Information Paper for Consideration by IHO Council 5

S-100 testbed project

Submitted by:	Republic of Korea (KHOA), USA (NOAA)
Executive Summary:	ROK and USA are conducting the S-100 testbed project to support the IHO S-100 Implementation Roadmap. This paper describes the major results carried out in 2021 and future research plans.
Related Documents:	Roadmap for the S-100 Implementation Decade (2020–2030); A-2 PRO-2.2 Risk assessment on the "Dual Fuel" mode of ECDIS HSSC13-05.1H INF, ROK-US S-100 testbed framework on advancement of S-98 Interoperability Catalogue, S-164TDS
Related Projects:	S-100 testbed framework, KHOA S-100 Viewer

Introduction / Background

1. KHOA and NOAA have been working on the operation of S-100 testbed framework and are conducting the S-100 testbed project to support the stable and systematic introduction of S-100 for data production, distribution and utilization of hydrographic dataset based on the S-100 Implementation Roadmap.

2. The S-100 operation infrastructure including the S-100 GI Registry has almost reached to the stage of completion. IHO subsidiary bodies are updating the S-100 Ed. 5.0.0 and testing product specifications to prepare it for the operation phase. We are focusing on the development of interoperability among S-10X products, which is one of the core contents of S-100. In this regard, KHOA tested the draft of interoperability catalogue developed with NOAA in the 2021 joint project.

3. Regarding the concerns raised at A-2 on the Dual Fuel ECDIS concept required for the S-100 implementation and the necessity to review various aspects according to the introduction of S-100 in a safe navigation environment, we believe that quantitative analysis of practical considerations and benefits in applying S-100 data for a primary navigation purpose will be able to relieve those concerns and make S-100 implementation more attractive to join the transition period. Therefore, the possibility of quantitative analysis on the use of S-100 data was considered in the KHOA S-100 testbed project.

Analysis/Discussion

Overview of KHOA S-100 testbed project

4. KHOA developed the S-100 operation infrastructure including the Registry, FCB/PCB and KHOA S-100 Viewer. The KHOA S-100 Viewer was released in 2021 and has been updated as Member States and stakeholders use it to test their products. The KHOA S-100 Viewer was used to establish the testbed system consisting of a Full Mission Bridge (FMB) simulator and S-100 ECDIS. KHOA has built and operated a centre that can validate the S-100/S-10X standards and TDS at all times.

Fig. 1. KHOA S-100 testbed system

KHOA S-100 testbed project in 2021

- Date: 8 – 9 September 2021
- Location: KHOA S-100 Testbed Centre
- Details
  (Day 1) Testing technical issues
  (Day 2) Fundamental review to quantitatively measure the usability and benefits of S-100 hydrographic data services

5. The KHOA S-100 testbed project in 2021 included various technical topics such as interoperability catalogue, alert & indication, S-111 thinning algorithm new symbols for S-101 ENC. This test is notable in that the interoperability catalogue, an outcome of a joint project between KHOA and NOAA, was validated on the testbed's S-100 ECDIS level 6 of the S-100 testbed framework rather than at the S-100 viewer level. It was confirmed that the tested issues operate S-100 ECDIS normally and appropriately. There was a minor issue to discuss at the TSM to improve alert & indication catalogue. See Annex 1 for details of the outcomes.

Efficiency measurement of using S-100 data in a navigation environment

6. It is expected that the S-100 data service will greatly improve safe navigation and efficiency in a navigation environment, however, there has been no research on the effectiveness of using next generation navigational data service and there are concerns on the great impacts to the industries and unknown compatibility issues. We believe that quantitative measurements of the work efficiency while using the S-100 dataset would help the community see the requisite of S-100. Quantitative data of S-100 implementation will possibly support to emphasize the needs for the conversion of S-100 data service to the IMO and the shipping industry. Therefore, a fundamental research was conducted on the possibility of quantitative measurement of the usability and benefits of introducing S-100 dataset for primary navigation. The project reviewed the major procedure of navigation provision, compared the process between existing nautical publications and S-100 dataset in addition to ENC, and tried to measure the efficiency quantitatively. See Annex B for details.

7. As one of the quantitative measurement options, KHOA intends to propose an eye tracker device that can collect the type of information that the subject is focused on, time, fatigue, etc. to measure the usability and efficiency in the field of ergonomics. KHOA will apply the eye tracker device to measure the usability and efficiency of S-100 data in the 2022 S-100 testbed project such as the following:
   - Technical review of Dual Fuel concept using S-57 ENC and S-101 ENC
   - Development of TDS and scenario for testing the DF ECDIS
   - Expected process for navigational provision using S-100 data
   - Measuring the usability and efficiency of using the S-100 data compared to the existing nautical products
   - Unit task definition and time measurement for route planning and preparation
   - Scenario and test dataset including update for navigation provision

8. Actions Required of Council

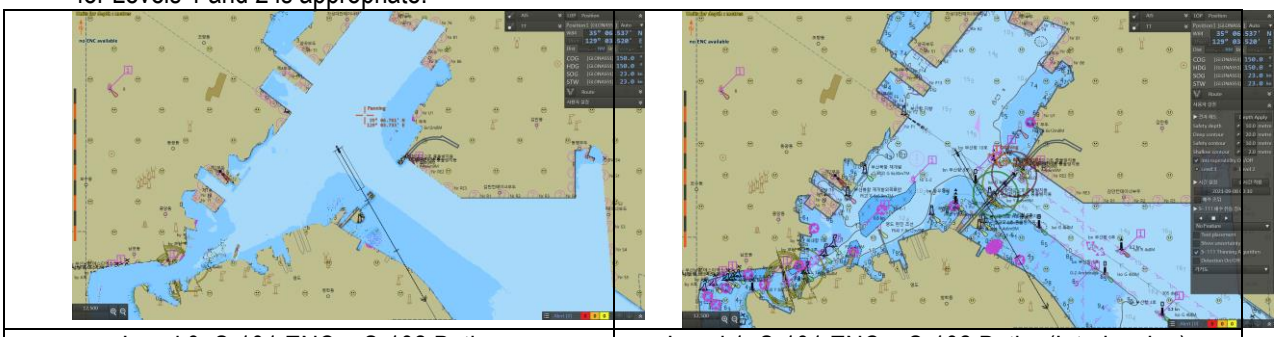
- The IHO Council is invited to note the activities of KHOA and NOAA.
- KHOA-NOAA S-100 Testbed project invites the IHO Council to note the approach to measure the efficiency quantitatively for the use of S-100 data service and suggest other participants or measures.

Annex A

Outcome of operating the S-100 testbed for testing technical issues

1. Technical issue a. : Interoperability catalogue produced from the joint project between KHOA and NOAA

- Background
  The drafted interoperability catalogue (IC) for Levels 1 and 2 was tested on the S-100 ECDIS (shore-based ECDIS).
- Result
  It was confirmed that the interoperability catalogue operates normally on S-100 ECDIS and the setting value for Levels 1 and 2 is appropriate.



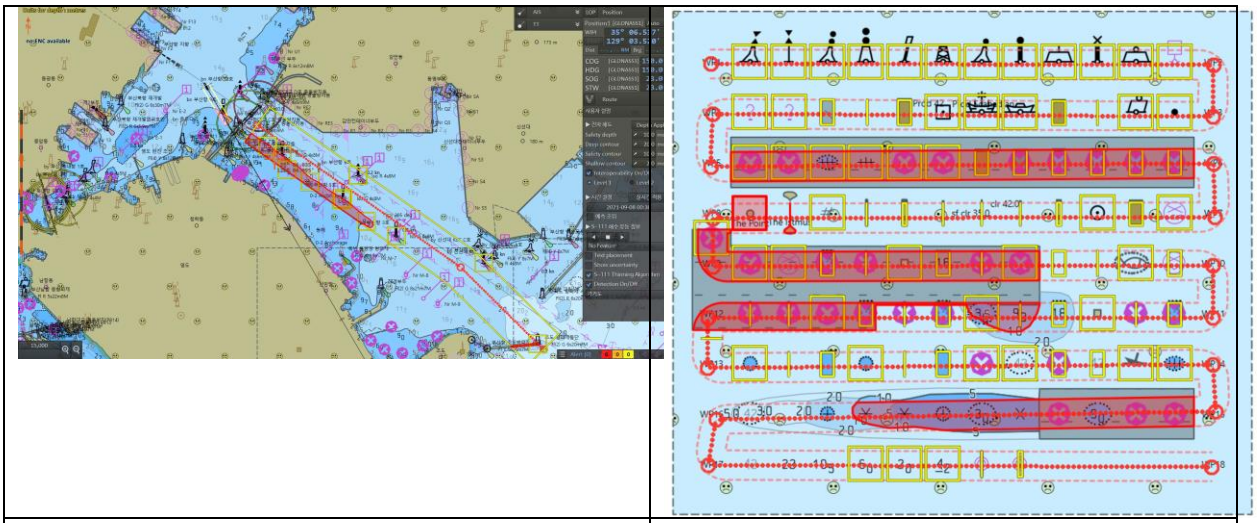
Level 0: S-101 ENC + S-102 Bathy	Level 1: S-101 ENC + S-102 Bathy (Interleaving)

Fig. 2 Testing the interoperability catalogue

2. Technical issue b. : Functions to detect obstructions and process alert & indication catalogue

- Background
  The functions for route planning and obstruction detection were newly developed. This project tried to test those functions and review the alert & indication catalogue which was included in the latest version of S-101 portrayal catalogue package.

- Result
  The S-101 TDS using the S-64 TDS was produced. The new functions for route planning and obstruction detection were tested. The project tested the alert & indication catalogue in the S-101 PC and identified minor issues that require technical discussion. The issues will be reported to the next TSM.



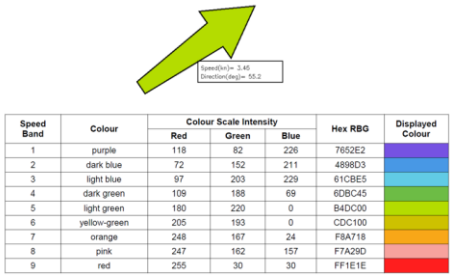
Route planning and detection function	Testing the Alert & Indication Catalogue

Fig. 3. New functions for route planning and obstruction detection and testing A&I Catalogue

3. Technical issue c. : Thinning algorithm of S-111 Surface Current Product Specification

- Background

The S-111 PT under the TWCWG defined the following two suggested rules to solve the symbol cluttering problem on a small-scale screen. This project tried to test the first suggested rule.



Speed Band	Colour	Colour Scale Intensity			Hex RBG	Displayed Colour
		Red	Green	Blue		
1	purple	118	82	226	7652E2	
2	dark blue	72	152	211	4898D3	
3	light blue	97	203	229	61CBE5	
4	dark green	109	188	69	6DBC45	
5	light green	180	220	0	B4DC00	
6	yellow-green	205	193	0	CDC100	
7	orange	248	167	24	F8A718	
8	pink	247	162	157	F7A29D	
9	red	255	30	30	FF1E1E	

Surface current Symbol

Suggested Rule 11. For thinning regularly gridded data, arrows at every n^{th} column and every n^{th} row are drawn, but making sure that the row and column with the maximum vector is drawn. With a R_{max} value of 0.5,

$$n = 1 + fix\{H_{max}/(0.5D)\} \quad [Eqn. I.3]$$

The value of *n* must be calculated by the ECDIS.

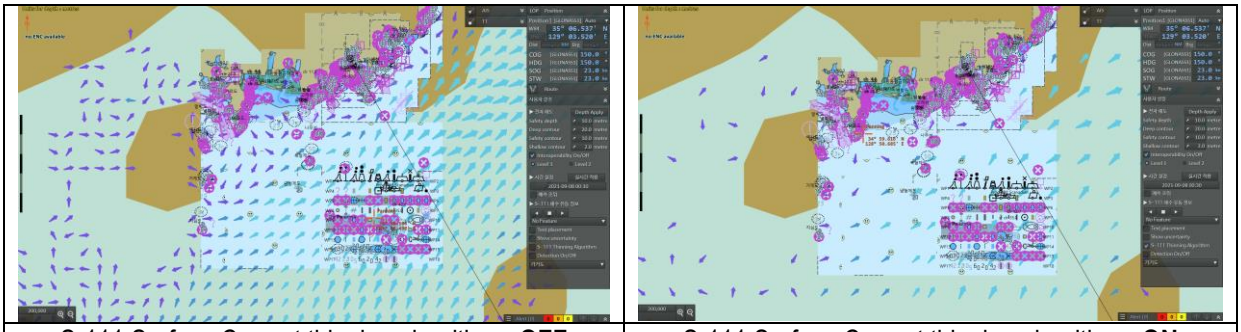
Suggested Rule 12. For thinning non-regularly spaced data, one potential solution would be to either reduce the reference height H_{ref} or increase the reference speed S_{ref} (Table I.2), so as to make each symbol smaller. Thus either S_{ref} of H_{ref}, or both, must be user-selectable.

Suggested Rule for thinning algorithm

Fig. 4. Surface current symbol and suggest rules for thinning algorithm

- Result

It was confirmed that the thinning algorithm suggested in the product specification works normally on a small scale screen using the surface current TDS from the Busan Port area.



S-111 Surface Current thinning algorithm - **OFF**

S-111 Surface Current thinning algorithm - **ON**

Fig. 5. Testing the thinning algorithm suggested in the S-111 PS

4. Technical issue d.: Testing new symbols for S-101 ENC

- Background

The project developed 9 new symbols based on the discussions of the S-101 portrayal subgroup. The new symbols were tested.

- Analysis

The project designed the new symbols as SVG format and included them in the S-101 portrayal packages. Details of the new symbols will be reported to the S-101 PT meeting in December 2021.

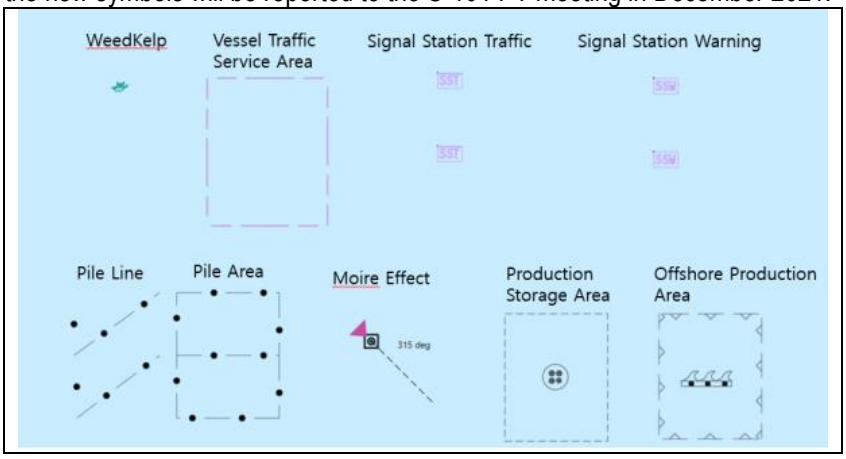


Fig. 6. New symbols for S-101 ENC

Annex B

Major procedure of navigation provision, compared the process between existing nautical publications and S-100 dataset in addition to ENC

Precondition & Limitation

- Limited to the use of some nautical publications among full navigation provision tasks
- Comparison between nautical publications and S-100 datasets
- Excluding update of S-100 dataset
- Measuring estimated time for inquiry and recognition of nautical data using an eye tracking device

✓ Navigation provision
- Appraisal: Nautical chart, nautical publications, update of chart and publications, review of safety information
- Planning: ECDIS/ENC, setting safety contour, check safety margin, tidal table, currents, sailing direction, NAVTEX, navigational warnings, navigational recommendation and guideline, route planning, route checking

✓ Tidal table
- As-is: Check the tidal value of a specific date at a target port, and a mariner calculates the water level for the expected date.
- To-be: Mariner selects the S-104 datasets and checks the exact values of water level from the dataset.

✓ Surface current
- As-is: Check the surface current of a specific date at a target port. Select the surface current value close to the desired time.
- To-be: Mariner selects the S-111 dataset and checks the speed and direction of surface currents for the desired time and position.

✓ Navigational warnings
- As-is: Identify messages related to the list of NAVTEX or navigational warnings.
- To-be: Mariner selects the S-124 navigational warning data and identifies S-124 datasets related to position and time.

✓ Sailing direction
- As-is: Identify VTS service area, reporting contents and channel information for arrival/departure report.
- To-be: Select the S-127 marine traffic management datasets and check the information for VTS report.

* As S-100 data service will be implemented in parallel with the S-57 ENC according the S-100 Implementation Roadmap, technical considerations and systematic testbed will be needed.