDA, several policies have been implemented that can aid the groups' use of AI. Some policies are critical to MDA. These include the following:

- **Memorandum M-25-34/NSTM-2, "Fiscal Year (FY2027) Administration Research and Development Budget Priorities and Cross-Cutting Actions."** This memo indicates that AI is a research and development budget priority to support leadership in the field; the memo emphasizes AI architecture, data efficiency, and high-performing AI techniques and systems (Vought and Kratsios, 2025).
- **Executive Order 14179 (2025), "Removing Barriers to American Leadership in Artificial Intelligence."** This executive order establishes federal policy "to sustain and enhance America's global AI dominance to promote human flourishing, economic competitiveness, and national security."
- **Memorandum M-25-21, "Accelerating Federal Use of AI through Innovation,**

Through cooperation efforts, groups can facilitate faster information exchanges, reduce duplication of efforts, and create opportunities for joint operations that improve interdiction outcomes.

Governance, and Public Trust." This memo provides guidance for AI innovation, governance, and public trust (Vought, 2025a).

- **Memorandum M-25-22, "Driving Efficient Acquisition of Artificial Intelligence in Government."** This memo provides guidance to agencies on AI procurement, emphasizing three themes: ensuring that the government benefits from a competitive U.S. AI marketplace, safeguarding taxpayer dollars through AI performance tracking and risk management, and promoting effective AI acquisition through cross-functional engagement (Vought, 2025b).
- **Executive Order 14243 (2025): "Stopping Waste, Fraud, and Abuse by Eliminating Information Silos."** This executive order directs agencies to eliminate barriers to data-sharing.

All together, these cooperative arrangements demonstrate the scope of the partnerships that support MDA. The primary benefit of such arrangements lies in enabling data-sharing and operational coordination across agencies and jurisdictions, which in turn allows any one entity to build a more complete picture of maritime activity than it could achieve on its own. Through these cooperation efforts, the participating groups can facilitate faster information exchanges, reduce duplication of efforts, and create opportunities for joint operations that improve interdiction outcomes. However, cooperation also presents challenges: Data-sharing agreements can be limited by legal authorities, privacy constraints, or incompatible information technology systems, and varying organizational cultures and priorities can create friction. These benefits and challenges are especially relevant as DHS considers the wider adoption of AI. Multisource data-sharing strengthens the quality of AI models and their outputs, while gaps in cooperation or access can undermine the accuracy and utility of analytic tools.

Conclusions and Recommendations

For DHS to address the capability needs to achieve greater MDA between ports of entry, there are several possible complementary courses of action that it can take. Some of these recommendations might seem obvious, and several are already being pursued in some form at varying levels. However, such initiatives should be fulfilled at scale with the aims of reducing duplication, optimizing mission effectiveness, and ensuring the most efficient use of taxpayer investments in DHS personnel and assets. The final choices on which solution approaches to implement, when to implement the approaches, and how extensively to implement them should be based on such factors as cost, the risk of not filling gaps for each mission, and the threat risk for different locations. We did not include these factors in our analysis, and further research would be needed to address those factors. However, several steps can be taken even without that additional information:

- Improve data-sharing, integration, and maintenance between and across components and partners, such as by
  - identifying and using opportunities to improve data-sharing at the local level, within and among DHS components, and between DHS components and other federal departments and agencies

  - identifying technical barriers that inhibit sharing (e.g., labels, formats, taxonomies) for potential mitigation
  - establishing an authoritative, enterprise-level MDA data foundation to support future system acquisitions and analytics that would include governance mechanisms, standardized metadata, designated data stewardship, and automated data ingestion and sharing across DHS components (and other government agencies)
  - ensuring that new systems collect and integrate sufficient information to inform component missions (e.g., radar returns, EO/IR feeds, AIS, track histories, contextual information about vessels and infrastructure data).
- Invest in automation capabilities, such as by
  - automating routine monitoring and alerts using AI or rule-based mechanisms to support timely operational cueing
  - continuously monitoring, tuning, and governing automated systems to minimize false-positive alerts (which can lead to a misuse of resources) and false-negative alerts (which can lead to missed alerts), while maintaining appropriate human engagement.
- Enhance coordination and governance, such as by
  - leveraging the important contributions that community members have already made to improve their organizations' MDA
  - ensuring that appropriate staffing, training, and governance are in place to support the sustained use of shared data, analytics, and AI-enabled MDA systems
  - making commercial purchases of data and analytic systems at the department level to ensure that components have reasonable access to those systems.
- Improve the sensor data coverage in one or more ways, such as by
  - adding more sensors (starting with high-risk areas but aiming for full temporal and spatial coverage) while optimizing across such factors as the risks and costs for installation locations, the order of installations, and the types of sensors to install and operate
  - updating data-sharing policies to better align with existing needs and related policies and capturing technology changes (e.g., permissions, data formats) to increase sharing within DHS and with DHS's partners
  - sharing sensor data at the lowest processing level possible (e.g., raw or unfiltered) to allow partners to process the data for their own targets of interest
  - sharing processed data (e.g., tracks, image snippets) with partners for real-time events and post-event investigations.
- Enhance capabilities for processing data, such as by
  - automating processing where possible and providing operators or watch standers with alerts of possible targets (alerts can be based on rules or results of a trained AI and ML systems)
  - providing feedback on the accuracy of alerts and predictions to the analysis systems to ensure that the AI and ML systems are properly trained and adapt to the threats' changing tactics, techniques, and procedures.
- Ensure that operators can view results efficiently on as few screens as possible.

DHS components have a large area of responsibility in which to achieve MDA, and although some capabilities exist, there are improvements that DHS can implement. We have suggested several policy and planning considerations to properly increase MDA systems' effectiveness. The specific examples and suggestions presented were for MDA between the ports of entry, these basic approaches are applicable to the approaches to ports of entry and at the ports of entry.

Notes

[1] We acknowledge that *maritime* specifically refers to salt water, while several DHS-relevant maritime domains are fresh water (e.g., rivers, Great Lakes). We use the term *maritime* to refer to all surface water–based transportation surveillance activities.

[2] The mission to counter drugs and the mission to counter fentanyl specifically are nearly identical. The difference is that the fentanyl mission includes countering the precursors to making the drug. Some of the precursors are legal substances, and there are legal reasons to possess and transport them into the United States.

[3] The scope of the effort to monitor every subsurface and surface vessel might seem extreme, but, for DHS, this scope could be limited to all bodies of water within the U.S. EEZ (200 nmi from the U.S. coastline, except where the EEZ meets another nation's zone). However, information about where a vessel began its voyage, where it stopped along the way, whether it rendezvoused with another vessel, and whether it transferred (or could have transferred) people or cargo enroute are all important aspects in determining the intention and potential threat.

[4] The EEZ is based on laws for the maritime domain between 0 and 200 nmi from shore; zones within that distance include the coast (0 to 3 nmi), the territorial sea (0 to 12 nmi), and the contiguous zone (12 to 24 nmi). Areas past 200 nmi are considered the high seas (United Nations Convention on the Law of the Sea, 1982). U.S. federal definitions of the limits are up to 200 nmi from the baseline for the United States and territories in which sovereign rights and jurisdiction might be exercised (U.S. Department of State, 2023). The U.S. EEZ is more than 3.4 million nmi^2 (National Oceanic and Atmospheric Administration, 2023).

[5] U.S. Code, Title 15, Section 9401, Paragraph 3 defines *AI* as

> a machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions influencing real or virtual environments. Artificial intelligence systems use machine and human-based inputs to—(A) perceive real and virtual environments; (B) abstract such perceptions into models through analysis in an automated manner; and (C) use model inference to formulate options for information or action.

[6] U.S. Code, Title 15, Section 9401, Paragraph 11 defines *ML* as "an application of artificial intelligence that is characterized by providing systems the ability to automatically learn and improve on the basis of data or experience, without being explicitly programmed."

[7] AIS and VMS are not identical. VMS is used for commercial fishing vessels, while AIS is used more widely. We are generally considering VMS synonymous and interchangeable with AIS in this report. Not all vessels are required to transmit AIS or VMS signals. Cooperative vessels are those transmitting required signals and noncooperative vessels are those not transmitting any signals—that is, vessels that are not required to transmit signals and vessels that should be transmitting signals but are not.

[8] Examples of the variety of tools used for MDA are SeaVision (SeaVision, undated), the Team Awareness Kit (DHS, 2020), Rapid Tactical Operations Reconnaissance (DHS, 2026b), and USCG and CBP/AMO assets, including cutters, boats, and aircraft. There are also several DHS centers of operations that involve various DHS components working on regional activities related to MDA. Some of these centers include the Air and Marine Operations Center (CBP, 2025), the Joint Harbor Operations Center in San Diego (Kostelnik, 2011), and the Joint Intelligence Operations Coordination Center in Miami (CBP, 2021).

[9] We use the term *COP* to refer to an operational display of an existing situation that is shared within and across agencies. Data displayed are frequently from multiple sources, which might be different types of data or similar types of data from different agencies. Usually, the controls of the different systems are found elsewhere (e.g., for a C2 system), but sometimes control can be (temporarily) shared.

[10] This observation is based on our visit to a small number of sites; no formal quantification was made.

[11] The Department of War is designated the Department of Defense under Public Law 81-216, National Security Act Amendments of 1949.

[12] For more information on natural language processing, see Network of the National Library of Medicine, 2026.

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About This Report

We conducted a market and capability analysis to understand how artificial intelligence applications for existing maritime domain awareness (MDA) platforms might be of use to or fall short of needs for the U.S. Coast Guard (USCG), U.S. Customs and Border Protection Air and Marine Operations (CBP/AMO), and Immigration and Customs Enforcement Homeland Security Operations (ICE/HSI). MDA is a capability that the U.S. Department of Homeland Security (DHS) needs to aid many of its missions, particularly those related to border security in which there is a maritime nexus. Our work included reviewing existing and potential commercial and government solutions. With this report, we share the results of our capability analysis. The findings should be of interest to those at DHS and all its components who work to enhance MDA and appropriators.

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