Paper for Consideration by S-100WG3

Report on S-100 Sea trial of KHOA

Submitted by:	Republic of Korea (KHOA)
Executive Summary:	This paper reports the S-100 sea trial by KHOA.
Related Documents:	S-100 Version 3.0.0, Test Bed Platform
Related Projects:	IHO S-100/S-101 Test Bed Project

Introduction / Background

KHOA has been producing S-10X data set prototypes and developing test bed to support the development of S-100 and S-100 test bed. In 2017 KHOA conducted a second sea trial to validate the outcome of the data sets. This document introduces major achievements and the outcome of the sea trial for next-generation hydrographic information.

Analysis/Discussion

Production of S-100 Test Data

KHOA has been producing prototypes of next-generation hydrographic information to obtain the capacity for developing next-generation hydrographic information product specifications. The test area was Busan Port and the following shows development methods for each S-100 test data:

Table 1. S-100 Test Data Product Specifications and their Development Methods

No.	Product Specification	Development Method
1	S-101 Electronic Navigational Chart (ENC)	- Tools: NOAA/Esri S-101 Converter (Version 0.8.19), CARIS S-57 Composer, KHOA S-101 editor. - Procedures: S-57 ENC data (ER) → CARIS S-57 Composer
2	S-102 Bathymetric Surface	- Tools: KHOA S-102 Editor (developed using open source application from the Open Navigation Surface Working Group). - Procedures: Survey data → Upload to DEM Database → Convert and edit using the S-102 editor (BAG).
3	S-104 Water Level Information for Surface Navigation	- Tools: KHOA S-104 Editor - Procedures: Water level in grid (sourced by KHOA Tidal system) → created by S-104 Editor
4	S-111 Surface Currents	- Tools: KHOA S-111 Editor. - Procedures: Speed and direction of surface current data (sourced by KHOA current system) → Created by KHOA S-111 Editor
5	S-112 Dynamic Water Level Data Transfer	- Tools: KHOA ASM Message 8 Encoder, water level service system connecting with AtoN AIS. - Procedures: Tidal station → Access and transfer the water level to QC system → Transfer the QC processed values to the water level service system → Encode the water level value to the ASM Message 8 → Send the Message 8 via AtoN AIS → Receive the ASM Message → Display the real time water level value in the sea trial system
6	S-124 Navigational warnings	- Tools: S-124 GML converter from NW DB - Procedures: KHOA NW DB → convert to S-124 NW GML data
7	S-412 Weather Overlay	- Tools: S-412 converter for Korean weather data - Procedures: KML (digital format for weather chart) → convert KML to S-412 GML data

We developed S-100 test data in 2016 and based on such experience we developed the following in 2017:

Table 2. Creation of S-100 Test Datasets

Num.	Product Specification	2016	2017
1	S-101 Electronic Navigational Chart (ENC)	Some attribute information was inputted using S-101 Converter.	Used various tools such as CARIS Composer and Converter. Used DCEG introduced in 2017. Inputted feasible features for effective testing.
2	S-102 Bathymetric Surface	Identified gaps between grid cells and differences between cell depth values. Did not input uncertainty.	Resolved gaps between grid cells and differences between cell depth values. Inputted uncertainty.
3	S-104 Water Level Information for Surface Navigation	Produced in HDF-5 format without complying with the specification (not applied to the system).	Produced in HDF-5 format according to S-104 data model.
4	S-111 Surface Currents	Produced surface current data with tidal current prediction values.	Produced surface current data with calculated values from surface current prediction model.
5	S-112 Dynamic Water Level Data Transfer	Water level value which was pre-processed on land was delivered through ASM on a random location.	Water level value collected from a tidal station was delivered through ASM.
6	S-124 Navigational warnings	Produced on a random location.	Navigational warning data suited for scenarios was developed and presented.
7	S-412 Weather Overlay		New item

Development of S-100 Test System
Based on the experience from S-100 test system developed in 2016, the research team developed S-100 test system for the sea trial in 2017 and below are its main features:

- Applied S-100 portrayal process to present S-100 test data sets (based on style sheets)
- Related AIS receiver and received S-112 real-time water level information
- Presented grid-based go/no-go areas using real-time water level, S-102 bathymetric grids and draught information
- Improved pick report function to enable search for S-100 test data attribute
- Applied S-100 Interoperability Catalogue
- Developed S-100 test data screens based on two monitors

Meanwhile a screen for displaying additional information and functions of next-generation hydrographic information was added and it provides the following main features:

- UKC chart function: Display UKC charts based on fairway information and the direction of the bow
- Display of dynamic hydrographic information based on vessel location: surface current velocity and direction from vessel location, S-102 depth from vessel location, S-104 prediction tidal height based depth
- Display of real-time marine information: Real-time tidal height and other marine information provided through ASM according to S-112
- Tide comparison graph: Display graphs based on highest tidal heights included in electronic tide tables. The graphs compare S-112 real-time tidal height information and electronic tide table values.
- Display of no-go areas: Display no-go areas using S-102 and S-104
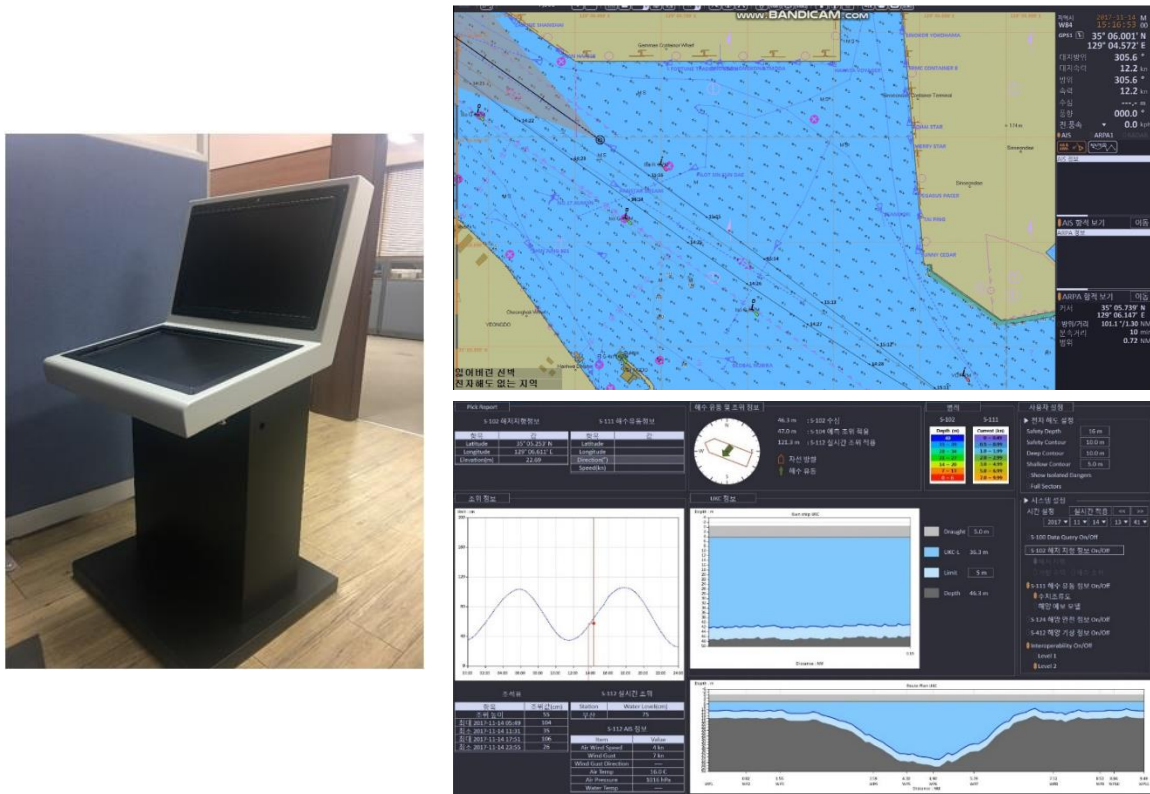
Fig. 1 Outcome of Developing S-100 Test System

Procedure for Testing Next-Generation Hydrographic Information

We validated S-100 test datasets on the sea trial and tested the following S-100 datasets with the following scenarios:

1. Test environment
   - Tested at the Busan Port using a KHOA survey vessel
   - Installed S-100 test system on the bridge
   - Two participants present (A professor who lectures navigational equipment (ECDIS) in a mariner's training institution, a marine information expert who has sailing experience at KHOA)
   - A questionnaire to be filled in by the participants after the trial

2. Scenario planning

2.1 Pre-training
   - Introduced S-100 dataset and the test system
   - Introduced the objective of the test

2.2 Before departure
- Scenario 1: Planned the navigation using S-100 datasets (used meteorological, dynamic and tide information)

2.2 During navigation
- Scenario 2: Display go/no-go areas using S-102, S-104 and real-time water level data. Compare existing ECDIS (safety contours) and S-100 test system
- Scenario 3: Increase draught, minimize navigable areas and compare existing ECDIS and S-100 test system
- Scenario 4: Apply S-100 Interoperability Catalogue and review S-100 datasets display. Check if maritime safety information is appropriately displayed and if symbols clutter.

2.3 After arrival
- Enquire feedback from the participants on the scenarios using the prepared questionnaire.
- The questionnaire was focused on (1) Was S-100 data helpful for the safety of navigation? (2) Are there any improvements to the S-100 test system compared to existing ECDIS? (3) Were there any difficulties due to the variety of S-100 data?

Overview of the Next-Generation Hydrographic Information Sea Trial

The objective of the trial in 2017 was to validate the prototype of next-generation hydrographic information and test the suitability of its additional functions and S-100 Interoperability Specifications. Brief information of the trial is shown below:

- Date and time: 2pm, Tuesday 14 November 2017
- Location and test vessel: Busan Port Pier No. 5, *Haeyang 2000* (KHOA survey vessel)
- Duration: 2 hours for the length of 14km (round trip)
- Participants: KHOA, project contractor, external experts
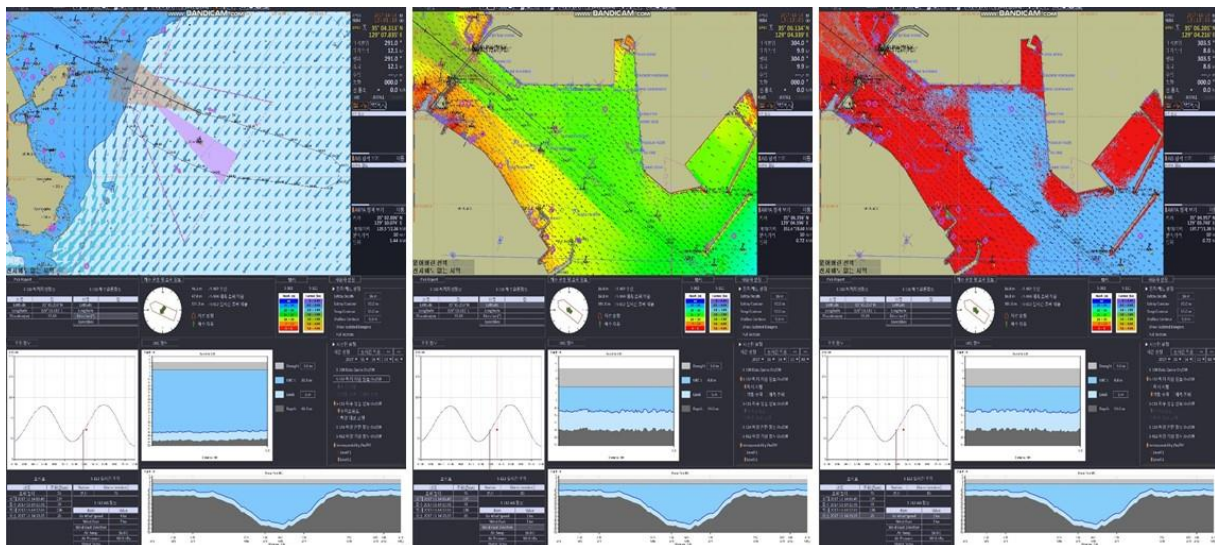

Fig. 2 Route of the Sea Trial

Fig. 3 Screens from the S-100 Test System

Major Outcome from the Trial

The trial was participated by KHOA, project contractor and external experts and reviewed the outcome of developing next-generation hydrographic information and S-100 test system. Major outcome from the trial is shown below:

1) "?" in presenting S-101 seemed to be the portrayal catalogue or the test system software problem.
2) The product specification was improved to reduce the frequency of warning area alarms on S-101 but this could not be confirmed on this trial.
3) S-101 prototype data could be validated on land first and not on the sea trial.
4) S-102 was appropriately presented. We reflected experts' feedback on presenting no-go areas.

5) S-102 data did not match with ENC soundings.
6) Need to resolve the seamlessness in S-102 data
7) When S-111 surface current information is presented, symbols clutter badly so it is necessary to apply thinning algorithm.
8) There was confusion when integrating codes at the final stage of developing the test system and some functions did not work so it was difficult to check them.
9) S-412 weather charts are useful for mariners but lacked portrayal.
10) S-124 Navigational Warnings presentation function did not work.
11) Since the system is focused on next-generation hydrographic information, it lacks the capacity equivalent to commercial ECDIS.
12) The system is not optimized for S-100 interoperability so it takes a lot of time to start its functions.
13) If the system menu is complicated, it cannot be applied when navigating.
14) Some functions consume excessive time to work. There should not be any delay no matter how useful the data may be.
15) Next-generation hydrographic information seemed useful and the test system was also useful overall.
16) It was the first time using S-100 hydrographic information and it will surely be more useful than existing ECDIS.
17) Dynamic tidal current information does not match in breakwaters and narrow channels. If it cannot be provided, it is necessary to filter uncertain information so as not to show it.
18) Providing wind direction/velocity grid information for S-412 weather information would be useful.

Fig. 4 Sea Trial of Next-Generation Hydrographic Information

Conclusions

KHOA has been producing next-generation hydrographic information prototypes to build its foundation and experience from it and support the development of product specifications. And we developed the S-100 test system to validate outcome of developing S-10X next-generation hydrographic information. In November 2017 we delivered a sea trial to validate the outcome and the functions for providing additional information.

Through the trial, we identified improvements and considerations for developing next-generation hydrographic information and the test system. We plan to use this experience to improve the development and the system.

Action Required of S-100WG

The S-100WG3 is invited to:
   a.   **Note** this paper