NOTE / TECHNICAL REPORT

# Shared waters, same standards – The Baltic Sea e-Nav project: A partnership for the future of marine navigation

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## Abstract

In order to deploy the first layers of S-100 based navigation products in the Baltic Sea, and do so in a regionally harmonized manner, the Hydrographic Offices involved are partnering with academia and industry in the Baltic Sea e-Nav project. To unlock the full potential of the S-100 paradigm shift towards e-navigation, there is a need for transnational collaboration to build capacity and ensure seamless, harmonized products. In addition, the project will test S-100 products from an end-user perspective to ensure the most relevant and useable navigation data possible. The recently started project will continue until 2026 and is co-financed by the EU Interreg Baltic Sea Region programme.

**Keywords**

S-100 · Baltic Sea · ECDIS · international collaboration · EU project

## 1 Introduction

During the past decades, the countries around the Baltic Sea have cooperated in the process of conducting modern hydrographic surveys of the main shipping areas of this highly navigated region, to obtain detailed, quality assured hydrographic data. By using the Baltic Sea as a testbed, surrounding countries will now take the next step towards the development of navigation in the Baltic Sea and implement the next generation of navigational products based on the new S-100 standard, developed by the International Hydrographic Organisation (IHO). The International Maritime Organization (IMO) has agreed to require S-100 compliance in the IMO ECDIS Performance Standards (IMO, 2022) for the next generation of vessel navigation systems and has defined S-100 as the underlying data model for e-navigation (IMO, 2018).

Introducing these machine-readable products and services is a major step towards digitalized and more automated sea traffic. Electronic Navigational Charts (ENC) compliant with the new S-101 product specification will be the new base layer in the next generation of S-100 compatible navigation systems. Combining these ENCs with other S-100 products will make it possible to calculate more precise under keel margins, and give the navigators a better situational awareness of the navigable waters around them. Depth contours, currently portrayed at static depth intervals, will be able to be generated from more detailed and dynamic information, and consequently provide the navigators with

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more relevant and precise "go and no-go areas".

Expected benefits are increased safety for both people and environment, new opportunities for vessels to optimize their routes and cargo loading, and thereby more eco-efficient solutions for shipping. The new S-100 products also address the increasing cyber security threats by raising data protection in navigation systems to current standards and best practice. Additionally, S-100 will be a major step towards automated navigation and autonomous shipping as the data becomes more machine readable.

For the Baltic Sea e-Nav project, the goal is – by the end of the project in 2026 – to achieve significant and regionally harmonised S-100 compliant product coverage of the Baltic Sea with commercial ENC (S-101), detailed bathymetry data along important shipping routes (S-102), and prototype water level and current services (S-104 and S-111).

## 2 The challenges to implement S-100 products in the Baltic Sea

While there have been various testbed projects for S-100 products, on-going or finished (e.g. CHS, 2018; UKHO, 2022; Jang et al., 2023), that investigate different aspects of the S-100 potential, the Baltic Sea e-Nav project is probably the foremost project looking at S-100 from a truly multinational perspective: How do S-100 data producers need to collaborate across borders, to ensure that the end users can navigate with the help of seamlessly harmonized data products? How should one manage the S-100 product rollout in an area where most vessel voyages stretch across the areas of responsibility of several coastal states? And how can the data producers' varied, shared expertise be leveraged for an efficient, collaborative transition to the S-100 world?

To trigger market adoption of S-100 products and S-100 compatible end user systems, especially for the highly regulated market segment of Electronic Chart Display and Information Systems (ECDIS), sufficient and relevant S-100 product availability is a key factor. The challenge to upgrade ECDIS on-board existing vessels to S-100 compatible systems requires that S-100 products provide a significant added benefit for the navigators. Probably ENC alone, even in S-101 format, will not be enough to justify the investment in new bridge systems. Still, coverage with S-101 products being the ENC base layer are needed to enable the use of other products, such as more detailed S-102 gridded bathymetry. Consequently, the hydrographic offices need to produce and update S-101 ENCs with at least the same informational content and up-to-datedness as the corresponding legacy S-57 ENCs, which also need to be maintained in the product portfolios.

This increased product portfolio complexity, together with the challenge to implement entirely new products for navigation, such as S-102 gridded detailed bathymetry products or S-104 and S-111 oceanographic services, is a major challenge for the data producers in making the transition to S-100. The technical capacity and production readiness for S-100 varies between the different Baltic Sea countries. Therefore, the common Baltic Sea e-Nav project for S-100 implementation is also a platform for sharing experience and capacity building, which will streamline the rather rapid rollout of S-100 products until the agreed upon transition period for ECDIS between 2026 and 2029.

The degree of maturity for the development of data according to the new standards is different in different Baltic Sea countries. Testing of the new standards against relevant use cases is essential at this phase of S-100 implementation. The project will utilize the Baltic Sea as a testbed for this, to test, analyse and refine the new navigational products. The results will be spread to all relevant actors in the Baltic Sea Region, and also beyond through the regular international collaboration within the IHO.

Finally, in an area such as the geographically confined Baltic Sea which is highly used for ship traffic, it is vital for the navigators' decision making that the navigation products they use are harmonised across borders and well-adopted to the particular regional conditions. A patchwork of differing national interpretations of S-100 based product specifications could otherwise lead to a worsened user experience and thereby potentially decreased navigational safety.

Therefore, the Baltic Sea Hydrographic Commission (BSHC) has decided that S-100 products in the region should be as harmonised as possible regarding criteria such as information content, coverage, spatial resolution and availability. For this purpose, the Baltic Sea e-Nav project will coordinate the development of common guidelines for S-100 data producers, to be adopted by the BSHC for application in the Baltic Sea region.

## 3 The project partnership

The project consortium consists of several building blocks, which together comprise the full value chain from product development through distribution of navigation data to the potential end consumers (Fig. 1).

Firstly, the core of the partnership are data producers in the form of all Baltic Sea coastal EU member states' respective hydrographic offices, with full partners from Denmark, Estonia, Finland, Germany, Latvia and Sweden, as well as associated partners from Lithuania and Poland. Together they form the majority of the BSHC. Furthermore, the partnership includes the Finnish Meteorological Institute as one of the relevant national meteorological and oceanographic agencies, which are important partners for the oceanographic S-100 products for navigation (water level and surface currents).

Secondly, two applied research institutes in the field of shipping technology, RISE Research Institutes of Sweden and the Finnish Satakunta University of Applied Sciences, will lead the testing activities and help the data producers with structured development and refinement of their products.

Thirdly, the navigation system manufacturing company FURUNO Finland will supply the project with the

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needed S-100 navigation system technology and further insight from their close relation to the end users of navigation data products.

Finally, the two ENC distribution hubs PRIMAR and IC-ENC will, as associated partners, support the project in aspects related to the S-100 product distribution chain.

Most of the project partners have a long record of productive collaboration, both in various projects but also as members of the BSHC.

## 4 The scope and expected outputs of the project

### 4.1 A harmonized Baltic Sea e-Nav base package

The Baltic Sea e-Nav project will achieve two specific outputs: Firstly, the rollout of a number of commercial S-100 based products with significant coverage in the Baltic Sea, the "Baltic Sea e-Nav base package". Secondly, the project will develop detailed product harmonisation guidelines for the data producers in the Baltic Sea region.

The primary goal of the project is to introduce significant coverage of relevant S-100 products in a regionally coordinated manner, both with regard to the timing, the geographic coverage and also the informational content of the products.

In order to ensure a seamless user experience when navigating with products from different producers, but also to make capacity building and international collaboration easier, the project will develop concrete product harmonisation guidelines for data producers. This will be done in liaison with the BSHC and its relevant working groups, so that the BSHC eventually will formally adopt the guidelines. Similar cross-border harmonisation guidelines already exist for (legacy) S-57 ENC in the Baltic Sea, which even have been re-used as examples in other regions in the World.

### 4.2 Focus on four important S-100 products

The project will develop a set of four different S-100 based product lines: ENC and bathymetry products, as well as water level and surface currents services.

For ENCs, by the end of the project there will be full coverage of the major shipping routes in the Baltic Sea with S-101 ENC, with usage bands and

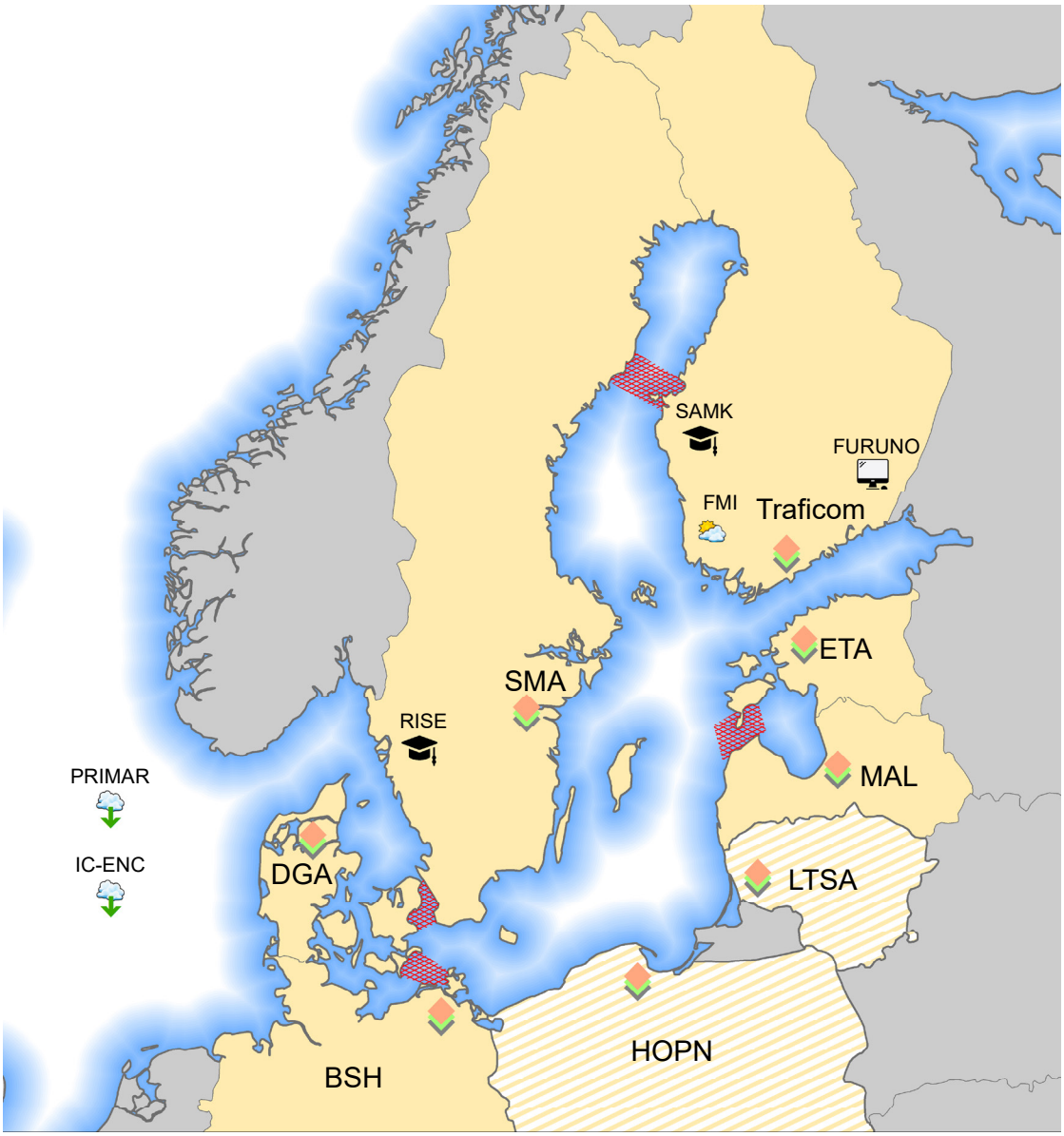



**Fig. 1** The partnership of the Baltic Sea e-Nav project covers (almost) the entire area of the Baltic Sea, with partners being the Hydrographic Offices of Denmark, Estonia, Finland, Germany, Latvia, Lithuania (associated), Poland (associated) and Sweden, as well as the Finnish Meteorological Institute (FMI), Satakunta University of Applied Sciences (SAMK), RISE Research Institutes of Sweden, Furuno Finland and the associated partners PRIMAR and IC-ENC. The initial testing of S-100 products will be carried out in cross-border areas with some level of navigational challenges (red).


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geographic coverage equivalent to present S-57 ENCs.

Additionally, in relevant shipping areas, which are surveyed to modern standards, S-102 bathymetry products will become available for navigation. The S-102 coverage will likely vary depending on individual countries' specific conditions, and the informational content of these entirely new products is still being worked on.

Overview services for the oceanographic products S-104 water level and S-111 sea surface currents will probably cover mainly the Finnish areas of the Baltic Sea, and may still be prototypes at the end of the project. But the project will contribute to a solid understanding of what would be required to fully operationalize S-104 and S-111 services for navigation, covering the entire Baltic Sea.

### 4.3 Prototyping, testing and upscaling

The work in the project will be carried out in three phases, beginning with product prototyping, which is followed by testing and refinement before the final upscaling of the production for rollout.

In the beginning, product prototypes are being developed at the same time as testbeds are prepared. This includes the development of a navigation system prototype to be used in the existing bridge simulators that several partners own. Furthermore, based on a number of criteria, suitable geographic areas for product testing are being defined and particular navigation scenarios are being translated into testbed protocols.

In the second phase, product testing and refinement are being carried out iteratively. The bridge simulator tests will be conducted in virtual versions of real-world locations (Fig. 1) and relevant navigation scenarios, in order to bring a realistic end user perspective into the tests. Based on test findings, the S-100 products and harmonisation guidelines will be refined and tested again.

In parallel, the third phase of the project will be initialized by the data producers who need to upgrade their production workflows for the new products. As soon as the products are tested and defined, the data producers will start with the production of the Baltic Sea e-Nav base package.

According to plan, there will be a significant amount of relevant S-100 products available in the Baltic Sea when the first commercial end user systems in the form of S-100 ECDIS hit the market in 2026.

## Acknowledgement

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Information about the project's progress will be published on the project web site available at https://interreg-baltic.eu/project/baltic-sea-e-nav/.

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