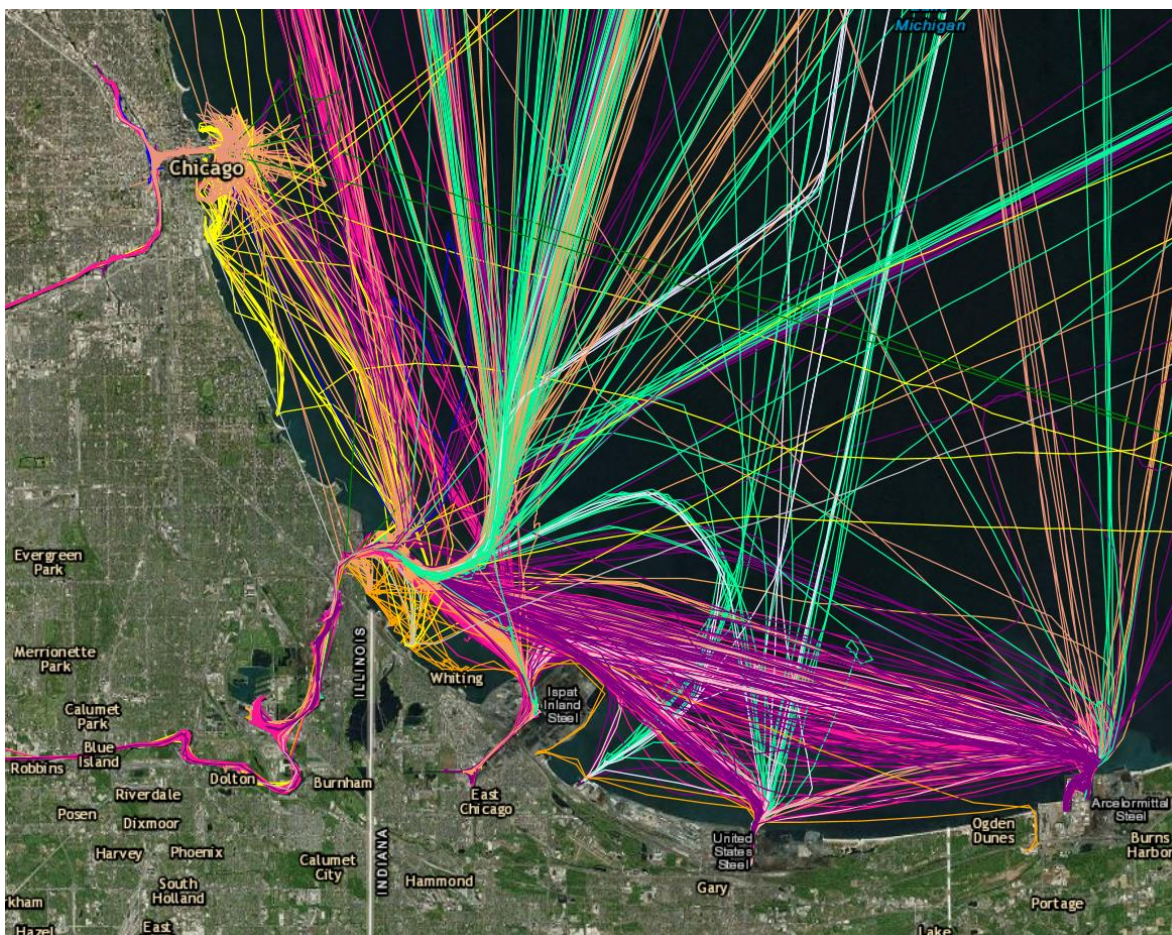


**ENHANCING ACCESSIBILITY AND USABILITY OF  
AUTOMATIC IDENTIFICATION SYSTEM (AIS) DATA  
Across the Federal Government  
and for the Benefit of Public Stakeholders**



**Maritime Data Integrated Action Team  
Automatic Identification System (AIS) Task Team  
U.S. COMMITTEE ON THE MARINE TRANSPORTATION SYSTEM**

March 2019

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- National Oceanic and Atmospheric Administration
- St. Lawrence Seaway Development Corporation
- U.S. Army Corps of Engineers
- U.S. Coast Guard
- U.S. Navy
- White House Office of Science and Technology Policy

**Cover Image:** AIS Historical Vessel Track Lines in Lower Lake Michigan Area.

Source: U.S. Coast Guard Nationwide AIS Archive. Processed using AIS Analysis Package (AISAP) developed by U.S. Army Corps of Engineers Engineer Research and Development Center. Credit: K.N. Mitchell



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## Executive Summary

The ability to identify watercraft and their intentions is essential for safe navigation, national security, situational awareness, and efficient movement of goods. Developed in the 1990s, Automatic Identification System (AIS) is a technology specifically designed to facilitate and provide this maritime capability. AIS is a means to exchange and collect information about vessels, including their position and other navigation information. Many Federal agencies have found the use of this data extremely valuable in support of their missions.

An AIS Task Team was established in late 2017 under the U.S. Committee on the Marine Transportation System (CMTS) Maritime Data Integrated Action Team to assess gaps and challenges in the accessibility and usability of AIS data, with the goal of increasing data accessibility, eliminating resource overlaps, and sharing developed capabilities and expertise between agencies.

The CMTS serves as a Federal interagency policy coordinating committee for assessing the adequacy of the marine transportation system; promoting the integration of the marine transportation system with other modes of transportation and other uses of the marine environment; and improving the coordination of, and making recommendations regarding, Federal policies that impact the marine transportation system. Over 25 different Federal agencies participate in the Cabinet-level Committee, and its subsidiary sub-Cabinet Coordinating Board, interagency Working Group, Integrated Action Teams, and initiatives. The AIS Task Team includes representatives from a dozen Federal agencies with maritime data interests.

The AIS Task Team presents the following report on increasing the accessibility and usability of historical, terrestrial-based AIS information across the Federal Government for the benefit of its partners and stakeholders. This report highlights the value of AIS information, summarizes current Federal capacity and applications of AIS information, breaks down the challenges of current AIS accessibility and usability, provides an overview of AIS technology, and proposes near-term recommendations to address some of the previously identified barriers. While real-time systems are integral, for example, to those in safety management or the intelligence community, for the scope of this report, the AIS Task Team addressed challenges and opportunities associated only with historical, terrestrial-based AIS data accessibility and usability. These findings and recommendations will inform future discussions on real-time and/or satellite AIS accessibility and usability.

Consistent access to, management of, and analysis of AIS data is a challenge for Federal agencies and stakeholders. The team broadly divided these challenges into categories pertaining to data:

- (1) Access,
- (2) Validity,
- (3) Management, and
- (4) User Support.

Barriers include, but are not limited to: policy and technical barriers to interagency data sharing primarily related to cybersecurity and information assurance policies, inability to access data in a timely manner, inconsistent data format and quality, impractical access to long-term data storage, need to validate data with third party sources, and a need for standard analysis products or decisional tools for users with limited capacity or expertise in AIS.

To gauge the status of current use of historical AIS information and associated challenges within the Federal Government, the AIS Task Team collected detailed requirements from agencies to more clearly define the challenges agencies face in acquiring and using AIS information. The Task Team analyzed agency perspectives in terms of data accessibility and usability. Accessibility is primarily concerned with user capacity to ingest and access data, and usability is concerned with user access to information produced from the data and the process(es) used to create information products.

Federal agencies both provide and use AIS data, with some generating AIS data and using AIS-derived products within the same agency. Three agencies are providers of terrestrial AIS information: U.S. Coast Guard, U.S. Army Corps of Engineers, and the St. Lawrence Seaway Development Corporation. All agency respondents are consumers of AIS data and information. Certain Federal agencies have significant expertise and capabilities for using AIS data, largely related to mission specific responsibilities. Current uses include waterways management, navigation safety, and support of security operations by the U.S. Coast Guard and the National Geospatial-Intelligence Agency; operations and management of waterways infrastructure by the U.S. Army Corps of Engineers; charting and marine resource management by the National Oceanic and Atmospheric Administration; planning and analysis for leasing and energy development by the Bureau of Ocean Energy Management; and statistical analysis by the Bureau of Transportation Statistics and the Maritime Administration, for example.

Based on the AIS Task Team's initial assessment of Federal usability and accessibility of AIS data and information, the Task Team proposes following short-term recommendations:

1. Better define and articulate the value proposition of open and easy access to AIS data across the Federal Government and public stakeholders.
2. Expand options for user access to AIS data by leveraging the Federally-managed MarineCadastre.gov as a platform for enhanced accessibility.
3. Increase awareness of existing AIS tools for Federal employee use that enable AIS information accessibility and usability.
4. Improve the usability of AIS-derived information products by establishing links to external data sources.
5. Identify geographic and temporal coverage gaps in U.S. AIS data and develop plans to fill them.

These recommendations necessitate, and are contingent upon, continued interagency coordination to develop prioritized requirements and to identify and maintain resources and funding. While this report is primarily focused on short-term recommendations, it also proposes initial long-term recommendations. Implementation of the long-term recommendations will

depend on individual agency capabilities and operations, and require the development of technological capacity to facilitate faster AIS data transfer between agencies, development of analytical tools to enable greater access to the data, and access to satellite-derived AIS information.

The accessibility and usability of AIS information will help enhance coordination for greater efficiencies in the marine transportation system and supports the current direction of data governance, including the White House Cross Agency Priority Goal for *Leveraging Data as a Strategic Asset*; Executive Order 13840, *Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States*, and its efforts to publicly release maritime data; the *Geospatial Data Act of 2018*; and the *Foundations for Evidence-Based Policymaking Act* (2019).

The AIS Task Team envisions that, ultimately, AIS data will be readily and easily accessible to all maritime and interested stakeholders in a timely manner, and in a manner that is appropriate for their use and capabilities. This enhanced accessibility and usability will support decision making for safe, efficient, and environmentally responsible use of, and activities within, waters where there are Federal interests.

## Abbreviations

A-DAPP	Automatic Identification System Data Analysis and Pre-Processor
AIS	Automatic Identification System
AISAP	AIS Analysis Package
API	Application programming interface
ATON	Aids to Navigation
AVIS	Authoritative Vessel Identification Service
BOEM	Bureau of Ocean Energy Management
BTS	Bureau of Transportation Statistics
CMTS	U.S. Committee on the Marine Transportation System
CSV	Comma-Separated Values
DHS	Department of Homeland Security
DOC	Department of Commerce
DOD	Department of Defense
DOI	Department of the Interior
DOT	Department of Transportation
EO	Executive Order
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
GIS	Geographic Information System
HDR	Historical Data Request (U.S. Coast Guard)
IMO	International Maritime Organization
KML	Keyhole Markup Language
LOMA	Lock Operations Management Application
LPMS	Lock Performance Monitoring System
MARAD	Maritime Administration
MMSI	Maritime Mobile Service Identity
MSP	Maritime Security Program
MSSIS	Maritime Safety & Security Information System
MTS	Marine Transportation System
MXAK	Marine Exchange of Alaska
NAIS	Nationwide Automatic Identification System
NARA	National Archives and Records Administration
NAVCEN	Navigation Center (U.S. Coast Guard)
NMEA 0183	National Marine Electronics Association Standard for Interfacing Marine Electronic Devices
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service (NOAA)
SART	Search and Rescue Transmitters
SLSDC	St. Lawrence Seaway Development Corporation (U.S.)
SLSMC	St. Lawrence Seaway Management Corporation (Canada)
TEU	Twenty-foot Equivalent Unit
TV32	Transview

USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFF	U.S. Flag Fleet
USG	U.S. Government
UTM	Universal Transverse Mercator (coordinate system)
VHF	Very High Frequency
VIVS	Vessel Information Verification Service
VTS	Vessel Traffic Service

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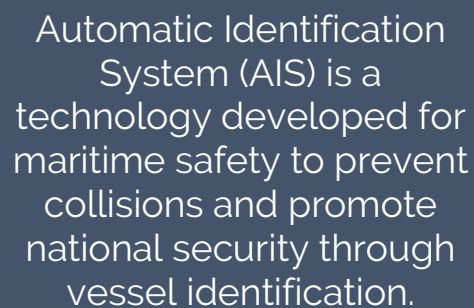
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## I. INTRODUCTION

The ability to identify watercraft and their intentions is essential to safe navigation, situational awareness, efficient movement of goods, and national security. Automatic Identification System (AIS) is a technology that came about in the 1990s and specifically developed to facilitate and provide this maritime capability. It was designed to promote ship-to-ship navigation safety, facilitate the provision of vessel traffic services, and allow coastal nations to monitor vessel activity in and near their waters.

AIS technology relies upon global navigational positioning systems, navigation sensors, and digital very high frequency (VHF) radio communication equipment that permit the exchange of navigation information between vessels and shore-side stations. AIS equipment on vessels can broadcast information about the vessel, such as its name or call sign, dimensions, type, position, course, speed, heading, navigation status and other pertinent navigation data. This information is continually updated in near real-time and received by all AIS-equipped stations in its vicinity. The advantage of this automatic and continuous exchange of information is that all can access it, tailored to the users' needs and desires. (See the Appendix for a primer on AIS technology and functionality.)

In 2002, the International Maritime Organization (IMO) made it mandatory for AIS to be fitted aboard all ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages, and all passenger ships irrespective of size<sup>1</sup>. In 2004, the U.S. accelerated and expanded upon these requirements to most commercial domestic vessels operating in U.S. navigable waters.



Automatic Identification System (AIS) is a technology developed for maritime safety to prevent collisions and promote national security through vessel identification.

Information derived from AIS data provides great opportunities to the U.S. Government (USG) and other maritime stakeholders to enhance marine transportation system safety, efficiency, and security. Although access to data and data products by non-federal agencies and stakeholders is not the primary objective of the U.S. Committee on the Marine Transportation System (CMTS), it is important to note that significant interagency work is driven by non-federal needs and the data access needs by Federal agencies will benefit non-federal audiences as well.

Federal agencies both provide and use AIS data, with some generating AIS data and using AIS-derived products within the same agency. Currently, however, obstacles within the

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<sup>1</sup> International Maritime Organization. (2018). *AIS transponders*. Retrieved from <http://www.imo.org/en/OurWork/safety/navigation/pages/ais.aspx>

following four categories inhibit Federal agencies and public stakeholders from effectively leveraging AIS data:

- (1) Access to Data,
- (2) Validity of Data,
- (3) Data Management, and
- (4) User Support.

The CMTS AIS Task Team is working to address the key challenges under each barrier to more effectively leverage AIS data for analysis and decision support. The scope of this report is focused on addressing the challenges and opportunities associated with historical (as compared to real-time), terrestrial-based<sup>2</sup> AIS data accessibility and usability, but may inform future conversations on satellite and/or real-time AIS accessibility and usability. These challenges include but are not limited to:

- Policy and technical barriers to interagency data sharing primarily related to cybersecurity and information assurance policies,
- Inability to access data in a timely manner,
- Inconsistent data format and quality,
- Impractical access to long-term data storage,
- Need to validate data with third party sources, and
- Need for standard analysis products or decisional tools for users with limited capacity or expertise in AIS.

This report focuses primarily on short-term solutions to these challenges, while long-term challenges are documented for future consideration, pursuant to resources and capabilities.

## History of Federal Efforts to Address AIS Challenges

The CMTS serves as a Federal interagency policy coordinating committee for assessing the adequacy of the marine transportation system (MTS); promoting the integration of the MTS with other modes of transportation and other uses of the marine environment; and improving the coordination of, and making recommendations regarding, Federal policies that impact the MTS. Much of the work of the CMTS is conducted through interagency Integrated Action Teams comprised of Federal subject matter experts.

The AIS Task Team was established in late 2017 under the CMTS Maritime Data Integrated Action Team to formally focus on Federal AIS requirements. The goal of the team is to assess gaps and challenges in the accessibility and usability of AIS data, with the goal of eliminating resource overlaps, increasing data access, and sharing developed capabilities and

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<sup>2</sup> See Appendix for more information on the difference between terrestrial and satellite-based AIS data.

expertise between agencies. The AIS Task Team includes representatives from a dozen Federal agencies with maritime data interests, including:

- Bureau of Transportation Statistics (DOT)
- Bureau of Ocean Energy Management (DOI)
- Environmental Protection Agency
- Maritime Administration (DOT)
- National Geospatial-Intelligence Agency (DOD)
- National Oceanic and Atmospheric Administration (DOC)
- St. Lawrence Seaway Development Corporation (DOT)
- U.S. Army Corps of Engineers (DOD)
- U.S. Coast Guard (DHS)
- U.S. Navy (DOD)
- White House Office of Science and Technology Policy

The work of the AIS Task Team builds upon a workshop held in the spring of 2015, hosted by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Coast Guard (USCG), on the use of AIS in support of science and research. One outcome from the workshop was the recognition of common concerns among agencies about consistent access to data and consistent quality of data.

The actions of the AIS Task Team also support and align with the current direction of data governance, including the White House Cross-Agency-Priority Goal for *Leveraging Data as a Strategic Asset*<sup>3</sup> and Executive Order (EO) 13840, *Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States*<sup>4</sup>. The Cross-Agency-Priority Goal is to “leverage data as a strategic asset to grow the economy, increase the effectiveness of the Federal Government, facilitate oversight, and promote transparency.” EO 13840 created the Ocean Policy Committee whose function includes to “coordinate timely public release of unclassified data and other information related to the oceans, coasts, and Great Lakes that agencies collect, and support the common information management systems, such as Marine Cadastre<sup>5</sup>, that organize and disseminate this information.” Supporting legislation includes the *Geospatial Data Act of 2018*<sup>6</sup> and the *Foundations for Evidence-Based Policy Making Act* (2019)<sup>7</sup>.

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<sup>3</sup> White House (2018). *Leveraging Data as a Strategic Asset*. Accessed from [https://www.performance.gov/CAP/CAP\\_goal\\_2.html](https://www.performance.gov/CAP/CAP_goal_2.html).

<sup>4</sup> White House (June 19, 2018). *Executive Order Regarding the Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States*. Accessed from <https://www.whitehouse.gov/presidential-actions/executive-order-regarding-ocean-policy-advance-economic-security-environmental-interests-united-states/>.

<sup>5</sup> <https://marinecadastre.gov/>

<sup>6</sup> *Geospatial Data Act of 2018*. P.L. 115-254. Available at <https://www.fgdc.gov/gda/geospatial-data-act-of-2018.pdf>.

<sup>7</sup> *Foundations for Evidence-Based Policymaking Act*. (2019) P.L. 115-435. Available at <https://www.congress.gov/115/bills/hr4174/BILLS-115hr4174enr.pdf>.

## Value of Federal Agency Collaboration and Coordination

Federal agencies with maritime missions can enhance the benefits derived from the use of AIS data by expanding coordination with other Federal partners and stakeholders.

Collaboration fosters a common understanding and use of the data, enabling analyses to be conducted on data sets that are consistent across agencies. If data comes from different sources, has been processed in different ways, does not include metadata or quality information, the conclusions drawn from analyzing it may be incomplete or erroneous, and will not be able to be reliably compared with similar analyses done on different data sets. If data sets must be different because of requirements for different outcomes, such differences are then explainable. Coordination also limits the duplication of effort and associated costs. For example, if an agency has a need for AIS data and is unaware of the availability of Government-collected AIS data that can easily be shared, they may purchase AIS data from a commercial source when it was already readily available to them at no cost.

## Considerations

In developing this report, the AIS Task Team agreed on the following principles:

***Leverage existing expertise in agencies:*** Some agencies already have significant expertise and capabilities using AIS data for mission specific responsibilities. These agencies have invested a substantial amount of time and resources to develop capabilities to access and use AIS data. This report is intended to leverage best practices from agencies, rather than advocate for new systems, so that new Federal and public stakeholders can leverage existing capabilities.

***Support Public Use and Stakeholder Access:*** As a product of multiple Federal agencies, this work is in support of the public good, serving stakeholders including state, local, and Tribal governments, academia, and the public. AIS data forms a key piece of ocean transportation industry knowledge, which can be used to better inform operational and policy decisions and enhance entrepreneurial opportunity. For example, Federally-produced derivative products can provide value to stakeholders where raw data access is limited. Furthermore, collection and management of federally provisioned AIS data are paid for by taxpayers. Therefore, the AIS Task Team should consider how this analysis and ultimate recommendations increase public access to and benefit from AIS data.

AIS data forms a key piece of ocean knowledge, which can be used to better inform operational and policy decisions and enhance entrepreneurial opportunity.

## II. EXISTING AGENCY AIS DATA ACCESS, CAPACITY, AND ANALYSIS PLATFORMS

### Methodology

To gauge the status of current use of AIS data and associated challenges within the Federal Government, the AIS Task Team developed an informal request for information, which was distributed by the AIS Task Team to affiliated Federal agencies (Table 1). Federal partners provided their specific agency requirements and more clearly articulated individual AIS challenges.

*Table 1: Agency AIS Questionnaire*

(1) Agency	(a) What Agency do you represent?
	(b) Which Office in the Agency?
	(c) Point of Contact (Name and email)
(2) Data Format	(a) What AIS fields (elements) do you require?
	(b) What format do you require? (e.g. .csv, NMEA, KML, other?)
	(c) Do you need real-time/live data or historical/archived data?
	(d) What time-lag/latency is acceptable? (e.g. none, a few minutes, days, weeks, other?)
	(e) Would you prefer standard analysis products or AIS data that you must process?
(3) Application	(a) What is the purpose of your application?
	(b) Do you need to correlate the AIS data with other data sources? If so, what data sources? (existing or desired)
(4) Data Source	(a) Do you get your data from the Federal Government? If no, skip to (5).
	(b) Do you get the data directly from the USCG?
	(c) Do you get the data from a non-USCG source? If yes, from where? e.g., MarineCadastre.gov, other government source, “free” site, own receiver(s), etc.
(5) Cost of Data	(a) Do you purchase AIS data from a third-party? If no, skip to (5d).
	(b) Approximately how much does your agency pay?
	(c) Are you paying for value-added services? If yes, what are they?

	(d) Aside from financial costs, what agency resources and manpower are spent in the data lifecycle: making data requests, processing received data, storing data, analyses, visualization, etc.?
	(e) Are there costs not captured in the questions above?
(6) Data Records	Does your agency own its own AIS archive?
(7) Data Needs	Are you aware of any AIS coverage gaps? If so, where?
(8) Other	Please add any other notes about how your agency receives and uses AIS data not captured above.

The team received 24 responses from five Departments. The results and following analysis are qualitative and not quantitative. The White House Office of Science and Technology Policy provided analytical support through the Science and Technology Policy Institute to look at the questionnaire responses.

Agency perspectives were analyzed in terms of data accessibility and usability. One useful way to distinguish between these two closely related data evaluation factors is that accessibility is primarily concerned with user access to data and usability is focused on user access to the data analysis production process. For example, enhanced data accessibility through ocean data portal development is viewed as an important factor for transparency and effective ocean planning<sup>8</sup>. However, access to data alone does not determine usability. Transforming data into actionable data, information, and knowledge products requires sustained value added by both users and producers. For example, usability requires co-production to balance user perspectives of saliency, credibility, and legitimacy<sup>9</sup>. Factors that explain access to data include exposing users to agency resources, interoperability, and user capacity. Factors that explain usability include user access to the production process to ensure saliency, credibility, and legitimacy from the perspective of multiple users.

### Agency Perspectives on Current Uses of AIS data

While the IMO's original intent for AIS was for ship-to-ship collision avoidance, coastal state monitoring of ships, and traffic management, stakeholders are increasingly recognizing the applicability and relevance of the data made available by AIS for a variety of purposes that have great value both within and outside the Federal Government.

In addition to navigation safety management, AIS data is also used for waterways management, risk assessments, coastal and ocean planning, port management, fisheries

<sup>8</sup> Lathrop et al. (2017) *The Role of Mid-Atlantic Ocean Data Portal in Supporting Ocean Planning*. *Frontiers in Marine Science* 4, p.256. Accessed from <https://www.frontiersin.org/articles/10.3389/fmars.2017.00256/full>

<sup>9</sup> Cash et al. (2003) *Knowledge Systems for Sustainable Development*. *Proceedings of the National Academy of Sciences* 100 (14). Accessed from <http://www.pnas.org/content/100/14/8086>

enforcement, environmental compliance, marine mammal avoidance, and freight statistical analyses by both Federal and public stakeholders. Current Federal uses of AIS data are examples of AIS data transformed into usable products, albeit often for a single agency. As illustrated below, Federal agencies can address a wide variety of missions and activities with their current access to AIS data (Table 2). Despite the noted obstacles to the data’s accessibility and usability, agencies are using AIS data for purposes that the information and technology were not originally imagined or designed for.

*Table 2 High level overview of agency responsibility and application of AIS information. In many cases, different offices within a given agency utilize AIS information for differing purposes.*

Federal Agency	AIS Lifecycle Role				Application			
	Provider	Disseminator	User	Regulator	Waterways Management	Waterways Safety & Security	Marine Planning	Statistical Analysis
BOEM		X	X				X	X
BTS			X					X
EPA			X					X
FCC			X	X				
MARAD			X					X
NAVY		X	X			X	X	
NOAA		X	X			X	X	X
SLSDC	X		X		X	X		
USACE	X	X	X		X	X	X	X
USCG	X	X	X	X	X	X	X	X

### U.S. Coast Guard

The USCG, with support from the Federal Communications Commission (FCC), is the national competent authority for AIS and operates the Nationwide AIS (NAIS) network which provides AIS coverage for U.S. coastal waters and selected segments of the Nation’s inland waterways for monitoring vessel traffic for safety and security, providing vessel traffic services, and communicating navigation safety information to vessels.

#### *USCG Navigation Center*

The USCG Navigation Center<sup>10</sup> (NAVCEN) provides two core services to internal and external stakeholders: data distribution and AIS Enforcement. NAVCEN provides NAIS data in several formats. In 2018, NAVCEN maintained 97 ‘live’ or ‘streaming’ data feeds offering government partners, USCG Programs, Vessel Traffic Services (VTS), port partners and other stakeholders near-real time AIS data fed directly from NAIS production servers.

<sup>10</sup> <https://www.navcen.uscg.gov/>



Federal and non-federal stakeholders can actively access NAIS information dating back three years through Historical Data Requests<sup>11</sup> (HDR) to re-create events, view trends and norms, and inform marine spatial planning. Beginning in 2017, NAVCEN introduced numerous internal process improvements and efficiencies, which drastically reduced the time needed to complete HDRs. At present, most requests and delivery of information can be provided within 30 days. NAIS information older than three years is stored with National Archives and Records Administration (NARA) in a format that requires significant effort to retrieve and access.

AIS Enforcement plays a vital role in improving the quality of NAIS data. In 2017, NAVCEN launched an online tool called the Vessel Information Verification Service (VIVS) to provide mariners, VTS, Marine Inspectors, Boarding Teams, and other maritime stakeholders a publicly accessible means of verifying the fidelity of AIS broadcasts. VIVS is a central component of the USCG's AIS enforcement program, which is designed to improve safety of life and safe navigation by reducing collision avoidance discrepancies. Fewer AIS discrepancies also translates to better AIS data quality.

#### *Nationwide AIS*

Nationwide AIS (NAIS) consists of an integrated system of AIS base stations, data storage, processing, and networking infrastructure. It consists of approximately 130 AIS stations located throughout the coastal continental U.S., inland waterways, Alaska, Hawaii, and Guam. NAIS collects AIS transmissions out to minimum 50 nautical miles from shore, including 58 critical ports and 11 waterways throughout the U.S. for use by USCG and other Federal, State and municipal entities. The primary goal of NAIS is to increase Maritime Domain Awareness through data collection and dissemination via a network infrastructure, particularly focusing on improving maritime security, marine and navigational safety, search and rescue, and environmental protection services. In addition, NAIS integrates with other systems for purposes of sharing infrastructure, speeding implementation, and improving performance.

#### *Authoritative Vessel Identification Service*

The USCG Authoritative Vessel Identification Service (AVIS) examines AIS data received from vessels, performs analysis on the data, and compares the vessel identifying information to other databases to determine the most probable actual identity and characteristics of vessels. This can be used to "correct" incorrectly entered information in AIS data transmitted by vessels.

AVIS creates a composite vessel identifier using various identity fields in the AIS position and static voyage messages, combined and compared with vessel identifying data from other sources. It uses algorithms and human validation to map the source of AIS messages to a unique vessel and provides the capability to track the historical identity of any given vessel. AVIS also augments the basic identifying information

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<sup>11</sup> <https://www.navcen.uscg.gov/?pageName=dataRequest&dataRequest=aisHistoricalRequestForm>

contained in AIS messages with additional authoritative data such as official number, year of build, documented dimensions, owner/operator, and radio license to provide complete, reliable, and authoritative vessel information.

### *Office of Navigation Systems*

The Office of Navigation Systems is responsible for establishing requirements, regulations, policy, program level guidance, and coordinating processes, platforms, and personnel necessary to establish, maintain, and operate the United States Aids to Navigation (ATON) System, which includes AIS. In addition, it creates policy and regulations and provides technical expertise for Marine Safety Information, Marine Spatial Planning, VTS, Navigation Carriage Requirements (including AIS), Port and Waterways Safety Assessment, and the Navigation Rules of the Road (including AIS).

### National Oceanic and Atmospheric Administration

NOAA uses AIS data to monitor and analyze fishing activity, improve marine mammal protection, and prioritize charting and surveying activities based on measured traffic volumes. Within NOAA, the National Weather Service (NWS) uses historic AIS to assess ship avoidance practices to hazardous weather and weather warnings. This work is expected to expand to include the integration of real-time weather and vessel positions.

NWS is working on a pilot project to utilize AIS to transmit automated weather observations from ships to enhance its Voluntary Observing Ship Program. The objective is to expand observations and improve the quality of weather forecasts. NOAA is working with the USCG to enable real time environmental data to be distributed via NAIS to ships operating along the coast to promote safe and efficient navigation.

### Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) uses AIS data to support its marine planning needs associated with offshore energy development. BOEM uses AIS data, with other relevant data sources, to identify and understand the historic patterns and usage of offshore areas by existing users. This information is used to perform spatial analyses that inform siting decisions, safety and risk analyses, emissions inventories, and the evaluation of development plans. BOEM is a disseminator of AIS data, in partnership with NOAA, through MarineCadastre.gov.

### MarineCadastre.gov

NOAA and BOEM jointly manage MarineCadastre.gov<sup>12</sup>, a Geographic Information System (GIS)-based marine data viewer and repository that provides decision support tools for siting of offshore renewable energy, mineral extraction, aquaculture, and other activities. Since 2009, MarineCadastre.gov has operated as a distributor of USCG NAIS data in open and GIS formats, storing and providing access to coastal NAIS information from 2009-2017. However, data is only available for downloading in pre-defined temporal and geographical units.

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<sup>12</sup> <https://marinecadastre.gov>

MarineCadastre.gov provides tools for the end-user to create AIS-derived products including track lines, density plots, transit counts, web map services, tutorials and software for desktop GIS users. These data, tools, and support material are available to the public for a wide range of coastal and ocean management, planning, research, industry, and academic purposes.

### U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) uses AIS to assist in lock operations, waterway monitoring, and communication of navigation safety information to vessels. USACE uses AIS data for navigation planning studies, enhanced efficiency in reporting required information at lock facilities, and to rectify data submitted by commercial vessel operators. USACE has also developed robust analysis capabilities for AIS data that provide insight into vessel operations related to USACE-maintained infrastructure (e.g., dredged channels, breakwaters, locks). These analytical capabilities have also been applied to examine topics such as vessel behavior in critical habitat areas, on-water incident investigations, and port resilience in the face of hurricanes.<sup>13</sup>

#### *Lock Operations Management Application*

The Lock Operations Management Application (LOMA) is a set of capabilities developed and deployed by USACE initially to enhance lock operations and lock operator situational awareness, but users come from throughout USACE. It consists of over 130 AIS transceivers located at locations primarily along the U.S. inland waterways that receive transmitted messages from vessels and transmit navigation safety information to vessels (Figure 1). LOMA provides AIS data to the USCG NAIS as well as to internal USACE clients. LOMA retains a 45-day store of data for operational playback capabilities; longer term storage is provided by USCG NAIS.

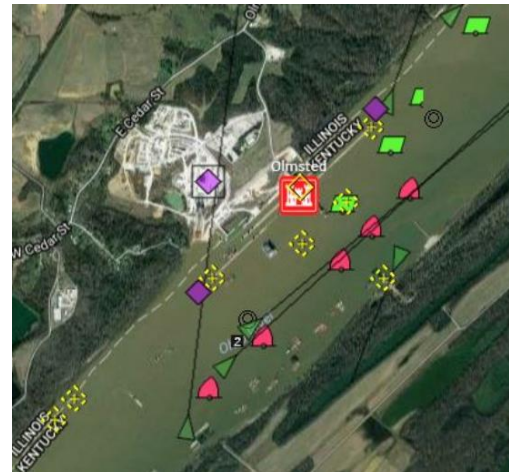


Figure 1: LOMA user interface. Real-time vessel locations, (dark green triangles), virtual ATON (yellow diamonds), and navigation safety information (purple diamonds) are shown near Olmstead Lock. Source: USACE

#### *Lock Operators Situational Awareness Tool*

The Lock Operators Situational Awareness Tool is an extension of the Lock Performance Monitoring System (LPMS) that combines existing USACE technologies to provide a visualization of vessel traffic and other data from LPMS to USACE lock operators. AIS data from LOMA are processed and displayed in Google Earth Pro. This provides lock operators a visual tool for checking vessels' locations and is the primary tool to setup automated timing zones for use in the LPMS.

<sup>13</sup> Touzinsky et al. 2018. Using Empirical Data to Quantify Port Resilience: Hurricane Matthew and the Southeastern Seaboard. *J. Waterway, Port, Coastal, Ocean Eng.* 144(4): 05018003. DOI: 10.1061/(ASCE)WW.1943-5460.0000446

### Automatic Identification System Analysis Package

The Automatic Identification System Analysis Package (AISAP) enables analysis of vessels' usage of U.S. coastal and inland waterways based on historic AIS data accessed through the USCG NAIS. AISAP accesses USCG NAIS data archive via a suite of web services provided by the USCG; this allows most data queries to be processed through machine-to-machine interactions and returned to the user in seconds or minutes (Figure 2). Within the AISAP web-based interface users can:

- Request data for the location and time span of their choice within the past three years,
- Customize the vessel position sampling rate, from two seconds to multiple days,
- Search for individual vessels through time,
- Visualize vessel tracks and create heatmaps,
- Generate summary statistics of vessel activity in an area of interest,
- Examine vessels' interactions navigational projects and structures,
- Download and export data in multiple file formats [comma-separated values (CSV), keyhole markup language (KML), Microsoft formats including XLS and XML) for use in other mapping or statistical software, and
- Create animated playbacks of historical vessel activity with exported KML files.

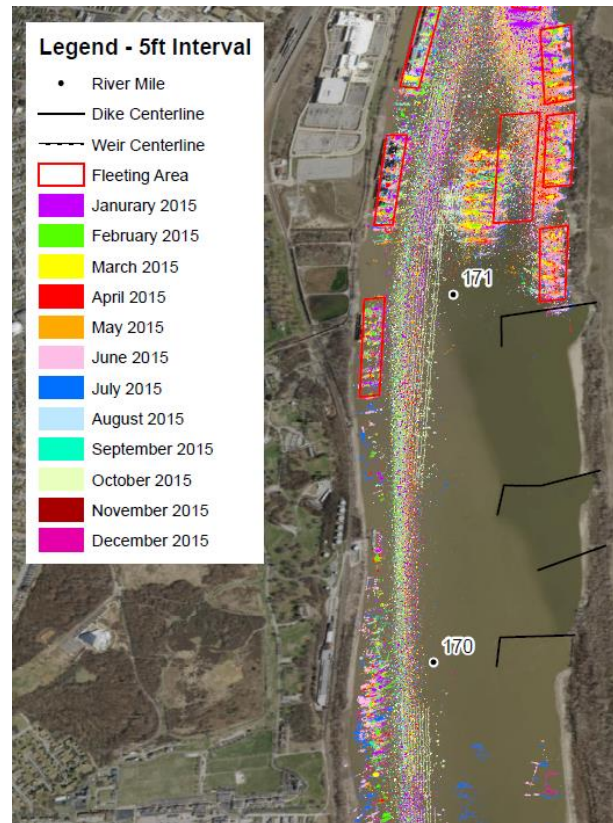


Figure 2 AIS data from LOMA transceivers on the inland system, processed via AISAP and exported to another mapping software. Results were used to identify previously unrecognized fleeting areas along the Mississippi River. Source: USACE, St. Louis District, C. Tabbert.

No geospatial or programming experience is required to use AISAP; it is accessible to users from all backgrounds. AISAP software is available to other federal agencies and is currently in use by personnel at USACE, USCG, NOAA, BOEM, and the Environmental Protection Agency (EPA).

### Container Model Suite of Tools

Under the Container Model Suite of Tools, a set of desktop programs and associated databases assist USACE planners and analysts working on port studies. The AIS Data Analysis and Pre-Processor (A-DAPP) is an advanced spatial analytic tool that allows for

the analysis of container vessel activities based on AIS data. A-DAPP uses AIS messages as well as vessel characteristics and port information from other sources. A-DAPP functions include identification of routes and services by containership vessel class, development of statistical information on arrival and departure draft, calculation of statistics on the amount of time spent by vessels at docks, determination of vessel speeds at various points along the route, and calculation of trip shares and other statistics by vessel class, service, and route group. This data can be combined with a planning level tool to facilitate economic analysis of proposed navigation improvement projects in coastal harbors.

### Maritime Safety & Security Information System

The Maritime Safety & Security Information System (MSSIS), is a government to government AIS data sharing network, developed and operated by the U.S. Department of Transportation (DOT) Volpe Center and funded by the U.S. Navy. Through secure Internet-based servers, MSSIS combines AIS data from 74 participating nations (including USCG-NAIS and USACE LOMA as the U.S. contribution) into a single raw-AIS NMEA 0183<sup>14</sup> data stream which amounts to over 150 million vessel position reports per day for as many as 60,000 vessels or more. Through MSSIS, participating governments can upload their local real-time AIS data and receive back the entire combined stream. Two AIS data platforms are available for display and conversion of AIS data: Transview and SeaVision.

#### *Transview*

Transview (TV32) is a Windows application with limited basic chart display capabilities and is used as the primary MSSIS client to access the streaming MSSIS data. Incorporating the Secure Sockets Layer service required by the MSSIS network, TV32 allows users to write the raw data stream to log files for data replay, perform off-line analytics, or direct the real-time raw data stream to other applications. TV32 and the associated MSSIS data stream is freely available to government entities in participating nations.

#### *Seavision*

SeaVision<sup>15</sup> is a web-based maritime situational awareness tool that enables users to view and share a broad array of maritime information to improve maritime operations. To assist the user in managing the information, SeaVision provides user-defined rules-based analytics to evaluate and notify the user of defined maritime activities or events. While MSSIS network contains only sharable AIS data from participating governments, SeaVision is also a visualization and management tool that has the ability to quickly add and correlate multiple data sources, including vessel positions derived from imagery or coastal radar, to meet various maritime mission needs. SeaVision implements access controls that allows data owners to specify dissemination permissions.

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<sup>14</sup> National Marine Electronics Association Standard for Interfacing Marine Electronic Devices, NMEA 0183

<sup>15</sup> <https://info.seavision.volpe.dot.gov/home>

## Saint Lawrence Seaway Development Corporation

The Saint Lawrence Seaway is a critical transportation link that connects the markets and manufacturing, mining, and agricultural producers of the upper Midwest and Canada to each other and to the Atlantic. Management of the Seaway is shared by and coordinated between the U.S. and Canada, through the Saint Lawrence Seaway Development Corporation (SLSDC) for the U.S. and the St. Lawrence Seaway Management Corporation (SLSMC) for Canada.

The first AIS system implemented in the U.S., the Seaway AIS system supports and is vital to the SLSDC's responsibilities for maritime safety and homeland security. SLSDC and SLSMC have long employed a VTS system to monitor the position, course, and speed of commercial maritime traffic to ensure safe and expeditious passages through the Seaway while minimizing shoreline erosion and protecting riparian interests.

The Seaway AIS, like other Federally-operated domestic AIS systems, is consistent with the Maritime Transportation Security Act of 2002, which requires that certain passenger vessels and other “high interest vessels,” like fuel tankers and hazardous-cargo ships, carry AIS equipment within the navigable waters of the U.S. In 2003, SLSDC and SLSMC amended their joint regulations to mandate the use of AIS in Seaway waters from Saint-Lambert, Québec, to Long Point, Ontario (Mid-Lake Erie).

## Environmental Protection Agency

EPA is developing a model that uses the vessel speed draft and location data from AIS records to estimate exhaust emissions from all category three commercial marine vessels operating in U.S. waters. Currently, AIS is the most comprehensive and detailed source of the type of vessel activity data needed to perform these calculations. EPA uses emissions models of this type to better understand the emission contributions of different vehicle types across the country, and to assess their impacts on public health.

## Bureau of Transportation Statistics

The Bureau of Transportation Statistics (BTS) uses AIS data to develop high-resolution and more timely statistics on port and terminal usage. For example, BTS (in partnership with USACE) analyzed containership and tanker dwell times within spatially-defined port boundaries using archival AIS vessel position reports from USCG NAIS to generate a wealth of statistical information in support of the Port Performance Freight Statistics Program. The large number of observations allowed BTS to calculate meaningful summary statistics, including mean U.S. containership and tanker dwell times as well as monthly dwell time indices for each port area (Figure 3). In addition, BTS used AIS data to visualize ferry routes in support of the National Census of Ferry Operators. Further, BTS is exploring the application of AIS data to calculate cruise passenger vessel statistics.

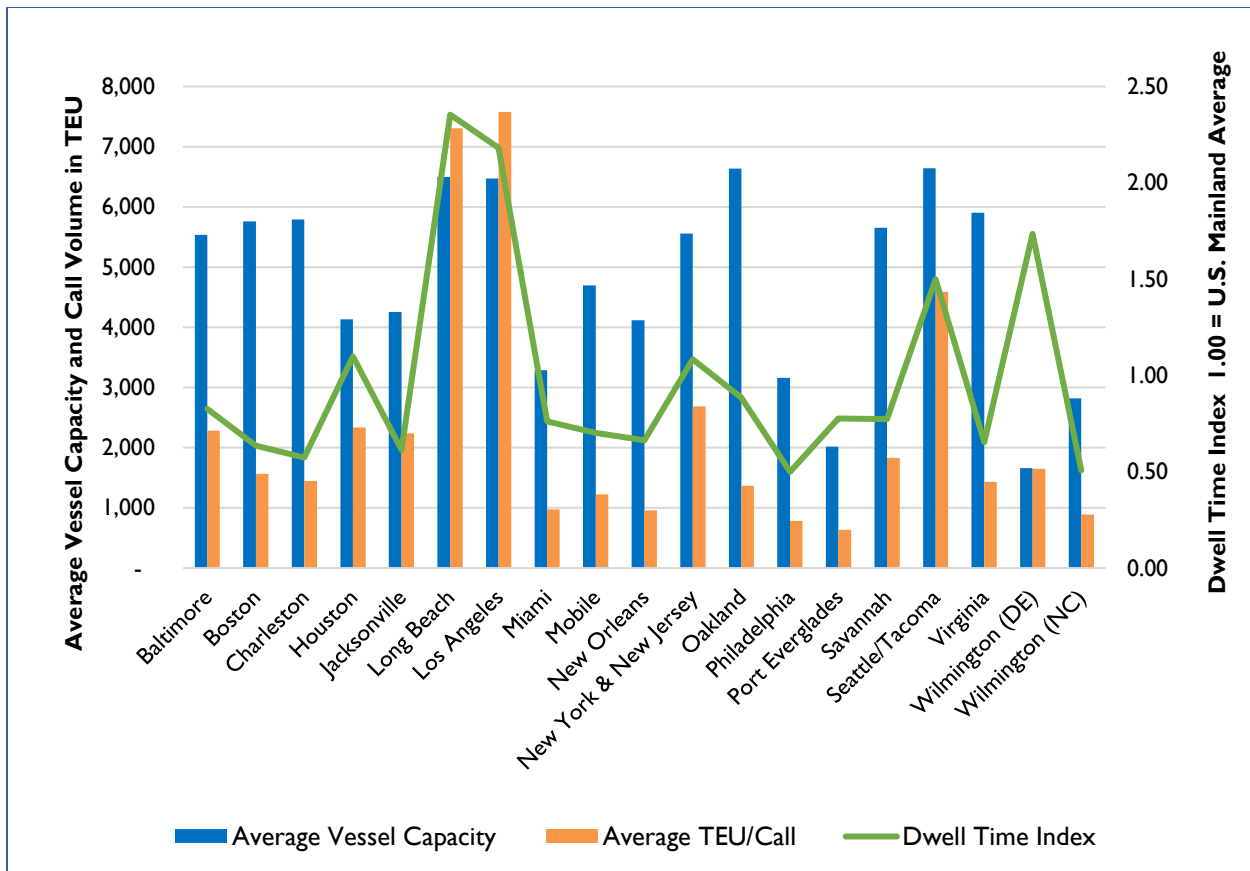


Figure 3 Average Vessel Capacity, TEU per Call, and Dwell Time Indices for Mainland U.S. Ports, 2016.<sup>16</sup>

### Maritime Administration

The Maritime Administration (MARAD) uses AIS data to track vessels in the U.S. Flag Fleet (USFF). One project highlights the extensive global reach of USFF service despite U.S. flag vessels carrying only 1.5 percent of international trade (Figure 4). AIS data for containerships was converted into lines depicting vessel routes and visualized by operator and capacity.

<sup>16</sup> Figure 3-10 from BTS 2018 Port Performance Freight Statistics Program Annual Report to Congress. **SOURCES:** **Dwell Time:** USDOT, BTS, and Volpe Center, calculated using AIS data provided by USACE Engineer Research and Development Center. **Vessel Size:** USDOT, MARAD, special tabulation, December 2018.

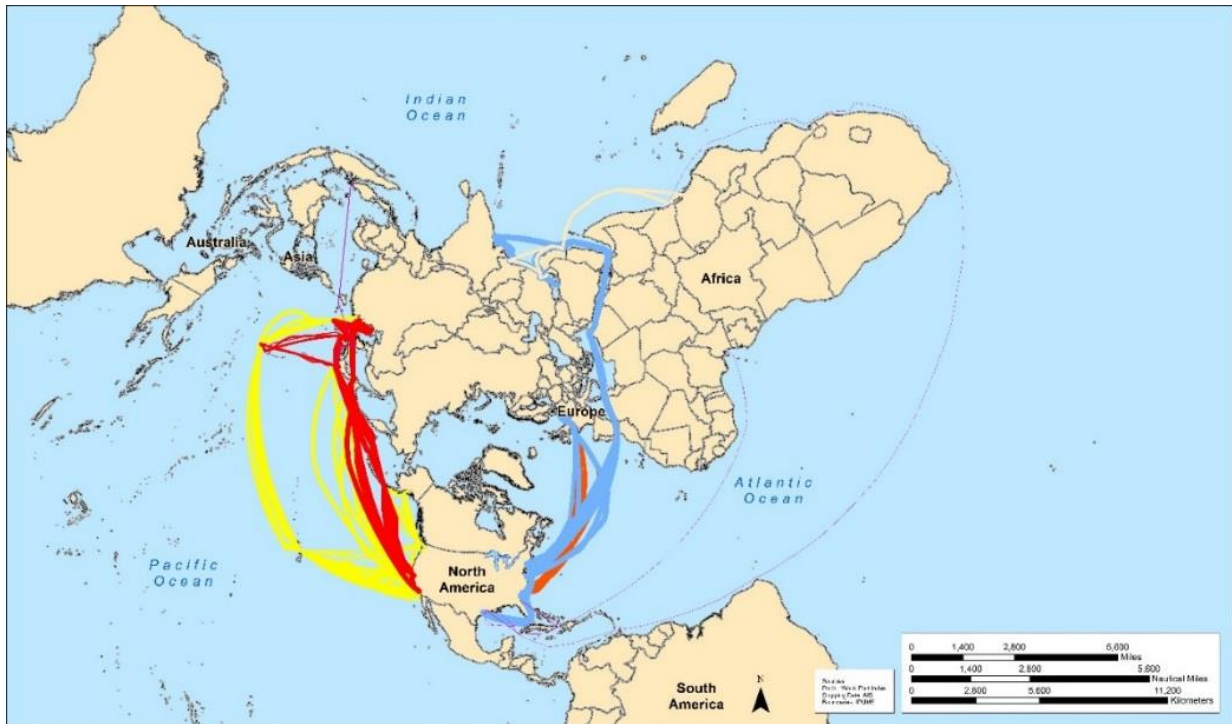


Figure 4 Depiction of USFF routes coded by operator and capacity. Source: MARAD

Additionally, MARAD used AIS data for a project to visualize the location and routes of ships in the Maritime Security Program (MSP). The MSP is a fleet of 60 U.S. flag commercial ships that can be called upon for national emergencies such as armed conflict or natural disasters. This information informs decision makers, in response to emergencies, to determine which MSP vessels are available in any given area.



## III. COMMON THEMES

### Application of AIS Data

In addition to the Federal uses of AIS illustrated above, the following summarizes the many types of applications identified in the questionnaire responses.

#### Waterways Management

- Vessel to vessel exchange of information
- Analyze ship traffic for navigational risk
- Inform vessels of hydrographic survey locations and chart adequacy
- Support Marine Planning needs, including offshore energy development
- Lock operations situational awareness
- Inland and coastal waterways operations

#### Safety and Security Management

- Risk Assessment
- Maritime Domain Awareness
- Weather forecast awareness for Safety of Life at Sea
- Incident investigation

#### Statistics

- Calculate dwell and transit times of vessels
- Calculate emissions inventories related to ship movements
- Track movement of USFF
- Quantify the level of disruption from storms or other events

### Historical vs. Real Time Data

About half of the Federal agency respondents used real-time data and the other half use historical data. Users in these two categories have very different needs. For the scope of this report, the AIS Task Team focused on accessibility and usability of only historical AIS data.

Only three agencies are providers of terrestrial AIS information: USCG, USACE, and SLSDC, each covering a distinct geographic section of the Nation.

### Provider vs. User of AIS Data

Federal agencies both provide and use AIS data, with some generating AIS data and using AIS-derived products within the same agency. Only three agencies are providers of terrestrial AIS information: USCG, USACE, and SLSDC, each covering a distinct geographic section of the U.S. USCG provides coverage of U.S. coasts, USACE provides coverage along the inland waterways, and the SLSDC provides AIS coverage along the St. Lawrence Seaway.

All agency respondents are consumers of AIS data and information. While all three Federal terrestrial AIS providers are AIS consumers, most agencies do not provide AIS data and are only users of AIS information.

### General User vs. Power User

The AIS Task Team divided the AIS audience into two categories defined by the group: the “General User” and the “Power User.” General users are those who are seeking to use parsed historical data, such as limited AIS fields, time periods shorter than one year, larger time intervals between data readings, and a limited region. General users may be interested in standard analysis products, such as track lines or vessel density maps. General users also include new users entering this space who may not be familiar with, or have the capabilities for, technical AIS data analysis. In contrast, “Power Users” are those with advanced existing AIS data management capabilities and familiarity working with USCG HDR, and likely have policy and technical requirements that exceed the scope of these recommendations.

### Data Format and Delivery Requirements

The team identified common data requirements across respondents in the following sections of the questionnaire: (2a) AIS fields, (2b) data format, (2d) acceptable time-lag or latency. Federal agencies primarily wanted the vessel specific AIS data fields, which include name, MMSI (Maritime Mobile Service Identity) and IMO numbers, call-sign, vessel class/cargo type, speed over ground, position, course over ground, and status.

Some respondents use the "original" AIS (NMEA 0183) formatted data, but most use derived data files in formats such as comma separated values (.csv). About a quarter preferred standard analysis products that can easily be read into GIS programs, rather than data that require further structuring and analysis. Some examples of preferred products are those that provide tracklines, density plots ("heat maps"), and transit statistics.

For historical data users, an acceptable latency, or delay in data availability, ranged from a few weeks to six months, with many mentioning 30 days as reasonable. Many agencies expressed a desire for a latency of less than one day. For agencies using real-time data, desired latency ranged between less than one minute and five minutes.

### Resources expended for acquisition and analysis of AIS Data

While some Federal agencies use Federally-provided AIS information, many indicated that they are buying AIS data from commercial sources to meet agency needs, including to fill coverage gaps and geographic areas outside of NAIS, at a variety of price points depending on the products purchased. In addition to commercially purchasing AIS data, agencies are purchasing vessel classification and other maritime-related databases to correlate and validate their information, including IHS/Lloyd’s and Clarkson’s. Resources expended for acquisition and analysis also included agency staff and computing capacity.

## Functionality with Other Data Sources and Platforms

Many agencies expressed a requirement to validate AIS information with other data sources for robust analysis and decision making capabilities. These include linkages with USG databases, such as those provided by USCG (like AVIS), U.S. Customs and Border Protection, or the Census Bureau, or other historical Federal data sets.

Additionally, AIS information needs to be able to be “read into” other systems, both navigational software and geospatial analysis programs. AIS information is also often overlaid with environmental information, including radar and satellite imagery, and on electronic navigation chart systems or plotters.

## Storage of Data

Agencies, separate from USCG, are independently archiving AIS data for many reasons with varying levels of management. This includes archival of purchased data and previously requested data from USCG. Responses to the questionnaire revealed that non-USCG agencies are storing data because it is easier than making multiple requests of USCG.

USACE has short term 45-day temporary archive for internal use of its own AIS data. USCG NAVCEN stores three years of AIS data in a format accessible through HDR. MarineCadastre.gov, with its NAIS record dating back to 2009, thus provides some of the longest time periods of AIS data publicly available.

## IV. ANALYSIS OF THE PROBLEM

### Problem Statement

Information derived from AIS data provides great opportunities to the U.S. Government and other maritime stakeholders to enhance marine transportation system safety, efficiency, and security. However, consistent access to, management of, and analysis of AIS data is hindered by the following barriers: cumbersome data access, inconsistent data, coverage gaps, suboptimal data management, and lack of comprehensive resources for AIS end user support.

The CMTS AIS Data Management Task Team is working to address the key challenges under each factor. These include, but are not limited to:

- Policy and technical barriers to interagency data sharing primarily related to cybersecurity and information assurance policies,
- Inability to access data in a timely manner,
- Inconsistent data format and quality,
- Impractical access to long-term data storage,
- Need to validate data from third-party sources, and
- Need for standard analysis products or decisional tools for users with limited capacity or expertise in AIS.

### Requirements for AIS Data Management

The problem statement falls into four larger categories of requirements for data management:

- (3) Access to Data,
- (4) Validity of Data,
- (3) Data Management, and
- (4) User Support.

These categories were developed from the questionnaire responses, discussions among the AIS Task Team, and conversations at the NOAA/USCG AIS Workshop held in 2015.

#### (1) Access to Data

First, barriers to AIS information access include a variety of interagency data sharing limitations, such as cyber-security rules, data sharing policy, and resource and personnel limitations that would enable access. For example, USCG can share live satellite AIS data only within DHS, but outside of the Department, waivers are required. This requires time and resources from Federal agencies wishing to have access to this data.

Second, multiple agencies are paying for data. While there is value in purchasing data from multiple satellite providers because they can fill temporal and geospatial gaps, especially outside of the terrestrial NAIS coverage zone, this is not necessarily the case for all Federal purchasing of data. Additional information is needed on which specific data sets are being purchased, how much is being spent, and if there is redundancy in these purchases to determine whether these costs be redirected more efficiently.

Third, there is a need for a single “authoritative” source for consistent data access. Existing authoritative data repositories are described in Section IV of the report. Although access to data and data products by non-federal agencies and stakeholders is not the primary audience of the CMTS, it is important to note that significant interagency work is driven by non-federal needs and the data access needs by Federal agencies will also benefit non-federal audiences as well. Concerns have been expressed over dissemination of proprietary information and how wide access to AIS data may harm certain shippers’ business case. However, as AIS transmissions are unencrypted and do not include sensitive information (e.g., personally identifiable information, specific cargo information), this information is not considered to be proprietary. The USG’s responsibility is to maintain a level playing field regarding access to AIS information and these considerations will be addressed.

Fourth, access to AIS data is a big data challenge. Many users, especially general users as defined above, do not have the capacity to ingest and process these big data files. To process AIS data on a large scale requires high computing capability. General users typically have limited computing capacity and desire derived products or simplified/aggregated formats.

## (2) Validity of Data

First, there are challenges with the original format of AIS data. While the native NMEA 0183 data format includes high density of data, it must be parsed to be usable and most stakeholders need only a few of the available data fields. They also require data in a format that is more readily usable in analytical software such as GIS applications. Most Federal agencies work primarily with text formats (e.g., CSV), but KML and GIS-readable formats are becoming more common. For general users of AIS data, a user guide may be necessary to explain the process of converting source data into analytical software inputs.

Second, regardless of the parsed data format, there is a need for consistency in availability of AIS data elements and their values. The elements identified by Federal agencies as most commonly utilized (e.g. MMSI, Name, Call Sign) should be maintained consistently so that they can be easily read into analytical software. When these fields are not maintained consistently, conclusions drawn from analyzing the data may be incomplete or erroneous, and will not be able to be reliably compared with similar analyses done on different data sets. Consistency of data should align with international and national data standards.

Preservation of these data elements and fields also enable correlation and/or validation with external data sources. Users require the ability to correlate and/or validate AIS information

with other authoritative data sources and information to accurately identify the vessel(s) analyzed for more effective use with other maritime-related data sources. A major quality issue with AIS data is that the information being transmitted by ships is often incorrect, in particular manually entered information. Also, depending on how values are parsed, there may be errors or inconsistencies in the presentation of default values, or indicators that certain data elements are out of scale or unavailable.

Third, AIS information demand is split among real-time or historical, and parsed or complete data needs. The AIS Task Team is intentionally focusing its work on accessibility and usability of parsed historical AIS data. Additionally, there may be a need for standardized parsed data at set sampling rates and methods; NAVCEN currently provides HDR in five-minute increments (usually adequate for most HDRs).

### (3) Data Management

First, storage of AIS data is a resource intensive, but necessary, component of accessibility and usability. It is important to evaluate if there are hardware or bandwidth concerns of the authoritative data providers. It is not in the AIS Task Team's purview to assess storage capabilities of end-users; instead end-users with limited capacity may instead desire standard analysis products.

USCG NAVCEN can easily retrieve the most recent three years of AIS data, while there is still demand for AIS information from previous periods. Older data is stored with NARA, where the data is still available, but not readily accessible.

USCG NAVCEN can easily retrieve the most recent three years of parsed AIS data, while there is still demand for AIS information from previous periods. Many users have articulated requirements for ready access to data older than three years. Providing access to AIS information through HDRs for periods of time beyond three years has been determined by USCG to not be practical. Further investigation needs to be done to solidify this requirement and identify what resources would be required to make older data available through HDRs or other means of accessibility.

USCG is using NARA standards to guide how much data to maintain and keep available. Everything required under NARA standards is packaged and stored with NARA, where the data is still available, but not readily accessible (and may not meet future needs).

Second, there is a need for improved metadata so end users can better understand the content and limitations of this data. Metadata should include origin [e.g., USCG, USACE, SLSDC, the Marine Exchange of Alaska (MXAK), or other sources]. Other information should address the data validity, its pedigree, coverage gaps, boundaries, etc. For those using data

previously requested or processed by other entities, the data chain of custody is important to understand what additional alterations have been made. Further requirements for metadata is required in this area; compliance and alignment with other Federal and international metadata standards should be ensured.

#### (4) User Support

When broad access to a data-rich information source is provided, general and technical support will be necessary to ensure users have seamless access to the information and that it is suited to their needs. This includes support for utilizing the data and for any data platform itself. First, there is a steep learning curve for new data users, and even General Users, most of whom may not be geospatial experts or do not have the computing capacity to process large data sets. Therefore, there is a demand for standard data analysis and products for users. There is a significant amount of expertise and existing strengths within the USG that should be leveraged for this.

Lastly, administrative support will be necessary for whatever database or platform facilitates access to the data. This includes good documentation on the data and end user support for individuals with questions, account management, and training, as necessary. Challenges for end user support include the need for continuous funding and resources to maintain capabilities. Additionally, resources will be necessary to continuously meet changing needs of users and evolving technology.

## V. RECOMMENDATIONS

To meet the needs of AIS “General Users,” as previously defined, the following recommendations were developed to address the challenges with AIS usability and accessibility. Additionally, these short-term recommendations were identified as a high priority among Task Team member agencies to address immediate barriers and inefficiencies in agency operations. These recommendations necessitate, and are contingent upon, continued interagency coordination and prioritized and maintained resources.

### Short Term Recommendations

#### **1. Better define and articulate the value proposition of open and easy access to AIS data across the Federal Government and public stakeholders.**

AIS data serves a valuable role in Federal maritime activities. It is therefore of utmost importance that availability of, and access to, AIS data remains possible across the Federal Government and to maritime stakeholders. Efforts should be taken to articulate the value of AIS data to decision makers and to encourage support for the recommendations in this report. To reiterate, significant interagency work is driven by non-federal needs and the data access needs by Federal agencies will also benefit non-federal audiences as well. Additionally, AIS information should be considered in the larger context of all ocean data and big data.

Responsible Parties: This recommendation is directed at all Federal agencies with maritime data interests.

#### **2. Expand options for user access to AIS data by leveraging the Federally-managed MarineCadastre.gov as a platform for enhanced accessibility.**

In support of EO 13840, the team recommends supporting increased access to AIS data through MarineCadastre.gov. MarineCadastre.gov has demonstrated success in providing AIS data that meets a variety of stakeholder needs. The following recommendations would build upon their current structure.

Responsible Parties: This recommendation is primarily directed to NOAA and BOEM for implementation through MarineCadastre.gov, and USCG NAVCEN upon which the data access is dependent. The implementation of this recommendation is dependent on increased availability of resources and capacity for USCG and MarineCadastre.gov.

- a. Commit to providing AIS accessibility through MarineCadastre.gov.* Currently MarineCadastre.gov is supported on an ad hoc basis. Dedicated support in the form of resources and funding for an easy-to-use platform would provide long term reliable access to these data.



- b. ***Decrease the processing time before AIS data is made available on MarineCadastrre.gov.*** Currently, MarineCadastrre.gov processes AIS data on an annual basis, making a calendar year's AIS data available on the site 6 months into the following calendar year. Additional analysis is required to coordinate and develop a timelier solution for the public release of filtered, historic (>96-hour), AIS data, provisioned exclusively through Federal sources. The Task Team recommends decreasing this processing period into shorter timeframes, i.e. six months, one month, with the ultimate goal of near-real-time data availability. Collaboration among Federal agencies is required to identify efficiencies in batch or continuous feeding of historic AIS data, data quality review, and formatting of data sets.
- c. ***Update existing historical AIS data within MarineCadastrre.gov.*** There are two recommendations related to this:
  - i. AIS data from inland waterways has been excluded from the data portal primarily because MarineCadastrre.gov's original purpose was for ocean planning. The team recommends adding inland waterways AIS records for past years, which is available through NAIS.
  - ii. The team recommends that pre-2015 AIS data, which had the MMSI numbers "anonymized" be updated to "de-anonymize" the MMSI, or provide tools to do so.
- d. ***Improve the ability to select desired AIS data.*** Currently MarineCadastrre.gov provides AIS data in files of one-month temporal extent and UTM zone geographic extent. The ability for users to more concisely select the time and area of data they are interested in would be valuable. Providing an interface to allow this selection, including filters for common AIS data fields (e.g. speed, course, vessel type) would allow for more targeted and useful data access.
- e. ***Provide tools to access AIS data in various formats.*** Currently MarineCadastrre.gov provides the data files in .csv format, which is the most open format they can provide. Providing tools or software that can enable the user to convert the data to other formats, would be useful to a broader range of users. MarineCadastrre.gov already provides a way to convert AIS information to a geodatabase format.
- f. ***Scope the ability to access AIS data via web services.*** An application programming interface, or API, would allow web service calls to MarineCadastrre.gov data and return specific queries of data and analysis products. This would allow users with existing systems to take advantage of AIS data capabilities without having to perform manual conversion for their specific usage. As this would be a resource intensive task, the team recommends scoping the necessary resources to implement.

### **3. Increase awareness of existing AIS tools for Federal employee use that enable AIS information accessibility and usability.**

As previously noted, Federal agencies have invested significant resources to develop tools and platforms that enable the accessibility and usability of AIS information within their own agencies, such as the web-based AISAP available through USACE. AISAP is a research

tool that has been available within USACE for over two years, and made available to the larger Federal community within the past year. Often, these tools can be used by members of other Federal agencies to meet AIS requirements. This recommendation aims to better leverage existing expertise and developed capabilities to meet multiple Federal stakeholder needs.

Responsible Parties: This recommendation is directed to all Federal agencies that have existing tools for AIS accessibility and usability, such as those identified in Section II, and encourages them to better educate the Federal community on their existing capabilities. Conversely, this recommendation is directed to Federal agencies that want to utilize AIS data but do not have specialized geospatial or big data processing capabilities in-house.

#### **4. Improve the usability of AIS-derived information products by establishing links to external data sources.**

The ability to link AIS data with a variety of authoritative sources of vessel data is a priority for AIS users. Users require the ability to use, connect, and validate AIS information with other authoritative data sources and information to identify data inconsistencies, build more robust data sets, and conduct data analysis. Although there is no definitive hull database across the Federal Government, for the 2015-2017 data MarineCadastre.gov has linked their system with the AVIS database.

Responsible Parties: This recommendation is directed to Federal agencies that provision authoritative data sources, including USCG and USACE.

#### **5. Identify geographic and temporal coverage gaps in U.S. AIS data and develop plans to fill them.**

As more users take advantage of AIS data, they are finding areas where data is not available, usually due to the absence of a transceiver in the geographic area of interest. To identify areas where there is insufficient coverage, a survey should be taken of users and received AIS data should be analyzed to identify gaps. Once these areas are identified, they should be prioritized to have coverage added. This will entail determination of how to pay for installation, operation, and maintenance of these new sites either by the Federal Government or third party providers.

Specifically, USCG has limited terrestrial AIS coverage in Alaska. Therefore, their coverage is augmented by purchasing terrestrial AIS information from the MXAK. Historical AIS information dating back three years from MXAK is currently available through NAVCEN NAIS HDRs. Given interests in Alaska and the U.S. Arctic by multiple Federal agencies, the team recommends ensuring that historic AIS information from the Alaska region continues to be made available.

Responsible Parties: This recommendation is directed to Federal agencies and affiliated organizations that collect AIS information, including USCG, USACE, and SLSDC. This recommendation should also direct AIS data users to make known AIS coverage gaps.

## Long Term Recommendations

The AIS Task Team developed the following long-term recommendations and tasks.

- 1. Remove barriers or impediments to machine-to-machine communication to facilitate immediate and reliable access to AIS data.**
- 2. Provide access to AIS data via web services.**
- 3. Provide additional metadata on AIS collection, including the specific location of where the data was collected, coverage, sensitivity, and accuracy/reliability of receivers.**
- 4. Develop forecasting tools to predict vessel movement given a variety of changing factors, e.g. environmental, social, political.**
- 5. Develop long-term storage solutions of AIS information that allow it to be readily accessible to users.**
- 6. Develop an authoritative, comprehensive, and universal vessel hull database for U.S. waters that can be linked to AIS data and other databases.**
- 7. Consider whole of government purchase of satellite AIS information.**

## VI. CONCLUSION

The value and uses of AIS data and information has evolved from its original purpose of facilitating waterways safety, situational awareness, security, and management. The ways in which Federal partners acquire, analyze and share AIS data no longer meet requirements of both Federal partners and public stakeholders. The AIS Task Team analyzed the gaps and challenges in the accessibility and usability of historical AIS data and proposed the above list of recommendations with the goal of increasing data accessibility, eliminating resource overlaps, and sharing developed capabilities and expertise between agencies. Implementation of the recommendations identified in the report by MTS-related Federal agencies and stakeholders can increase the efficiency, security, and productivity of the Nation's marine transportation system.

The short-term recommendations were identified as a high priority among AIS Task Team member agencies to address immediate barriers and inefficiencies in agency operations. These recommendations have an emphasis on MarineCadastre.gov as part of the solution, in alignment with EO 13840 and the existing public-facing capabilities of MarineCadastre.gov. However, it is important to note that the recently expanded capabilities in other Federal agencies may serve to surmount some of the known technical barriers in the short term. The long-term recommendations will require additional consideration of individual agency resources, capabilities, and interests to implement, including developing technological capacity to facilitate faster AIS data transfer between agencies, developing analytical tools to enable greater access to the data, and accessing satellite-derived AIS information.

Lessons learned from this process will inform other agencies working to address big data challenges, including balancing data sharing with cyber-, privacy-, and national security needs.

AIS data is currently the best source of vessel track data, but it is just one example among the plethora of maritime data available to the Federal Government and its stakeholders in this increasingly data rich operating environment. Within this report, the analysis of the problem and division of data challenges into four categories (access, validity, management, and user support) can serve as a case study and structure for broader discussions on data accessibility and usability. Lessons learned from this process can hopefully inform other agencies working to address big data challenges, including balancing data sharing with cyber-, privacy-, and national security needs.

The AIS Task Team envisions that ultimately AIS-derived information will be easily accessible to all maritime stakeholders in a timely manner, and in a means that is appropriate to their use and capabilities. This enhanced accessibility and usability will support decision making for a safe, efficient, and environmentally responsible use of the oceans and U.S. waters.

## APPENDIX: AUTOMATIC IDENTIFICATION SYSTEM (AIS): A PRIMER

The ability to accurately identify watercraft and their intentions is essential to safe navigation, efficient movement, and national security. Automatic Identification System (AIS) technology is one of many kinds of technologies used by modern mariners to locate other vessels; some technologies aid mariners in locating other vessels such as AIS, sonar, and radar, just to name a few. AIS allows mariners to not just see where vessels are, but to identify them, and communicate directly with them. In recent years, archived and collected AIS data has become a source for research studying navigation, cargo movement, and even marine conservation. This development in the use of AIS has opened doors for this technology to be used in other modes of transportation. It is this shift in use and interest from the research community which makes AIS a valuable tool for the marine transportation system (MTS). This primer provides an overview of AIS in the United States and the data that is produced.

### What is AIS?

AIS was developed for maritime safety to prevent collisions and promote national security through vessel identification. AIS is a system installed on watercraft that sends and receives information. Vessels transmit information via radio that may be received by satellite or shore based receivers that inform centralized command centers of the location and identification information of vessels.

Since the 1940s radar has been relied upon as a means to detect and track targets at a distance or in low visibility, which led to a desire to know a target's identity, flag of registry, dimensions, type, intentions, and reliable means to contact them. AIS was specifically designed to aid vessels of all types to communicate effectively with each other while in close proximity, thereby maintaining safety and national security on the waterways. In 2002, the International Maritime Organization (IMO) made it mandatory for AIS to be fitted aboard all ships of 300 gross tonnage and upwards engaged on international voyages, cargo ships of 500 gross tonnage and upwards not engaged on international voyages and all passenger ships irrespective of size.<sup>17</sup> In 2004, the US accelerated and expanded upon these requirements to most commercial domestic vessels operating in U.S. navigable waters.

### How does AIS Work?

Unlike transponders, which require extensive infrastructure and coverage to ensure their effective operation AIS works independently of external infrastructure. It uses the marine very high frequency (VHF) radio band, therefore generally limited to line-of-sight, autonomously and continuously exchanging messages amongst its users in a self-organizing network<sup>18</sup>. With marine

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<sup>17</sup> International Maritime Organization. (2018). *AIS transponders*. Access from <http://www.imo.org/en/OurWork/safety/navigation/pages/ais.aspx>

<sup>18</sup> U.S. Coast Guard. (2014). *Automatic identification system overview*. Accessed from <https://www.navcen.uscg.gov/?pageName=AISmain>

VHF there is a nominal range of 10-20 nautical miles for the transmission depending on the geography of the area and antenna location/height (i.e. open ocean vessel-to-vessel transmission can travel closer to 20 nautical miles)<sup>19</sup>. Figure 5 displays a simplified visual representation of AIS data transfer via VHF.

The Nationwide Automatic Identification System (NAIS) is comprised of about 130 AIS base station transceivers covering most of the coastal U.S. This network covers U.S. territorial waters, as well as surrounding sea areas.<sup>20</sup> Inland waterways are probably the least well-recognized portion of this network, but with over 25,000 miles of commercially navigable waterways, they are an important piece of the MTS.<sup>21</sup> These inland



Figure 5: Visual Representation of data transfer through VHF. Source: IMO

waterways include the Great Lakes, Saint Lawrence Seaway, and the Mississippi river, all of which are important conduits for the movement of goods. The U.S. Army Corps of Engineers aids the U.S. Coast Guard (USCG) in AIS coverage for inland waterways. Additionally, the St. Lawrence Seaway Development Corporation and Canadian counterpart, the St. Lawrence Seaway Management Corporation, feed AIS information for the St. Lawrence Seaway into NAIS. The Marine Exchange of Alaska has 130 AIS receivers in Alaska that inform NAIS to augment limited USCG terrestrial coverage in the region. This network culminates in an operational system which aids in providing navigational information for safety on the waterways, movement of freight and passengers, and emergency response (e.g. search and rescue and oil spill response).

When AIS data is transmitted, it contains a large amount of vessel data. In all, about 400 data elements can be transmitted over AIS. The most commonly used data are position reports along with static and voyage related data that enables users to track a vessel's whereabouts and future direction (Figure 6). Position reports describe where a vessel is at a point in time. This information includes the maritime mobile service identity (MMSI) number, latitude, longitude, speed, direction of travel, and rate of turn. Static and voyage data include MMSI number, IMO

<sup>19</sup> Id.

<sup>20</sup> Id.

<sup>21</sup> U.S. Department of Transportation, Bureau of Transportation Statistics. (2018). *2018 Pocket Guide to Transportation*. <https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/bts-publications/pocket-guide-transportation/215726/pocket-guide-2018complete.pdf>

number, call sign, type of ship and cargo type, estimated time of arrival (ETA), destination, and vessel status (docked or moving)<sup>22</sup>. It is the culmination of this information that Federal agencies and vessel operators use for maintaining waterways safety and security.

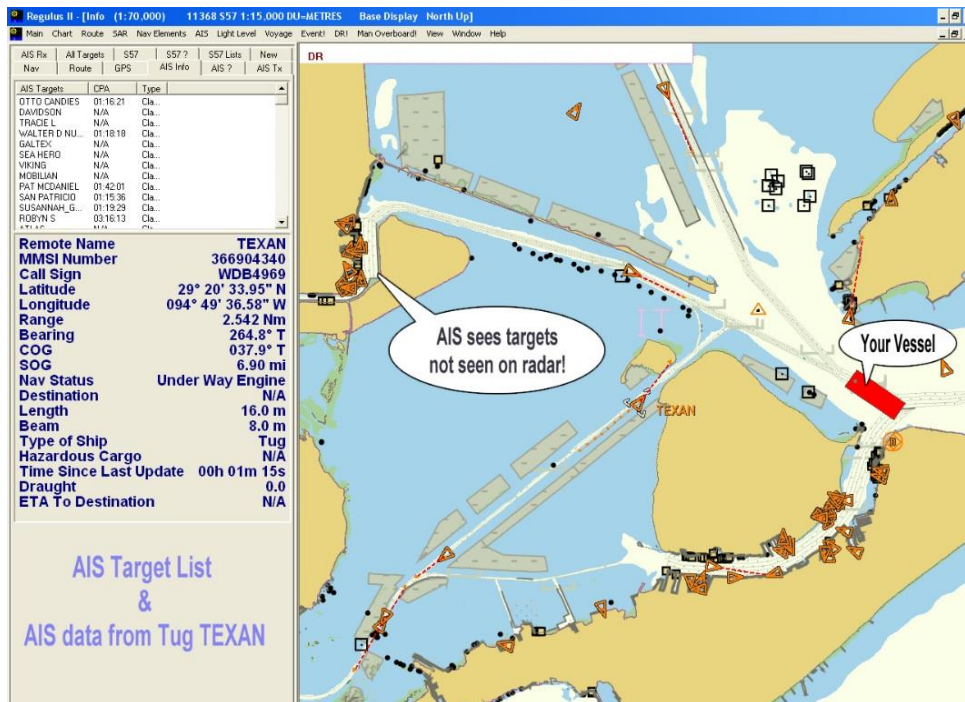


Figure 6 View of information transmitted via AIS. Source; USCG.

There are different types of AIS stations. Mobile (shipboard) systems include Class A and Class B. Class A systems are intended for larger vessels to meet carriage requirements; Class B systems for smaller vessels who usually carry AIS voluntarily. Both Class A and Class B devices transmit the vessel's dynamic information (e.g., position, course, speed) and static data (e.g. vessel name, call sign); Class A systems also transmit voyage related data (e.g., destination, ETA).<sup>23</sup>

Other types of AIS stations include base stations, Aids to Navigation, search and rescue transmitters (SART), and aircraft stations. Base stations are on land and provide identity, time synchronization, and text messages; they also may issue commands to “control the AIS network.” ATON stations are generally used to augment physical ATON and transmit additional navigation safety information. SARTs are used as a search and rescue locating device.

There is also the capability to receive AIS transmissions from ships from satellite AIS receivers. Satellite AIS receivers are used to augment terrestrial AIS stations to receive transmissions from ships outside the range of land stations. NAIS does not generally include data from these satellite systems, but there are systems in place to cover AIS out of the national network. The combination of these systems can be seen in Figure 7.

<sup>22</sup> Id.

<sup>23</sup> U.S. Coast Guard, 2014

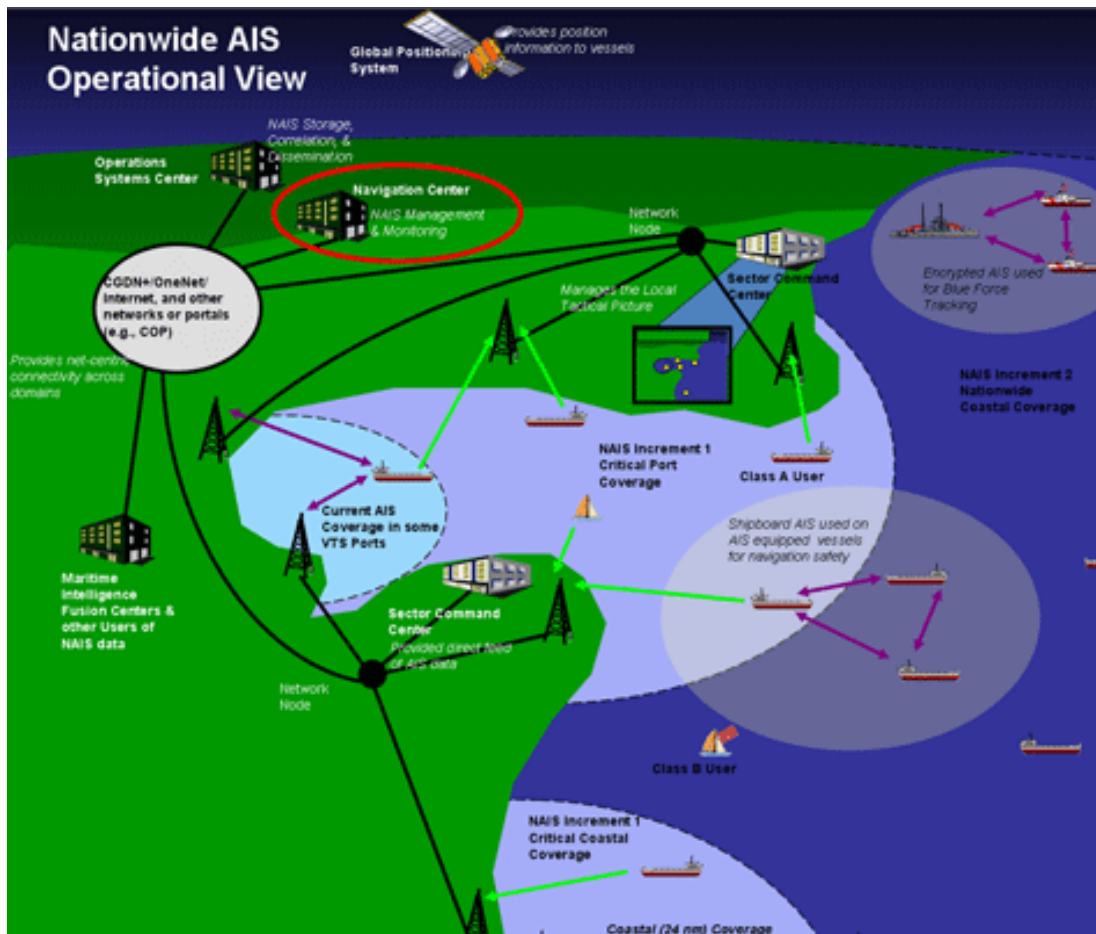


Figure 7 NAIS Operational View. Source USCG.