NaAVIC, a Free Downloadable ECS App that Runs on ENC Data Streamed Directly from a Cloud-based Infrastructure Specifically Designed for Marine Navigation

D. Peyton & E. Kuwalek
IIC Technologies, Riverdale, Maryland, USA

A. Alla
Naavic

ABSTRACT: NaAVIC, is a free and downloadable Electronic Chart System app specifically developed for boats of all sizes looking for safe and reliable professional navigation functionality on mobile devices and/or laptops. The app offers a range of features to make navigation easy and reliable, delivered through a clear and intuitive interface designed specifically for navigating at sea. The capabilities cover the range of essential features needed to maintain safety and situational awareness. Separate processes for download and update of the electronic chart data is not required because data is streamed in real-time from a cloud based open source database. The data is supplied to NaAVIC from Nautilus Cloud, a cloud based infrastructure designed for Marine Data, Solutions and Services for Government Organizations, Commercial Industry and Consumers. Nautilus Cloud is a "cloud native" approach and leverages high quality, open source components as its base technology. It uses open standards throughout to build a low-cost system which is flexible and has a much greater degree of interoperability with pre-existing components. A key feature of the Nautilus Cloud platform is the expansion of data holdings into a much wider family of related geospatial data products including the S-100 framework, harmonized metadata, raster and real-time sources. In essence, NaAVIC can operate on real-time and up-to-date information from charting agencies without a separate updating process. This enables the integration of real-time tides, weather, currents and other oceanographic information.

1 INTRODUCTION

1.1 *Current chart carriage requirements*

The International Maritime Organization (IMO) is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. The agency has established a comprehensive regulatory framework of over 50 international conventions and agreements that allow all of its 174 Member States to consistently implement and enforce a set of international maritime regulations.

The International Convention for the Safety of Life at Sea (SOLAS) is one the key IMO conventions as it sets minimum safety standards. In particular, SOLAS Chapter V sets forth the safety of navigation provisions applicable to all vessels on all voyages. A key safety provisions is the requirement for all ships to carry up to date nautical charts and publications on board to be able to plan and execute the intended voyage safely. The same Chapter V defines additional provisions related to use of an Electronic Chart Display and Information System (ECDIS) an accepted way of meeting the chart carriage requirements.

1.2 Role of International Hydrographic Organization (IHO)

Although the IMO is responsible for establishing all key safety provisions which require type approved ECDIS to be used in conjunction with up to date official ENC data, it is the IHO who develops and maintains the portfolio of relevant data standards, including: S-57 for data content and encoding, S-52 for data rendering, S-58 for data validation, and S-63 for data protection specifically referenced by the IEC testing standard which verifies an ECDIS against the IMO performance standard. The IHO is also working on the new family of S-100 standards that will eventually replace S-57 for ENC provision.

1.3 SOLAS and Non-SOLAS ships

The rules surrounding carriage requirements for ECDIS equipment have evolved considerably over the last 25 years. The implementation path gradually transitioned ECDIS equipment loaded with Electronic Navigational Charts (ENCs) from being approved as permitted replacement for paper charts in 2002 to eventually becoming a mandatory system for almost all vessels on international voyages in 2018.

The related rules were implemented using a rolling timetable factoring in vessel size, type and age to eventually make ECDIS mandatory to carry for all vessels over 500 GT. This rolling implementation schedule distinguishes between the ships which must carry ECDIS and comply with all related provisions and those who do not. Fundamentally when ECDIS is being used to satisfy SOLAS carriage requirements it must: be type approved, have an adequate backup in place, be adequately maintained, remain compatible with the latest applicable International Hydrographic Organization (IHO) standards and use up to date ENC data.

1.4 One SOLAS convention - two different user communities

The ECDIS system is without a doubt one of the most significant advancements in marine navigation. The efforts of countless professionals are paying off and we are observing a well-established ecosystem with global data coverage, well established international standards, mature data distribution chains, and sophisticated bridge systems all greatly contributing to safety and operational efficiencies.

At the same time, outside the primary SOLAS community there is a much larger non-SOLAS user community of smaller, mainly recreational boat operators which has considerably different operational needs. This community also has markedly different service level expectations. Accustomed to an instant information delivery these users expect to simply turn on a mobile app and start navigating with real time data simply "being there", without having to go through a complex process of ordering official ENCs, waiting for them to arrive, manually uploading and updating them on a certified piece of equipment - the steps professional ECDIS users normally have to deal with.

2 INNOVATIONS

2.1 NaAVIC

NaAVIC is a free and downloadable electronic voyage application that goes beyond the traditional Electronic Chart System (ECS) app where the data, including the ENC information, does not physically reside within the onboard device. Instead, all navigation data is streamed from an up-to-date database that exists in the cloud. The on-demand data delivery model is not confined to conventional chart data. Whilst it includes ENC-derived data as a base layer, it is also designed to take additional data layers. These layers can be user-selected according to the user's need to enhance the ECS display capabilities. For example, data layers can include raster satellite imagery, high-resolution bathymetry, weather radar imagery, predicted tides and currents, as well as real-time weather data streams and domain and locale-specific information. All data is streamed through an open source, open standards-based Nautilus Cloud platform.

The app functions on both Android and iOS devices, and offers a comprehensive range of essential features needed to maintain safety and situational awareness while making navigation easier and more reliable. There is no downloading of data - all data, including chart data, is streamed in real-time from a fully maintained and up-to-date database. The data comes from the Nautilus Cloud, a cloud-based infrastructure specifically designed for marine data. The technology is designed to provide the basis for maintenance and distribution services for any marine data supply. Nautilus Cloud adopts a 'cloud-native' approach as well as leveraging open standards and open source components throughout. The result is a powerful and flexible system with a much greater degree of interoperability in its components. This compatibility includes the emerging S-100 framework, harmonized metadata, raster datasets and real-time sources. The NaAVIC ECS operates on up-to-date information from data providers. This can include government agencies looking to make distribution and accessibility of their data more efficient without compromising its integrity by introducing third party distributors. Figure 1 outlines the key features that NaAVIC offers.

Figure 1. NaAVIC ECS features.

2.2 The Nautilus Cloud Framework

The data powering the ECS is supplied by Nautilus Cloud, a cloud-based platform for marine data, designed for solutions and services within government organizations, industry and consumers. Nautilus Cloud is an enterprise-grade system which is both flexible and has a much greater degree of interoperability with pre-existing components and multiple data sources. As such, Nautilus Cloud is optimized for import, validation, and data management, as well as commercial distribution of marine geospatial data for government organizations, the marine industry, and end consumers. Figure 2 illustrates the many additional ECS features that are supported by the Nautilus Cloud framework.
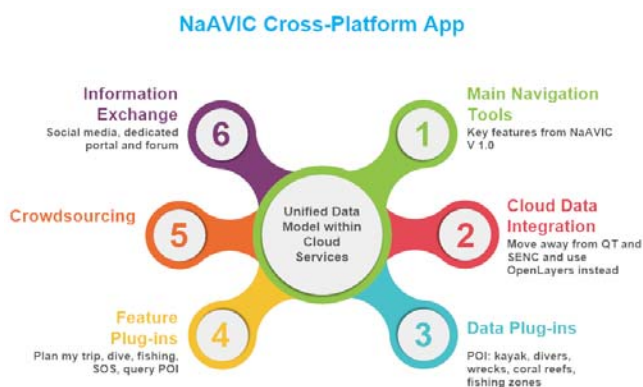

Figure 2. Geospatial features supported by NaAVIC ECS.

2.3 Key benefits

One of the key features of Nautilus Cloud is the expansion of data holdings into a much wider family of related geospatial data products. It is designed to handle the many forms of marine geospatial data under the emerging IHO S-100 framework. The modular design allows front-end applications to access the spatial data feed on any platform, from desktop and mobile platforms to OGC-compliant web service clients and web map tile services for onward consumption of data by other organizations.

The NaAVIC ECS app takes full advantage of many advanced features provided by Nautilus Cloud making it possible for charting agencies to distribute pre-updated data in real-time. This includes distribution of temporal services such as tides, weather, currents and other oceanographic data. This achieves a group of three important requirements for the ECS: content, quality, and data updating.

2.4 Redundancy of Data delivery

NaAVIC addresses the concern of reliable internet connection by providing a smart, user-controlled data caching functionality. It is capable of automatically caching data to ensure consistent availability. Users, based on their environment, will be able to set the app to auto-cache required data ahead of time for a predefined area. Alternatively, they can interactively define the area to cache before departure. Even for users using the app in nearshore coastal areas where modern data networks have coverage readily available however, caching can fulfill an important redundancy feature.

2.5 Key enablers

The Nautilus Cloud platform has the following key features:
− A 'cloud-native' approach where the technology is built from components designed to be run solely from cloud environments.
− A strong integration between data distribution and storage/management.
− A system leveraging open source components as its base technology and which utilizes open standards exclusively building a low-cost system which is flexible with a great degree of interoperability.

2.6 Connecting the data producer and end user

The approach taken is a conscious attempt to connect the user closely with the producer of nautical data. This closer engagement between supplier and consumer is a phenomena across the many domains in the geospatial industry. Data holdings are ever expanding and becoming more accessible, and under a common framework, S-100 , which provides unparalleled opportunities for compatibility and interoperability between previously unrelated marine geospatial domains.

This approach facilitates 'pluggable' architecture and allows for extensible, customizable data imports into the system, future-proofing it for a wide variety of organizational use cases. Additionally, a metadata management sub-system provides functionality to allow individual customers to easily generate metadata records compliant with their individual national metadata profiles.

2.7 Intelligent voyage visualization

NaAVIC and the Nautilus Cloud also aim to support the next generation of Intelligent Visualization technology – "the right information at the right time" - adding a completely new dimension of customization to traditional geospatial data rendering engines. This will make data intuitively useable for end users and, through web services, to onward systems and derived applications. This technology aims to solve the issue of properly balancing the availability of a wide range of data layers available but only selectively displaying those of most relevance to the task at hand.

2.8 Sharing the Journey

We are seeing with land-based journeys and within recreational activities as a whole that users want to share. The desire to share individual experiences comes with a desire to benefit from collective experiences of like-minded people. This has propelled social media to be the pre-eminent guidebook.

Up until now, ECS catered to the person controlling all aspects of the vessel, including its navigation. By utilizing a cloud-based approach with data streaming, NaAVIC ECS enables all members of an expedition to more actively engage in the voyage as well as sharing that voyage to fellow 'marine friends'. It provides ways for everyone to have a more enjoyable boating experience, providing an easy way to monitor the route with the main navigator, to see the basic boat information such as location, speed and heading, and exchange information about various points of interest with friends.

All users get access to community features, which include the feature to to post messages, share pictures, locations and to record and share voyages. Users can also add location sensitive notifications. The app also enables crowdsourcing activities by allowing users to use a set of pre-defined icons to capture a items of interest to specific communities. For example, marking new diving spot locations for the diving user community is as easy as dropping a marker and the platform will automatically share it with all other users, a specific group. Users can also keep all information private if they want to keep their findings to themselves!

2.9 *Flexible Business Model*

Nautilus Cloud's commercial distribution interface can assist organizations who need to sell data as part of their operating model. By offering both free and paid access to data, the system gives organizations the ability to switch between free and cost-recovery models as their demands dictate. It allows the substitution of multiple disparate systems which may be already in place, with a system at substantially lower costs for implementation and support.

The system uses a highly standardized data output interface and a comprehensive approach to data integrity which is crucial in the modern marine data environment. By providing open and efficient access to marine data, the system facilitates social and environmental value (e.g. providing easy standardized access for data to be used for marine pollution prevention, alternative energy production and marine research).

3 CONCLUSION

NaAVIC is a free and downloadable mobile ECS that represents a new approach where the electronic chart data does not physically exist within the onboard computer. The app attempts to thrust the sailing experience several steps further with all the features it offers its users. The system provides a flexible business model by facilitating the ability to switch between free and cost-recovery models of data distribution as their requirements dictate.

While the NaAVIC app mainly targets NON-SOLAS user community, it showcases many advanced capabilities both the app and the underlying Nautilus Cloud that could be very useful for the SOLAS community as well. It is our goal to see these innovations eventually transitioning into both communities as we believe they would benefit greatly vessels alike. Some of the innovations described aim to inspire both communities to see that the possibilities of streaming marine data real-time, consolidating multiple data sources and providing consistent data access to them is currently achievable. These advances can be used to power the next generation of ECDIS and ECS systems untimely benefiting all mariners.

REFERENCES

International Maritime Organization. Introduction to IMO. (n.d.). Retrieved from http://www.imo.org/en/About/Pages/Default.aspx
International Maritime Organization. International Convention for the Safety of Life at Sea (SOLAS), 1974. (n.d.). Retrieved from http://www.imo.org/en/about/conventions/listofconventions/pages/international-convention-for-the-safety-of-life-at-sea-(solas),-1974.aspx
International Hydrographic Organization. IHO Publications. (n.d.). Retrieved from https://www.iho.int/iho_pubs/IHO_Download.htm#S-5A
Open Geospatial Consortium. OGC Standards. (n.d.). Retrieved from https://www.opengeospatial.org/docs/is