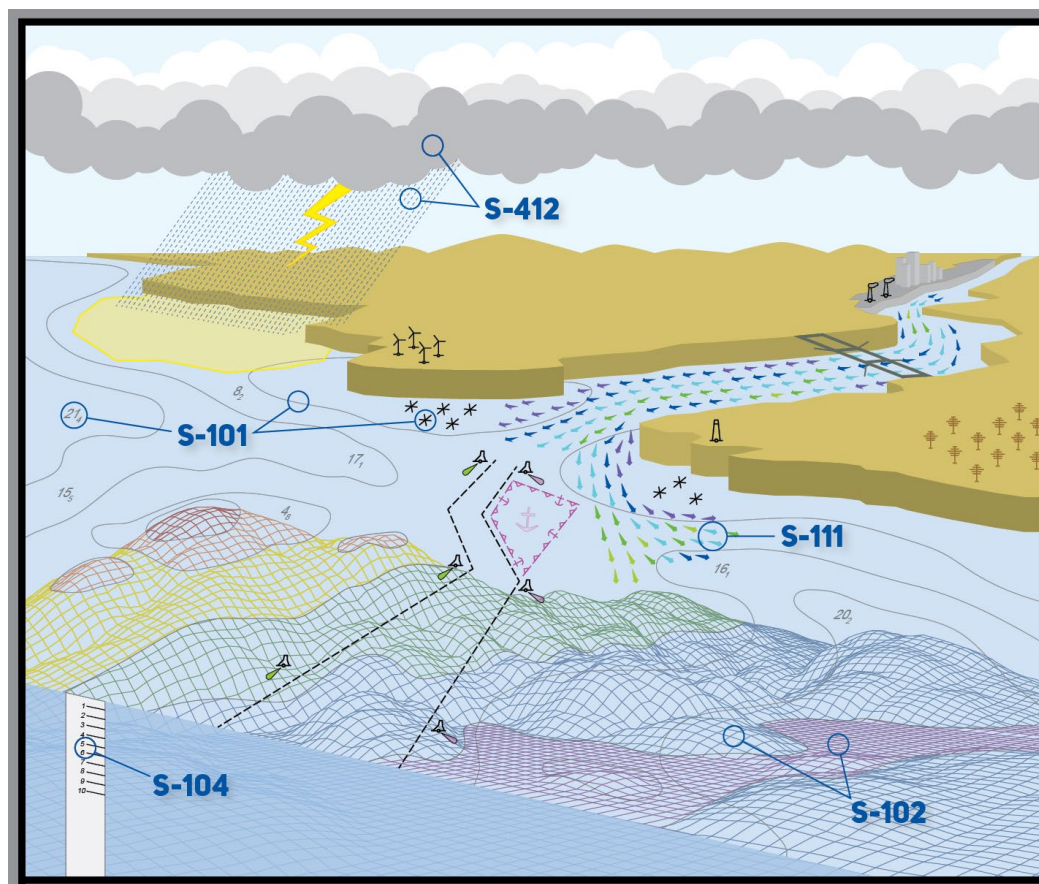# U.S. Navigation Information Strategic Action Plan: 2021-2026

U.S. Committee on the Marine Transportation System

March 2021

The U.S. Navigation Information Strategic Action Plan was developed by the CMTS Future of Navigation Integrated Action Team.

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EXECUTIVE SUMMARY

In February 2012, the U.S. Committee on the Marine Transportation System (CMTS) published the e-Navigation Strategic Action Plan (2012 SAP). As the first interagency document providing foundational information on e-Navigation, the 2012 SAP included the first vision, goals, and focus areas for joint U.S. execution in support of international initiatives and domestic requirements. Since that time, e-Navigation has evolved nationally and internationally from a concept to implementation. This document addresses the advancement in the capabilities to deliver navigation information services in support of identified maritime services and evolution of the e-Navigation concept as reflected in the title of this 2020 update to the "U.S. Navigation Information Strategic Action Plan" ("Strategy").

The CMTS has continued to work on e-Navigation implementation since 2012, including establishment of an e-Navigation (now Future of Navigation) Integrated Action Team (FutureNav IAT), CMTS Coordinating Board approval of a joint resolution promoting the use of the S-100 data framework, expanding the use of the Automatic Identification System (AIS) for communication of navigation safety information, and maintaining robust participation in international e-Navigation initiatives at the International Maritime Organization (IMO), International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), International Hydrographic Organization (IHO), and other national and international bodies.

The International Maritime Organization (IMO) defined e-Navigation as the "*harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.*"

Since the publication of the 2012 SAP, there have been several lessons learned by the federal agencies that provide navigation information services from their work done to implement e-Navigation. These include:

- The need for an organizational approach to e-Navigation implementation
- The importance of technical standards
- The need for harmonization of navigation information, and
- The challenges associated with lack of access to resources and policy alignment

This Strategy aligns with the CMTS *National Strategy for the Marine Transportation System: Channeling the Maritime Advantage* (2017-2022) (2017 National Strategy). The 2017 National Strategy provides strategic guidance to the Federal interagency partnership under five priority areas: 1) Optimizing System Performance, 2) Enhancing Maritime Safety, 3) Supporting Maritime Security, 4) Advancing Energy Innovation and Development, and 5) Facilitating Infrastructure Investment. This Strategy supports the *Enhancing Maritime Safety* priority area.

The vision and goal of this 2021 revision remain the same as the 2012 SAP; to establish a framework enabling the transfer of actionable information and the use of timely and resilient maritime data for safer, more secure and more efficient navigation.

The 2021 U.S. Navigation Information Strategic Action Plan focuses on six action areas:

- Integrating Systems
- Seamless Data Exchange
- User-based requirements
- Decision-focused information
- Improved Connectivity, and
- Inter-agency Information Coordination

There are separate and interlocking components, that must work together to improve the dissemination and integration of marine navigation information, including (but not limited to):

- Technical standards and capabilities
- The IHO S-100 Universal Data Model and product specifications
- The IMO defined Maritime Services
- Authoritative Data

These elements collaboratively provide responsible navigation agencies a pathway to deliver the defined maritime services.

As noted, the vision and goal of the 2012 SAP have been reaffirmed in this Strategy. The changes in e-Navigation since 2012 highlight the need to be in alignment with the ever-evolving world of technology. Identified technologies include but are not limited to: Electronic Chart Display and Information System (ECDIS) and S-100; cybersecurity and Positioning, Navigation and Timing (PNT) resilience; advances in communications; harmonized reporting; and automation.

U.S. Navigation Information Strategic Action Plan: 2021-2026

INTRODUCTION AND BACKGROUND

In the Fall of 2006, the CMTS Navigation Technology Integrated Action Team (NavTech IAT) was established by the U.S. Committee on the Marine Transportation System (CMTS) Coordinating Board to support coordination and information sharing among Federal agencies related to navigation services and technologies. It was during this time that the concept of e-Navigation was being developed at the international level.

The NavTech IAT recognized the need to look beyond discrete technologies and projects and examine the e-Navigation concept, determine the U.S. role, and harmonize e-Navigation efforts among Federal agencies. One response was to rename the NavTech IAT to the e-Navigation IAT. Concurrently, the International Hydrographic Organization (IHO) S-100 data framework was being developed, with the first edition released in 2010. Questions on how the S-100 framework would be implemented and its impact on delivery of maritime services to mariners became an additional focus for the U.S. team. In 2008, the Canadian Coast Guard published its e-Navigation Strategy, the catalyst for development of a U.S. counterpart: the 2012 e-Navigation Strategic Action Plan (2012 SAP).

The International Maritime Organization (IMO) defined e-Navigation as:

> *"…the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment.*

Additionally, per the IMO:
> *"e-navigation is intended to meet present and future user needs through harmonization of marine navigation systems and supporting shore services. The development and implementation of the concept is coordinated by the International Maritime Organization in accordance with the "e-Navigation Strategy Implementation Plan– Update 1"*
> > *Source: IMO and adopted in 2018 by the Maritime Safety Committee.*

IMO e-Navigation is not a system but standards, regulations, guidelines, training requirements, and product specifications, that are used to develop Maritime Services to be provided by parties to the IMO, including the U.S., to support a more efficient, robust, and integrated maritime navigation information environment. The Strategy provides specific actions and guidance to effectively implement U.S. navigation information (e-Navigation) capabilities in alignment with and support of the IMO (nationally and internationally).

Since the 2012 SAP, there have been numerous developments in navigation information (e-Navigation.) These include:

- Adoption of the IMO Strategic Implementation Plan (SIP) and tasks.
- Identification and expansion of authoritative data sources.
- Recognition that equipment and software manufacturers have become an intermediary between the government as providers of services and the mariners as users of these services.
- The need to leverage manufacturers' developments along with crowdsourcing, "big data," and deriving information from these sources.
- A recognition that data from such sources, while perhaps not appropriate for use in charting products, may be valuable for other purposes. An example of this is the Nippon Foundation-GEBCO Seabed 2030[1] project.
- Stakeholders' expectations and requirements are changing as they adopt expanded use of technology.

Since the publication of the 2012 SAP, there have been many accomplishments and lessons learned from CMTS implementation which have informed the path forward of this new document.

ACCOMPLISHMENTS:
- The CMTS adopted S-100 as its preferred data framework for the dissemination and exchange of digital maritime information and related MTS data collection requirements. [https://www.cmts.gov/downloads/s100_Resolution.pdf]

- As the e-Navigation concept further evolved, it was evident that a more appropriate title for the IAT would be the Future of Navigation IAT (FutureNav IAT), to better reflect the broader vision of the CMTS and the IAT.

- The U.S. Coast Guard sponsored 12 joint e-Navigation Listening Sessions across the country to learn and confirm the interests of mariners and recreational boaters with regard to navigation technologies. [Summary of listening sessions at https://www.cmts.gov/topics/future_of_navigation]

- The CMTS AIS Task Team completed a report "*Enhancing Accessibility and Usability of Automatic Identification System (AIS) Data Across the Federal Government and for the Benefit of Public Stakeholders.*" [https://www.cmts.gov/downloads/Accessibility_and_Usability_of_AIS_Data.pdf]

- Recognizing the importance of common reference to waterway identification, the Waterways Harmonization project was established, successfully receiving support and resources from the Department of Homeland Security S&T.

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[1] Seabed 2030 is a collaborative project between the Nippon Foundation and GEBCO. It aims to bring together all available bathymetric data to produce the definitive map of the world ocean floor by 2030 and make it available to all. https://seabed2030.org/

- The FutureNav IAT hosted a *Navigation Data Interoperability Roundtable* that brought together key Federal agency partners responsible for the policies affecting information systems and the interagency interoperability of navigation data by facilitating a discussion of interagency maritime data sharing requirements.

LESSONS LEARNED:
- Federal maritime agencies that provide navigation information services - primarily the U.S. Coast Guard, the U.S. Army Corps of Engineers, the National Oceanic and Atmosphere Administration, and the National Geospatial Agency - have benefited from joint decision-making through a methodical and focused course of action in support of maritime services[2], assessments and sharing and dissemination of information.

- A common data framework is critical to successful e-Navigation implementation. S-100 is the logical data framework for the compilation, harmonization, exchange and portrayal of digital maritime information and related MTS data collection requirements.

- The harmonization of interagency navigation information is complicated. Agencies must work to agree on applicable standards, identify authoritative data sources and stewards, establish data sharing and systems interoperability where appropriate, and make the commitment, up front, to make required changes to their individual policies, procedures, and systems to truly achieve harmonized maritime services.

  - An attempt by the interagency team to harmonize maritime safety information services among the different agencies (referred to as "eMSI") highlighted the challenge of melding different agency business practices in conjunction with ensuring policy alignment.

- There are challenges associated with working toward joint maritime services while balancing respective agency workloads and in the absence of targeted resources for these joint efforts.

- It is critically important to ensure that technical requirements are aligned with and support policy goals for safety and security.

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[2] "maritime services" in this document refers to the services identified by IMO as part of the e-navigation SIP. These services form the basis of the e-navigation framework that is outlined further along is this document.

ALIGNMENT WITH THE CMTS NATIONAL STRATEGY

The National Strategy for the Marine Transportation System: Channeling the Maritime Advantage (2017-2022) (2017 National Strategy) [https://www.cmts.gov/about/national_strategy] was developed by the CMTS and finalized on November 17, 2017. The 2017 National Strategy provides strategic guidance to the Federal interagency partnership to enhance the Federal understanding and support of the marine transportation system (MTS) under five priority areas:

- *Optimize System Performance*: Measuring the reliability of physical and operational elements of the MTS to inform and support strategies for targeted improvements as trade and supply chain competitiveness increases.

- *Enhance Maritime Safety*: Promoting an MTS free from collisions, allisions, groundings, and injury, death, and damage to property and environment as congestion and maximum vessel size within the MTS increases.

- *Support Maritime Security*: Evaluating the infrastructure and operations of the MTS; taking into account possible threats and vulnerabilities while continually assessing existing protective measures, procedures, and operations, supported by efforts to understand and incorporate maritime domain awareness into shipping activities.

- *Advance Energy Innovation and Development*: Identifying opportunities to utilize all sources of domestic energy and implement new technologies to ensure energy independence and more efficient fuel use.

- *Facilitate Infrastructure Investment*: Using all available resources efficiently and effectively for the improvement of the MTS.

The 2017 National Strategy, and, specifically, the *Enhance Maritime Safety* priority area, provide the overarching guidance to this Strategy, specifically under the following action areas:

- Deliver timely, relevant, accurate and user-accessible navigation safety information to mariners
- Incorporate MTS resilience and recovery capabilities into waterway design principles to best identify appropriate levels of service relating to delivery of navigation safety services
- Support the presentation of best available weather information in support of MTS operations.

VISION AND GOAL

The vision for U.S. navigation information is:

To establish a framework enabling the transfer of data between and among ships and shore facilities, and that integrates and transforms that data into decision and action information.

This Strategic Action Plan seeks to address the need to standardize data management, exchange and access capabilities for federal and regulated systems. It will support improved delivery of timely, reliable, and accurate information without burdening the navigation of the vessel, while working to avoid duplicate reporting while enabling two-way communication between stakeholders, especially government and industry. It will enable the interoperability of federal maritime information systems and provide for consistent service to stakeholders on all the nation's waterways. In addition to serving operational needs, program management and budgeting issues may also be served allowing for timely, well-informed resource decisions based on performance and use information.

The goal of U.S. navigation information is to:

Use authoritative, timely and resilient maritime information to make the U.S. Marine Transportation System operate better.

By "operating better" the U.S. Marine Transportation system will be:

Safer

Enhanced navigation information capabilities will contribute to safer waterways, reducing accidents and environmental incidents through improved situational and traffic awareness both afloat and ashore. It will provide more accurate and timely information for better decision making.

More Secure

Enhanced navigation information capabilities will contribute to the Nation's security by delivering vital information in support of national maritime domain awareness while respecting privacy and protecting proprietary information.

More Resilient

Enhanced navigation information capabilities will provide information to support MTS resilience. Conflicting information will be resolved and usable indications of confidence in the information will be provided. An enhanced navigation information program or e-Navigation will also increase the reliability of traditional "hard" navigation infrastructure, by making better information available about the use and condition of waterways, navigation facilities (e.g., locks) and adjacent structures (e.g., bridges, terminals).

More Efficient

Enhanced navigation information will provide for the more efficient dissemination and portrayal of information and facilitate decision making or action. This will reduce burdens on bridge crews and can include action information that supports efficient use of a waterway.

More Integrated

Enhanced navigation information will improve the federal collaboration on collecting and compiling information and providing an integrated marine transportation information infrastructure. The result should appear to the users as a single, outcome-oriented information service.

EMERGING ISSUES

Since navigation information is closely linked with the ever-evolving world of technology, there are emerging issues that need to be addressed as a part of e-Navigation implementation. The following paragraphs identify those emerging issues and outline actions to address them.

ECDIS/ECS and S-100: As S-100 product specifications are finalized and implemented, the existing ECDIS/ECS performance standard will need to be modified to incorporate them. NOAA and USCG will to continue to work together to help with is the inclusion of S-100 (specifically S-101 - but other S-100 product specifications as well) into the standard. Without this inclusion, much of the work that is being done for S-100 products and services will not be useable as part of regulated carriage.

Cybersecurity and PNT resilience: As navigation tools now rely on highly sophisticated technical equipment and software for efficient operation, their vulnerability to malicious action such as spoofing and jamming must be assessed and addressed. Efforts to best protect and inform mariners who rely on technology must be developed and communicated. Factors that must be addressed include: automated systems aboard ship, integration of multiple systems, the growing ability to remotely monitor systems, data and system redundancy, network reliance, and access to reliable and authoritative data and information products.

Advances in communications: Traditionally maritime communications have been limited to certain capabilities, such as VHF and HF maritime communications. However, global communications capabilities are expanding that should be recognized and considered as part of the e-Navigation framework. GMDSS has expanded to allow additional satellite communications capability; other similar capabilities are emerging. The expansion of 5G and other evolving cellular technologies should be considered as well.

Harmonized Reporting: The U.S. navigation information effort should support and facilitate harmonization of vessel reporting requirements of multiple federal agencies. Ideally, the required information would be submitted once and be available to all stakeholders who have a legitimate requirement for it.

Automation: Automation has been part of navigation for decades, with advanced autopilots and other capabilities in use aboard ships. However, there is substantial movement for much more expanded automation in vessel navigation that will rely on enhanced navigation information capabilities related to communications and ready access to authoritative reference data and information products. The impacts of increased automation will be monitored and assessed against e-Navigation implementation efforts.

THE U.S. NAVIGATION INFORMATION STRATEGY

The core of the U.S. Navigation Information Strategy is to incorporate navigation information components into systems that will enable a more integrated environment. In lieu of directly mandating equipment and technologies, this Strategy pursues a holistic approach by utilizing existing and planned components of navigation information services that include, but are not limited to:

- Overarching standards, regulations, guidelines,
- Authoritative data and data formats,
- Maritime services delivered agreed upon defined product specifications.

There is an extensive body of existing standards, recommendations, and guidelines published and maintained by several international and national bodies. These have long served the maritime community in providing valuable technical capabilities in support of navigation safety and efficiency that are in common use and can be referenced in regulations. Continued support of the development of these standards to ensure that they are aligned with and support the implementation of e-Navigation is critical.

The IHO S-100 Universal Hydrographic Data Model (S-100) has grown to incorporate more than traditional hydrographic information products, such as charts. It now includes products such as NAVigational TEleX (NAVTEX) messaging via the S-124 product specification. Established information product specifications allow for the integration of navigational information from various authoritative sources with bridge systems and shore systems using S-100. S-100 is divided into several "domains" and domain owners have been identified (see Appendix I).

Authoritative reference data about vessels, infrastructure, cargo, and other components of the maritime transportation system are critical to be identified, maintained, and made accessible to all stakeholders. Several key authoritative data sources are discussed in more detail below.

Common international maritime services have been identified by the IMO e-Navigation SIP. Maritime services will be delivered through the use of standards, authoritative data sources, and delivered using product specifications. Numerous US agencies and international bodies are involved; Table 1 provides an overview of how the specific maritime services will be delivered using product specifications and identifies the key international bodies and Federal agencies involved.

In support of the goals of S-100 and providing navigation information in a more integrated environment, individual agencies already have ongoing initiatives to accomplish their specific missions. Examples of these initiatives are:

- The U.S. Army Corps of Engineers is implementing River Information Services (RIS) to coordinate navigation information sharing leveraging existing systems and developing additional capabilities to enhance existing services. Efforts

include developing methods to predict vessel travel times, water levels, vessel congestion and other capabilities to aid in voyage planning and waterways infrastructure operation.

- The National Oceanic and Atmospheric Administration's Precision Marine Navigation program aims to seamlessly integrate high-resolution bathymetry, high accuracy positioning and shoreline data with forecast data—such as water levels, currents, salinity, temperature, waves, and weather forecasts. This data will be available via machine to machine discovery so that it can be easily ingested into navigation systems for use by mariners.

- The U.S. Coast Guards U.S. Aids to Navigation Information Management System (USAIMS) maintains the official electronic record of all Federal and private Aids to Navigation (ATON) and publishes the weekly Local Notice to Mariners and annual Light List (https://www.navcen.uscg.gov/) for use by all mariners who navigate the waters of the United States. The federal government provides core systems and capabilities. Positioning, navigation, and timing (PNT) services, such as the Global Positioning System (GPS) and official electronic charts and chart updating services are examples.

In addition to common, widely accepted data standards and product specifications (as provided by S-100), access to and maintenance of authoritative data sources is critical for successful e-Navigation implementation. There are a few key data source areas which are identified as needing action to address deficiencies:
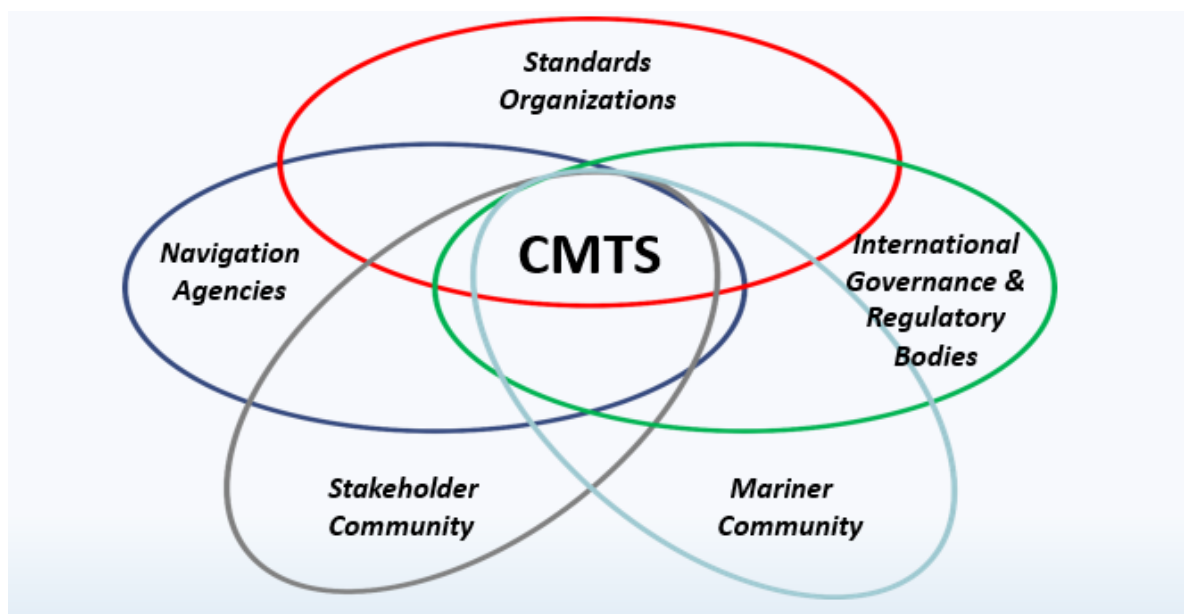
- **Vessel (hull) database**: The ability to definitively identify a vessel and obtain accurate details on its characteristics is critical to multiple agencies in accomplishing their missions. Currently, there are multiple databases serving different purposes with no standardization, none identified as authoritative, and little cross-referencing among them.

- **Waterways Harmonization**: Once the current waterway identification project, being done in conjunction with the United States Coast Guard (USCG) and the Department of Homeland Security/Science & Technology, is complete, impacted agencies will need to take specific actions to implement the scheme into their various systems, policies, and procedures. The effort to identify these actions will start prior to the completion of the harmonization scheme.

- **Automatic Identification System data**: AIS data has become critical to many agencies in support of many missions. The CMTS Report *"Enhancing Accessibility and Usability of Automatic Identification System (AIS) Data: Across the Federal Government and for the Benefit of Public Stakeholders"* [https://www.cmts.gov/downloads/Accessibility_and_Usability_of_AIS_Data.pdf] outlined this and made several recommendations to expand the accessibility of AIS data to agencies and the public. These recommendations should be acted upon.

EXECUTION

Implementation of this Strategy will be coordinated by the CMTS Future of Navigation Integrated Action Team (FutureNav IAT), co-led by U.S. Coast Guard (USCG), U.S. Army Corps of Engineers (USACE), and National Oceanic and Atmospheric Administration (NOAA) with participation by additional maritime agencies. Federal agencies will work collaboratively, abide by the principles listed below, and encourage those also involved in the effort to do the same. The FutureNav IAT will also work with industry, standards-setting organizations, and international partners to enlist their contributions to this effort.

Execution will be in alignment with national and international efforts. The U.S. plays a key role on several international bodies involved in the navigation information/e-Navigation concept. USCG has representatives at the IMO, IALA, International Electrotechnical Commission (IEC); NOAA represents the U.S. at the IHO.

FIGURE 1: RELATIONSHIP BETWEEN e-NAVIGATION BODIES

While its implementation will be collaborative, nothing in this strategy will detract from the authorities and responsibilities of any Agency. As part of the effort, detailed implementation and execution plans will be developed to identify, document, and prioritize framework components to be produced. This distributed approach is appropriate, since e-Navigation is a collection of infrastructure improvements rather than a monolithic system and is currently unfunded as a distinct activity. However, the CMTS and Federal agencies that provide navigation information services are committed to work toward the vision and goal of this Strategy.

Coordinated CMTS actions will maintain alignment with individual Federal Agency plans, including but not limited to:

- NOAA's National Charting Plan (November 2017) - a strategy to improve NOAA nautical chart coverage, products, and distribution.

- USCG Maritime Commerce Strategic Outlook (October 2018)- outlines the Commandant's long-term vision to support and grow maritime commerce in the United States.

- USACE Campaign Plan (FY18-22) – identifies priority areas and actions in all USACE mission areas, including Navigation.

The Strategy recognizes that engagement with and participation of the commercial shipping industry is critical to successful development and implementation. All implementation and execution plans will include outreach and communications with these stakeholders.

Another critical segment of the commercial industry is manufacturers of navigation equipment, software, and hardware. As technology has advanced, the provision of navigation information products to end users has shifted from being a purely government-to-user transaction, to one where software and equipment acts as "middleware" between the government-provided information and the end user. It is critical that manufacturers are included in e-Navigation implementation efforts. This will primarily be accomplished through participating in standards development initiatives alongside manufacturers, direct outreach, and via industry bodies such as the Radio Technical Commission for Maritime Services (RTCM), National Marine Electronics Association (NMEA), and others.

To ensure successful partnership, involvement, and coordination with external stakeholders, CMTS navigation information efforts will be guided by the following principles:

- Focus on identifying and addressing users' requirements
- Develop a collaborative partnership with the MTS community
- Make best use of existing systems and data
- Review and implement low cost/no cost systems wherever possible but not at the expense of navigation safety
- Encourage and support regular and frequent communications
- Be thoroughly transparent in decision-making activities
- Align with other national strategies that affect maritime transportation
- Align with international standards wherever possible

This Strategy focuses on six action areas. Each area has nexus with separate and interlocking components, that must work together to improve the dissemination and integration of marine navigation information:

1. **Integrating Systems**

   Integrated systems will be achieved through creating and deploying a federal framework of data standards, information content, delivery means and decision support applications. A major component of this will be achieved through adoption of the Internationally recognized IHO S-100 Universal Hydrographic Data Model. e-Navigation will improve the connectivity of authoritative data sources, eliminate redundant data, and create real-time access by authorized users.

2. **Seamless Data Exchange**

   Seamless data exchange will be achieved through improving the federal government's management of data, and through the federal coordination of data submission requirements. Navigation information will automatically be "pushed" to mariners and shore users and be available to be "pulled" when it is needed.

3. **User-based requirements**

   e-Navigation developments will be based on requirements focused on delivering services to end users, based on their situational needs. This will require government service providers, system manufacturers, and mariners to collaborate on identifying the means and prioritizing requirements.

4. **Decision-focused information**

   Decision-focused information will be achieved by extending system capabilities to include more procedural and decisional functionality as opposed to simply data-consumption and display. The government, working with industry and capability providers (e.g., equipment and software manufacturers), will help develop and codify the necessary procedures and decisions to be applied across all transportation systems.

5. **Improved Connectivity**

   Improved connectivity will be achieved by using federal assets such as sites, bandwidth, authorities, etc. to see that existing U.S. communications infrastructure fully serves the critical marine transportation zones. Obtaining bandwidth, reliable connectivity, and affordability are the goals.

6. **Inter-agency Information Coordination**

   Much of the marine transportation information environment is provided by or consumed by the federal government. Increased coordination among agencies, including navigation data interoperability initiatives, and the Geospatial Information Act, will be used to provide consistent data, consistently formatted, and provided via common delivery systems. Individual agencies will participate in alignment with and support of respective Agency missions and strategic plans

Federal agencies that provide navigation information services must be in alignment while supporting ever-evolving technology and internationally recognized frameworks such as IHO's S-100. Execution of this 2021 Navigation Information Strategic Action Plan will guide federal agency coordination in establishing a framework that enables the transfer of actionable navigation information and the use of timely and resilient maritime data for safer, more secure and more efficient navigation. The elements of this Strategy collaboratively provide a pathway for federal agencies to deliver defined maritime services and support technological advancements facilitating e-navigation.

Appendix I –Maritime Services, S-100 Product Specifications And Involved Agencies

Maritime Service	Lead Inter'l body	Applicable S-100 product specification	Involved Agencies
VTS: (includes: Information Service, Navigational Assistance Service, and Traffic Organization Service)	IMO / IALA	S-210 S-211	USCG
Local Port Service (LPS)	IHO (BIMCO)	S-1xx* still in development at IHO	NOAA / NGA / USCG
Maritime Safety Information Service (MSI)	IHO	Multiples S-1xx product specifications	NOAA / NGA / USCG
Pilotage service	IMO	S-127; S-131	USCG
Tugs Service	IMO	None	N/A
Vessel Shore Reporting	IMO / IALA	S-212; G-xxx (Dec 2020)	CBP / IRS / NGA/ USCG /USACE / DHS
Telemedical Assistance Service (TMAS)	IMO / WHO	None	N/A
Maritime Assistance Service (MAS)	IMO	None	USCG
Nautical Chart Service	IHO	S-101 S-401	NOAA / USACE / NGA
Nautical Publications Service	IHO	Various	NOAA / NGA / USCG
Ice Navigation Service	IMO / WMO	S-411	NOAA / USCG
Meteorological Information Service	IMO / WMO	S-41X	NOAA
Real-time Hydrographic and Environmental Information Service	IHO	Various	NOAA / USACE / NGA / USCG / USGS
Search and Rescue Service	IMO	None	USCG

Appendix II - IHO S-100 product specifications

Product Specification	Participating Agencies	Remarks/Current Status (as of January 2021)
IHO S-101 ENC	NOAA / USACE/ NGA / USCG	Edition 2.0.0 in work, expected publication early 2024
IHO S-102 Bathymetric Surface	NOAA / NAVY	Edition 3.0.0 in work expected publication in early 2023
IHO S-104 Tidal product for surface navigation	NOAA	Edition 1.0.0 in work expected publication in 2021
IHO S-111 Surface currents	NOAA	Edition 2.0.0 in work expected publication in 2022
IHO S-121 Maritime limits and boundaries	NOAA / NGA	Edition 1.0.0 Published
IHO S-122 Marine Protected Areas	NOAA	Edition 1.0.0 Published
IHO S-123 Radio Services	USCG	Edition 1.0.0 Published
IHO S-124 Navigational warnings	NGA	Ongoing work being conducted by a correspondence group Chaired by Canadian Coast Guard. NGA, NOAA, USACE & USCG are all participating agencies.
IHO S-125 Marine Navigational services	NOAA/NGA	Ongoing work being jointly conducted by IHO & IALA. IALA ARM Committee has the lead and WG2 is currently developing edition 1 and is Chaired by USCG. NOAA, NGA & USCG are the participating agencies.
IHO S-126 Physical Environment	NOAA	On hold
IHO S-127 Traffic Management	NOAA/USCG	Edition 1.0 - Currently in Draft
IHO S-128 Catalogue of Nautical Products	NOAA / NGA/ USCG	Edition 1.0 - Currently in Draft
IHO S-129 Under Keel Clearance Management	NOAA	Edition 1.0 - Published
IHO S-131 Marine Harbor Infrastructure	NOAA / USCG / UNH / NGA	Planned
IALA S-201 Aid to Navigation Information	NOAA / USCG	Edition 1.0 - Published
IALA S-210 Inter VTS Exchange	USCG	Planned
IALA S-211 Port Call Message Format	USCG	Edition 1.0 – Published
IALA S-212 VTS Digital Information Services	USCG	Edition 1.0 - Currently in Draft

IALA S-230 Application Specific Messages	USCG	Planned
IALA S-240 DGNSS Station Almanac	USCG	Edition 1.0 – Published
IALA S-245, S-246, S-247 eLoran related products	USCG	Edition 1.0 - Currently in Draft
IEHG S-401 Inland ENC	USACE	Edition 1.0.0 - Drafted and will be released at a future date TBD
IEHG S-402 Bathymetric Contour Overlay	USACE	Edition 1.0.0 - Currently under development
JCOMM S-411 Sea ice	NOAA / USNIC	TBD
JCOMM S-412 Wave and Weather Hazards	NOAA	Edition 1.0.0 - In work expected publication 2022
JCOMM S-413 Wave and Weather Conditions	NOAA	Edition 1.0.0 0 - In work expected publication 2023
JCOM S-414 Wave and Weather Observation	NOAA	Edition 1.0.0 - In work expected publication 2024
IEC S-421 Route Plan Exchange	NOAA / USCG	Edition 1 is in IEC approval process, estimated publish date spring/summer 2021.

NOTE:
- IHO publication S-99 - Operational Procedures for the Organization and Management of the S-100 Geospatial Information Registry (Edition 1.1.0, November 2012) describes the roles, responsibilities and procedures for operating and managing the S-100 Geospatial Information Registry and its component Registers.
- This framework is presented from the perspective of currently identified product specifications in Appendix II.

Appendix III - Summary of the status of the 2012 eNavigation Strategic Action Plan from the MTS Assessment (October 2020)

eNavigation Principle	2020 Status
Focus on meeting users' requirements. Develop a collaborative partnership with the MTS community	Through collaborative engagement, agencies have expanded IT applications including open source software, cloud computing and mobile devices. For example, NOAA charts are readily available online for free and accessible through a recreational boater's mobile device. USACE developed an inland "Lock Operations Management Application" to more efficiently operate locks and acquire better information from vessel operators. USACE also provides inland charts.
Make best use of existing systems and data.	Agencies are expanding access, use and exchange of existing AIS-derived information. For example, USCG now provides timely AIS data to the public via MarineCadastre.gov. NOAA's Precision Marine Navigation program was initiated to seamlessly integrate high-resolution bathymetry, high accuracy positioning and shoreline data with forecast data—such as water levels, currents, salinity, temperature, waves, and weather forecasts—to provide data in a format easily accessed and integrated into maritime portable pilot units or decision support tools. As a result, mariners will be better equipped to make critical navigation decisions.
Review and implement low cost/no cost systems wherever possible but not at the expense of navigation safety	Where possible, agencies are maximizing employment of existing information technology architectures. For example, USCG is expanding mobile and web access to frequently updated information products previously only available through weekly publications.
Encourage and support regular and frequent communications. Be thoroughly transparent in decision-making activities	Through bi-lateral agreements and through the CMTS, agencies have expanded interagency collaboration to support the

	MTS. For example, in June 2020, USCG signed an MOU with NOAA, Hawaii DOT, and USACE regarding maritime emergency harbor assessments within Federal waterways in Hawaii.
Align with other national strategies that affect marine transportation.	The work of the CMTS eNavigation Future of Navigation team is aligned with the 2017 CMTS National Strategy on the MTS: Channeling the Maritime Advantage.
Align with international standards wherever possible.	U.S. Federal navigation agencies and industries continue to play key roles, including the International Association of Lighthouse Authorities, International Maritime Organization, International Hydrographic Organization, and the Radio Technical Commission for Maritime Services. NOAA developed a prototype Precision Marine Navigation Dissemination system deployed on a public cloud to ingest, process, and disseminate selected NOAA marine navigation data via International Hydrographic Organization (IHO) S-100 framework compliant datasets.

Appendix IV - Summary of Acronyms

2012 SAP	eNavigation Strategic Action Plan
2017 National Strategy	2017 National Strategy for the Marine Transportation System: Channeling the Maritime Advantage
AIS	Automatic Identification System
CMTS	U.S. Committee on the Marine Transportation System
ECDIS	Electronic Chart Display and Information System
eMSI	e-Maritime Safety Information
FutureNav IAT	Future of Navigation Integrated Action Team
GMDSS	Global Maritime Distress and Safety System
GMWG	Geospatial Maritime Working Group
GPS	Global Positioning System
IEHG	Inland ECDIS Harmonization Group
IAT	Integrated Action Team
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization
MTS	Marine Transportation System
NavTech IAT	Navigation Technology Integrated Action Team
NAVTEX	NAVigational TEleX
NMEA	National Marine Electronics Association
NGA	National Geospatial-Intelligence Agency
NOAA	National Oceanic and Atmospheric Administration
PNT	Positioning, Navigation and Timing
RTCM	Radio Technical Commission for Maritime Services
SAP	Strategic Action Plan
SIP	Strategic Implementation Plan
STRATEGY	U.S. Navigation Information Strategic Action Plan
USACE	U.S. Army Corps of Engineers
USNIC	U.S. National Ice Center
USCG	U.S. Coast Guard
WMO	World Meteorological Organization
UNH	University of New Hampshire