S-100 Testbed Project of KHOA

22 Feb. 2023

KRISO Sewoong OH

On behalf of KHOA(Izzy Kim)

Korea Hydrographic and Oceanographic Agency

00 Contents

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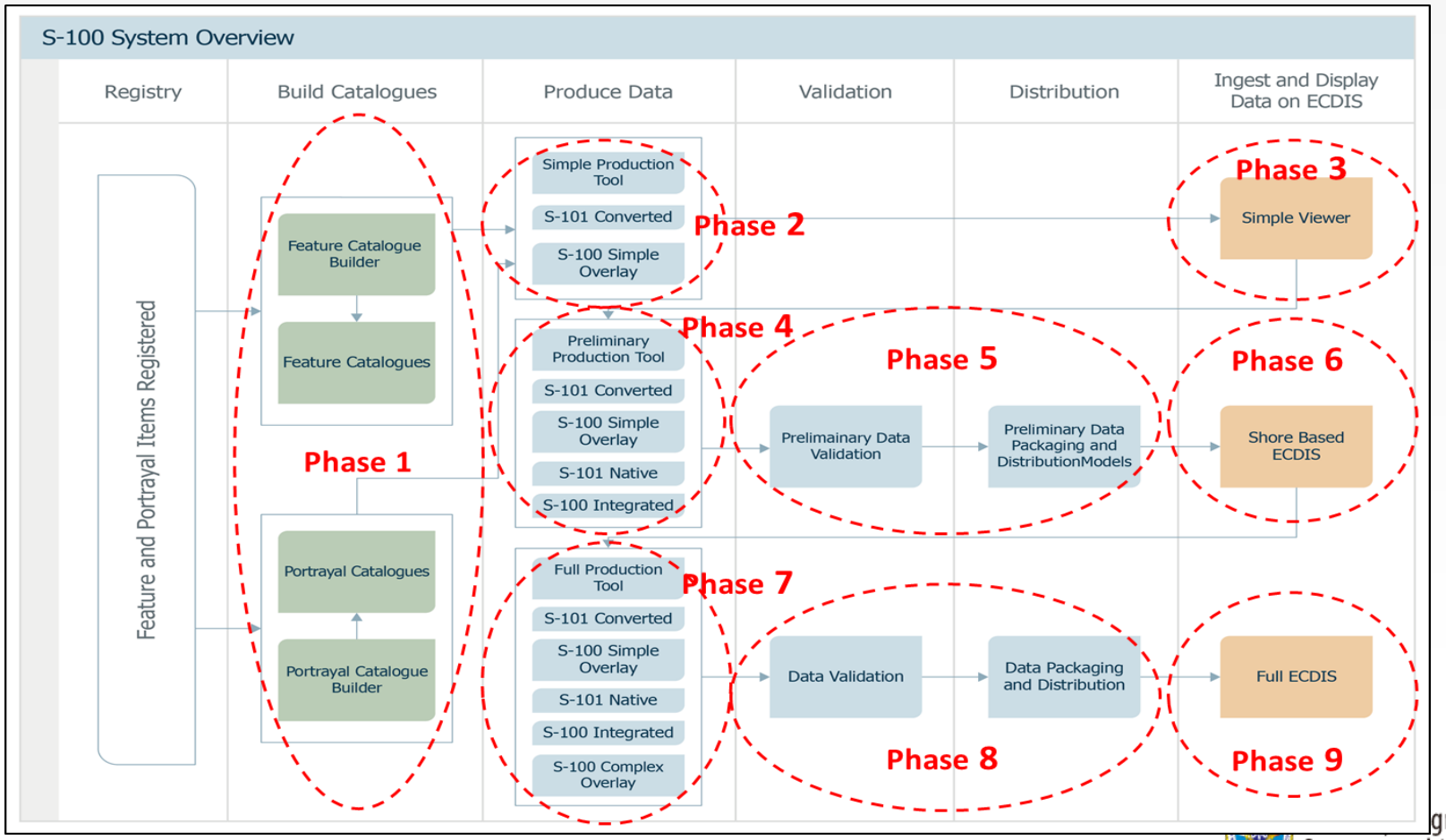
01 Introduction

- **Objectives**
  - Support the S-100 development of IHO for the S-100 infra system and S-100 testing system
  - Promote sharing platform of S-100 knowledge and resources
  - Provide the S-100 data for domestic e-Navigation project
  - Prepare the S-100 implementation plan of IHO
  - Establish and operate the national S-100 committee

- **Scope of KHOA S-100 testbed project**
  - Technical support to the IHO S-100 development
    - S-100 GI Registry and S-100 Tools
    - S-100 testing system (S-100 Viewer and S-100 ECDIS)
    - Measuring the efficiency of S-100 data service
  - Sharing platform of S-100 knowledge and resources
    - Open S-100(Open source code), S-100 Open Online Platform
  - S-100 data for domestic e-Navigation project
    - S-101, S-102, S-104, S-111, S-122, S-123, S-127
  - Establish and operate the national S-100 committee
    - 4 meetings were held

02 Status

- **Technical support to the IHO S-100 development**
  - Phase 1 (Registry, Tools and Catalogues)
  - Phase 3 (Simple Viewer), Phase 6/ Phase 9 (Shore based/Full ECDIS)



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- Technical support to IHO S-100 development
  - IHO GI Registry

International Hydrographic Organization

• S-100 Registry Development History

S-100 GI Registry

2018~ | 2016 | 2015

3rd Developing/Operating

- Applying Concept Register
- Binding Concept-Feature

2nd Development/Operation

- Developing proposal
- ProducerCode(S-63)

1st Test Operation

- Establish Register under FCD
- Establish Portrayal/Product Specification/Meta/ProducerCode

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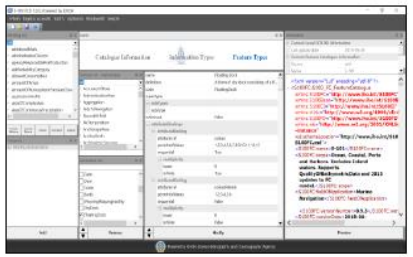
- **Technical support to IHO S-100 development**
  - S-100 Tools

International Hydrographic Organization

IHO S-100 Infra (Development, support and maintenance by KHOA)

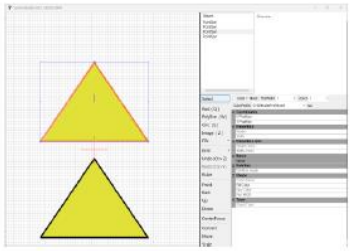
S-100 GI Registry

FC Builder | PC Builder



DCEG Builder

Symbol Builder



- SVG Editor
- Line Symbol Editor
- Color Profile Editor

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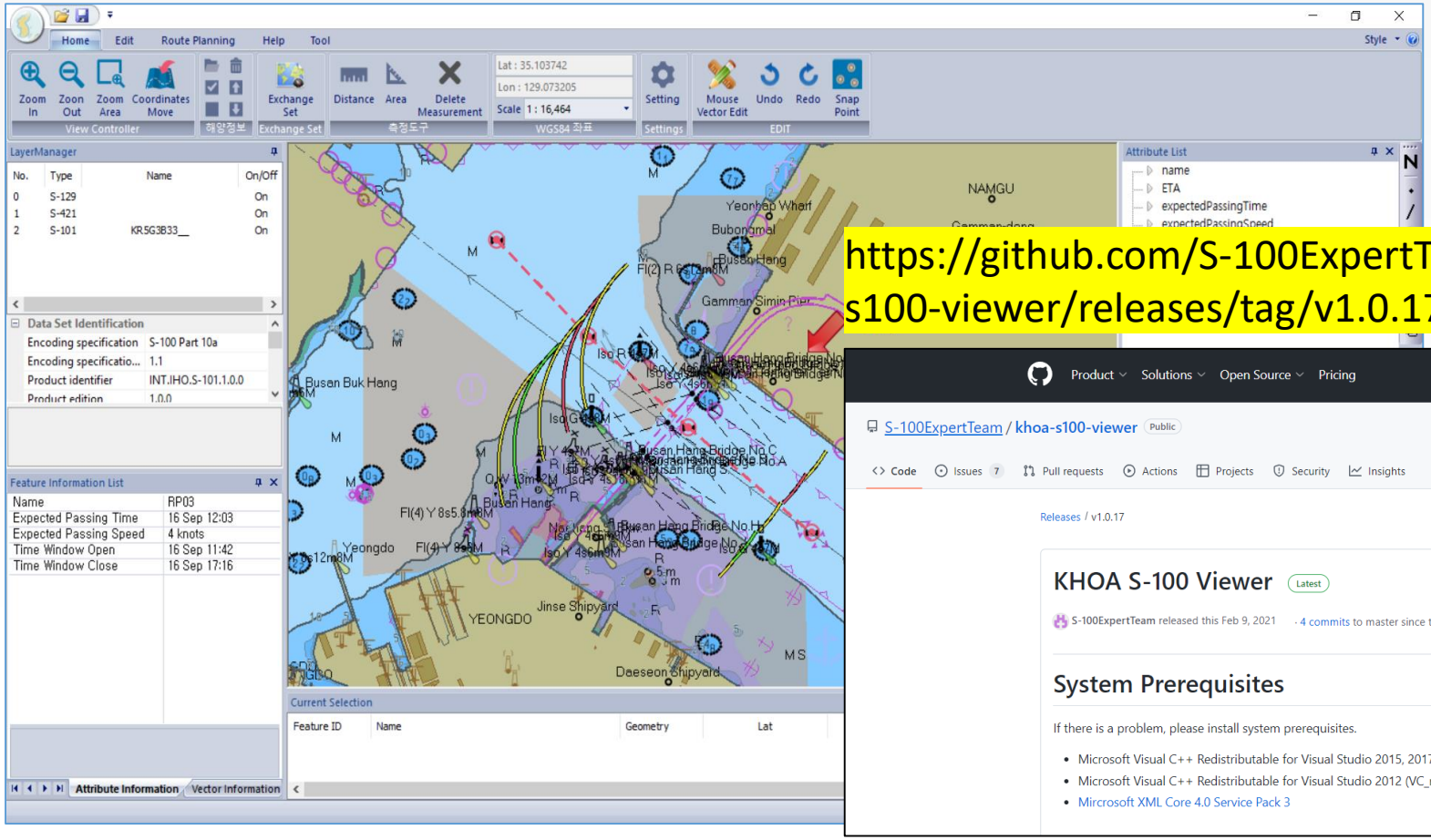
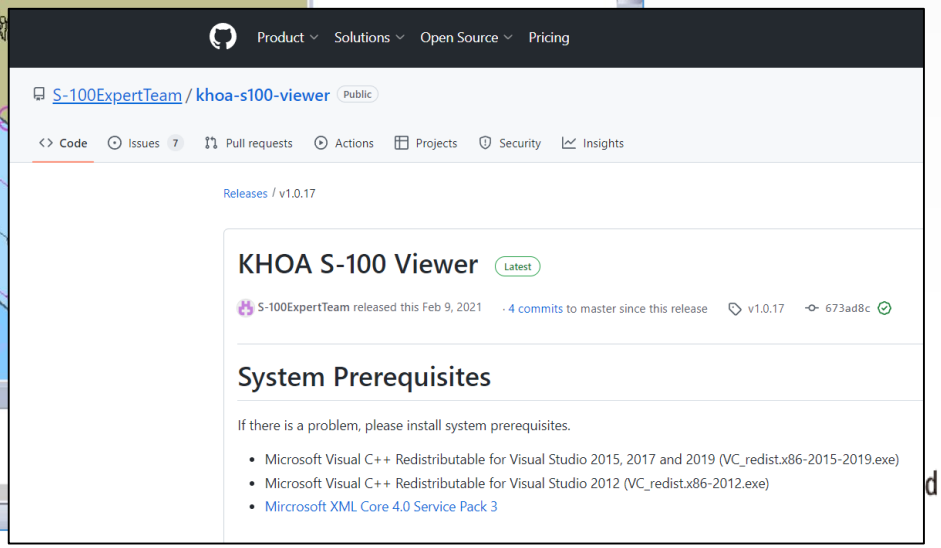
02 Status

- **Technical support to IHO S-100 development**
  - KHOA S-100 Viewer
    - Developed to test the S-1XX TDS and Catalogues (FC/PC)
    - Support S-101, S-102, S-111, S-122, S-124, S-123, S-127, S-129

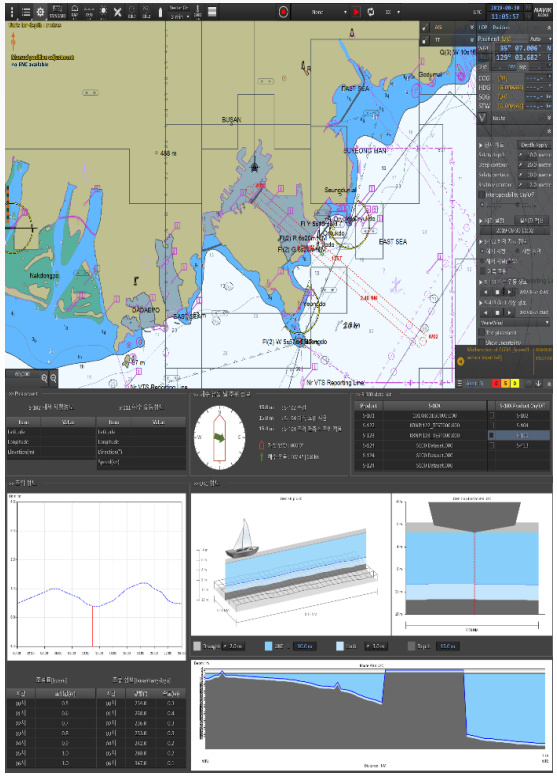


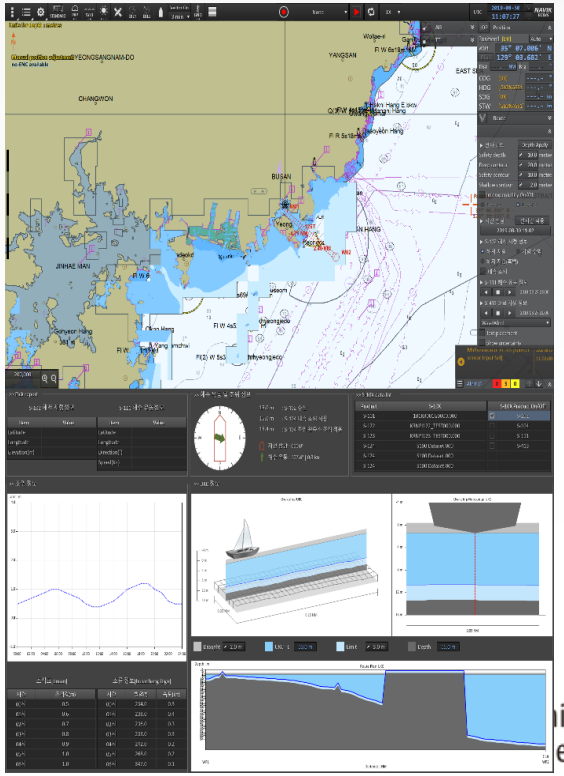
https://github.com/S-100ExpertTeam/khoa-s100-viewer/releases/tag/v1.0.17



02 Status

- **Technical support to IHO S-100 development**
  - Shore based ECDIS / Full ECDIS
    - KHOA has been developed to support the S-100 test framework
    - The shore based ECDIS was used to test various TDS in sea trial
    - Support S-101, S-102, S-104, S-111, S-122, S-123, S-124, S-127, S-129
    - DF-mode, WLA(Water Level Adjustment) tested



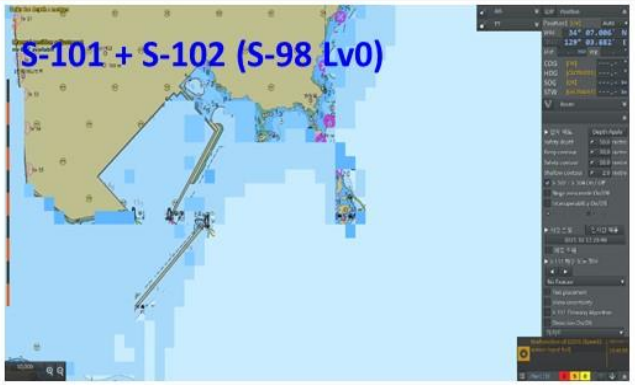


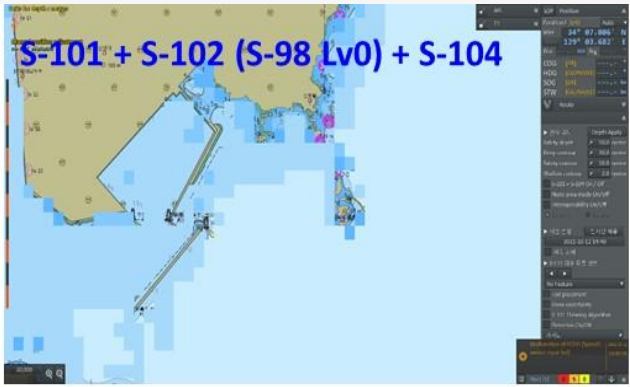
- **Technical support to IHO S-100 development**
  - S-100 Testing Center
    - The S-100 testing center was built with the FMB(Full Mission Bridge) Ship handling simulator
    - The TDS and PS(Product specification) were tested in simulated environment

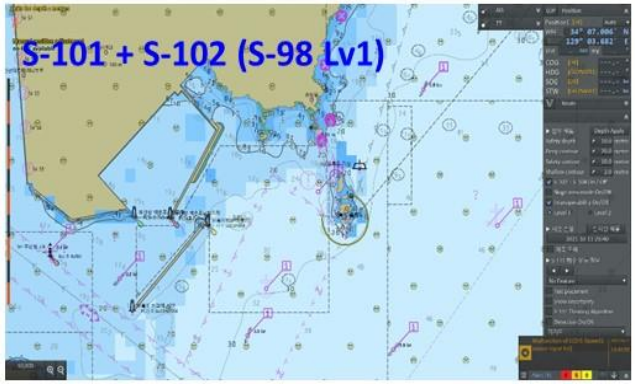
02 Status

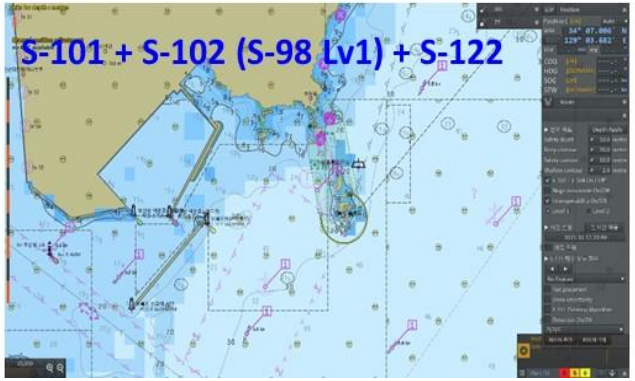
- **Decision C5/60**
  - The Council noted the approach proposed by the KHOA-NOAA S-100 Testbed project to measure the efficiency quantitatively for the use of S-100 data service and
  - invited Member States to join the project and suggest other quantitative measures (safety of navigation, efficiency) as appropriate
- **S-100 testbed project in 2022**
  - Technical issues of S-100
    - S-98 Interoperability
    - DF-mode in S-100 testbed system
    - Up-to-dateness of S-100 data using the S-128 dataset
  - Usability of S-100 service
  - Economic efficiency test of S-100 service

- **Technical support to IHO S-100 development**
  - **(Technical issues)** S-98 Interoperability
    - ROK-US joint project is improving the S-98 IC (Interoperability Catalogue)

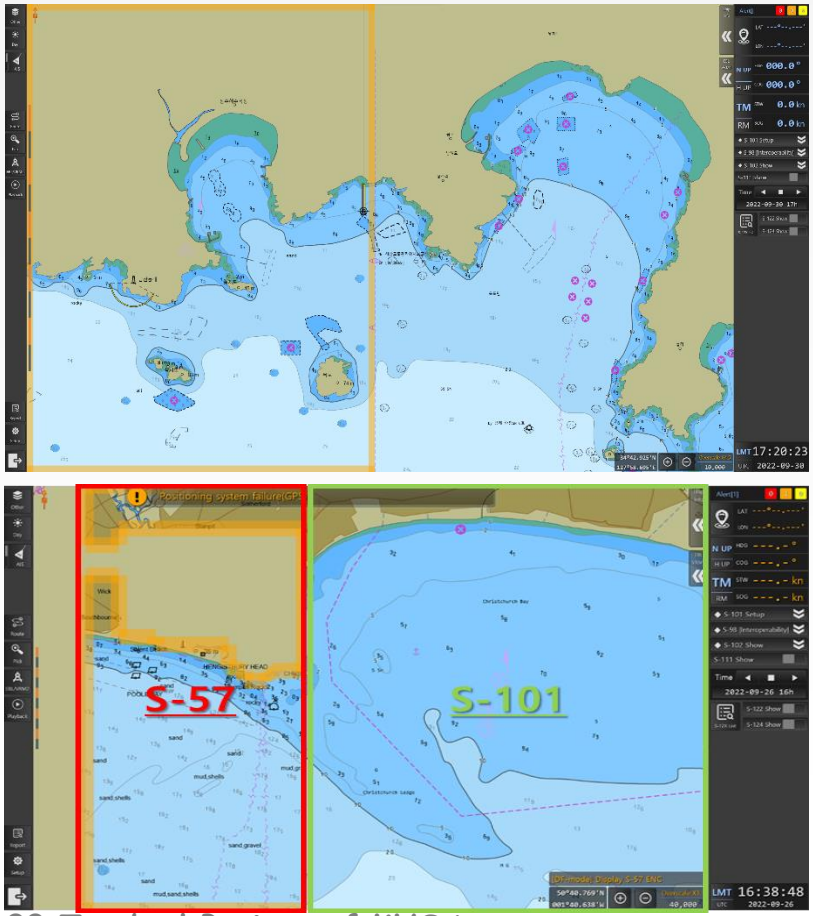








- **Technical support to IHO S-100 development**
  - **(Technical issues)** DF-mode in S-100 testbed system



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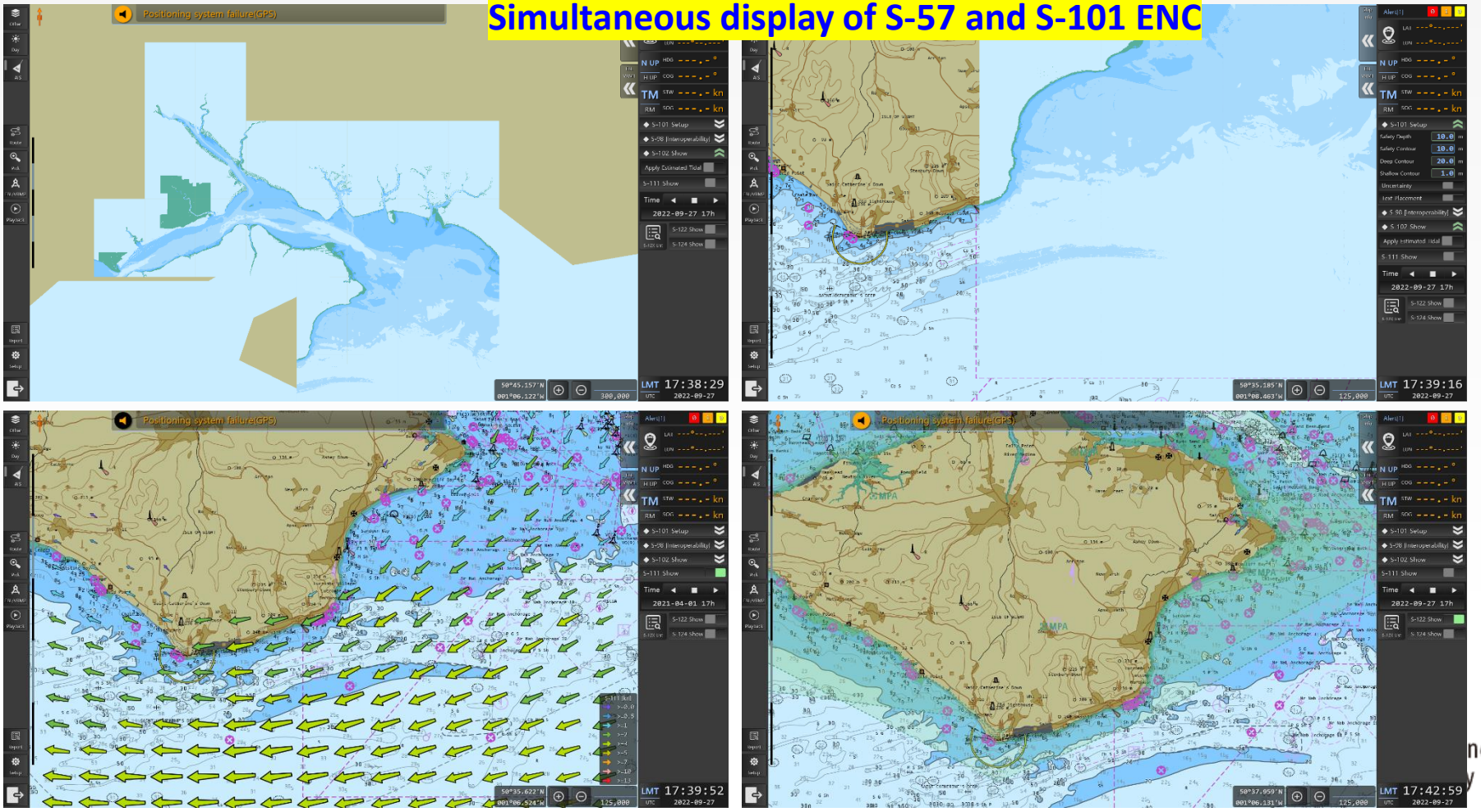
02 Status

- **Technical support to IHO S-100 development**
  - **(Technical issues)** DF-mode test using the UKHO dataset

UKHO contributed their S-100 based data sets for DF-mode test
Simultaneous display of S-57 and S-101 ENC



- **Technical support to IHO S-100 development**
  - **(Technical issues)** S-100 data update report using S-128 dataset

S-128 CNP Dataset of Week N

Process for verifying the up-to-dateness using S-128 S-100 data update status report

S-57/S-10X Product Management system

S-57 ENC
S-101 ENC
S-102 Bathy surface grid
S-104 Water level
S-111 Surface current
S-122 Marine protected area
S-123 Radio signal
S-127 Traffic Management

Week 1

Exchange set

Discovery Metadata

S-57 products

S-10X products

Week N

Update Number
Issue Date

ECDIS update status reports

NIPWG-VTC01-07.5.1A

02 Status

- **Technical support to IHO S-100 development**
  - **(Technical issues)** S-100 data update report using S-128 dataset

[Revised Form]

Report Name: Electronic Navigational Charts (ENC) Update Status Report

Vessel Name:

Identifier:

Update Reference Date: (from S-128)

Date of Report:

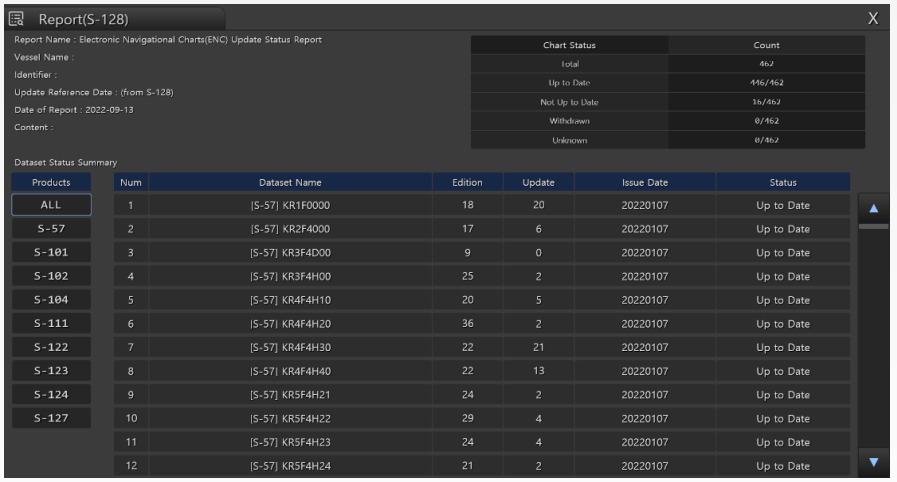
Content: Filtered for Route Plan "Goteborg – Kiel"

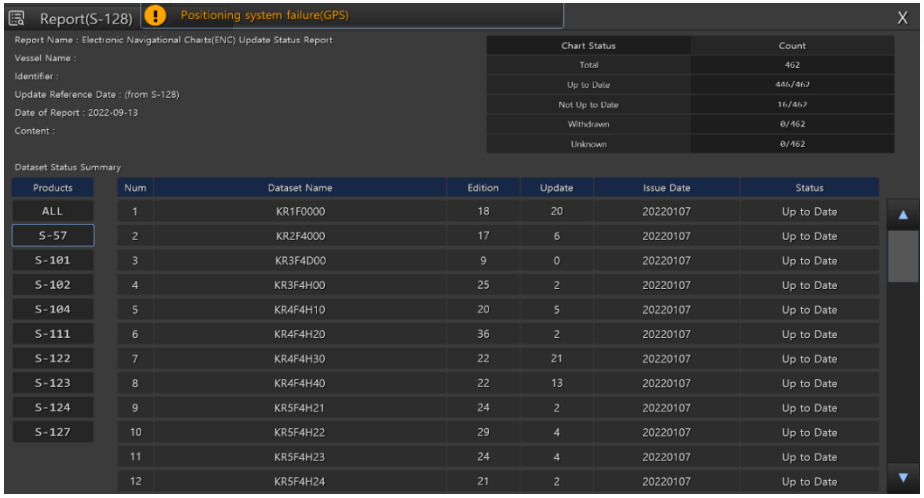
Start WP:

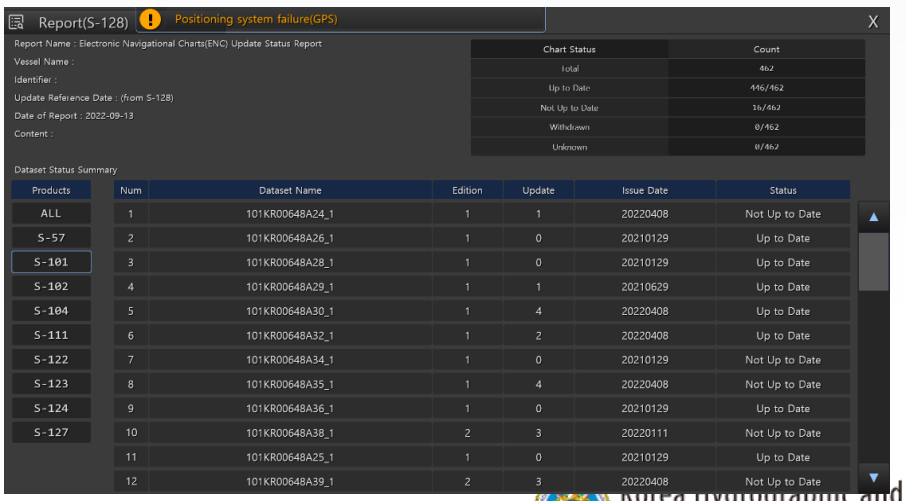
End WP:

Dataset Status Summary

Data Server: XXXX					
Product	*Dataset Name*	*Edition*	*Update*	*Issue Date*	*Status*
S-101	*101US23495820*	*10*	*4*	*2020-01-02*	*Up to Date*
S-102	*102US29348021*				







- **Technical support to IHO S-100 development**
  - Measuring the efficiency of S-100 data services
    - Traditional products(S-57 ENC and NPUB) vs S-100 data service
    - Quantitatively, measure usability levels for two types products

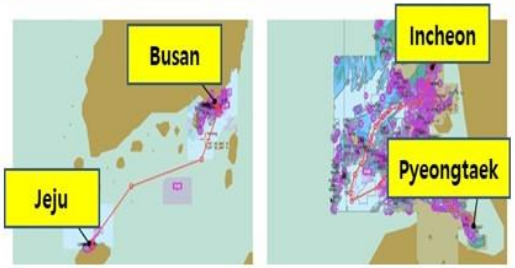
Test condition

- Conducted for 10 mariners with more than 3 years of navigation experience
- Testing procedure: Assignment of voyage planning missions with different levels of difficulty between "Busan↔Jeju" and "Incheon↔Pyeongtaek" routes. (4 courses in total)

Test equipment

Test scenario

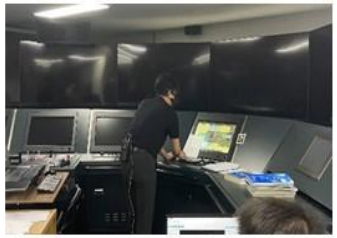
- Task 1. Update of nautical products
- Task 2. Navigational warning
- Task 3. Route planning
- Task 4. Check the surface current
- Task 5. Confirmation of route and save



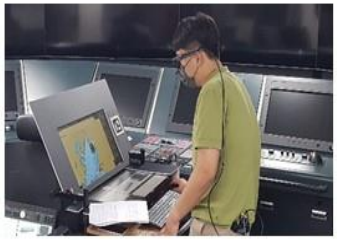
- **Usability evaluation**
  - Qualitative indicators (for questionnaire survey)
  - Quantitative indicators (for measuring eye movements)

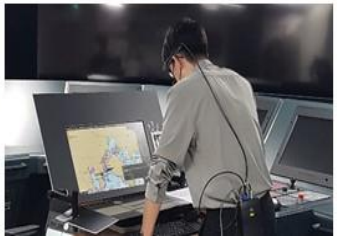
Evaluation indicators

- Qualitative evaluation indicators:
  Questionnaire for subjective discomfort (visual, control, total), 7 point scale for visual and control discomfort (from 1 for very comfortable to 7 for very uncomfortable)
  100 score scale for total discomfort
- Quantitative evaluation indicators:
  Utilization of eye tracking data to track eye movements during conducting each task by participants.







- **Summary of evaluation result**
  - The subjective discomfort level of the S-100 test bed system was small compared to the use of the traditional products.
  - The quantitative evaluation results (Duration Time, Number of Fixation, Number of Saccades) of the S-100 test bed system were excellent compared to the use of traditional products.
  - The usability of the S-100 test bed system provides a higher usability compared to the traditional products in updating nautical products, navigational warning, and checking surface current in arrival port.

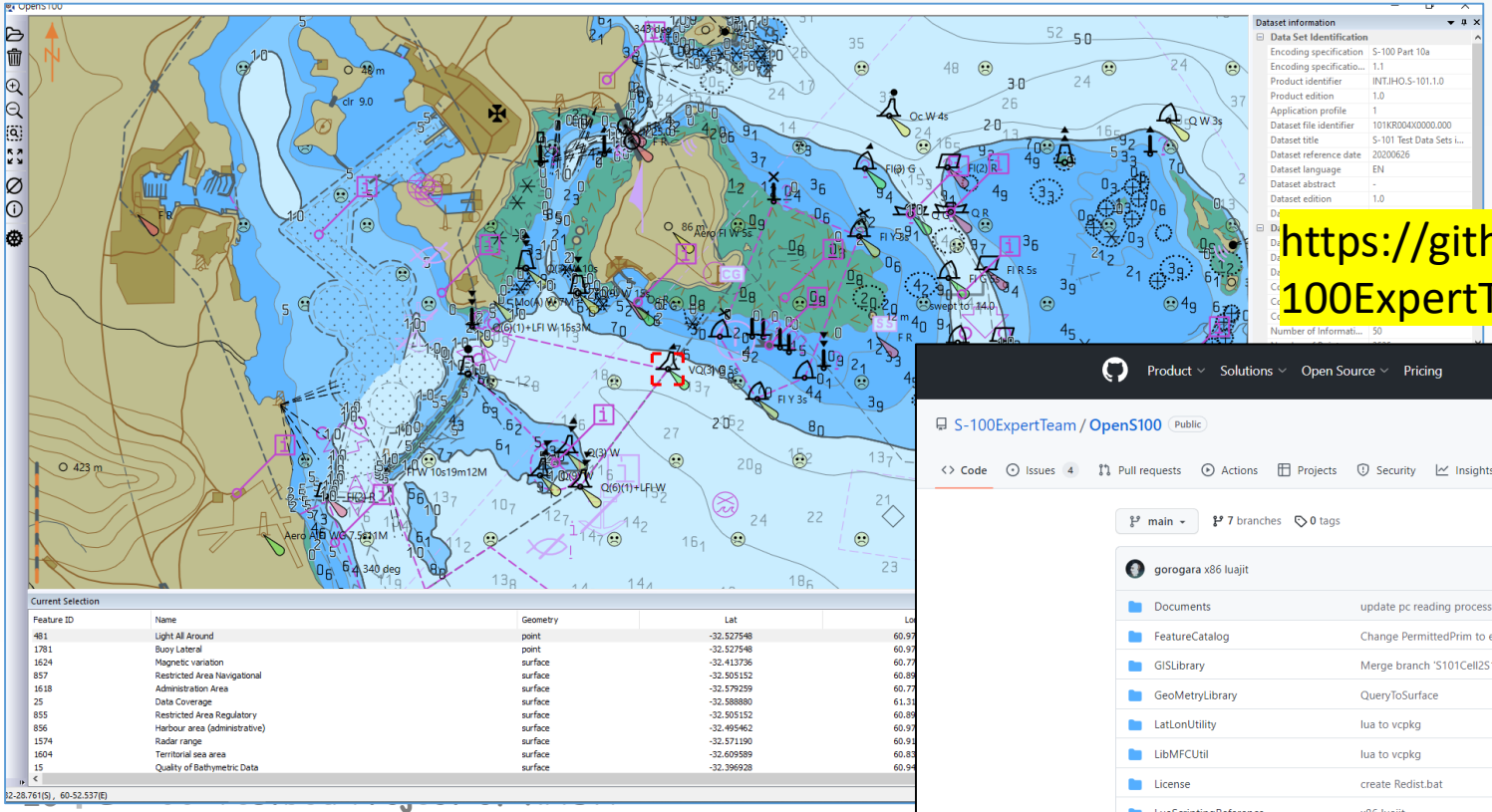
S-57 + Nautical publications

S-100 Testbed System

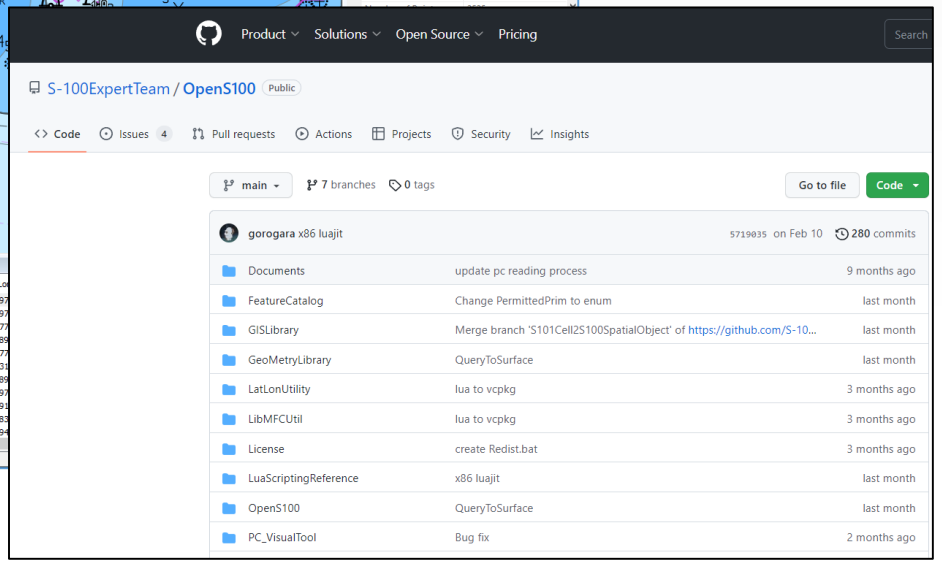
IHO - C6-07.7A INF

02 Status

- **Sharing platform of S-100 knowledge and resources**
  - Open source of KHOA S-100 Viewer
    - Developed to support SW developers
    - Aiming to improve it for S-100 Ed 5.0 and S-101 2.0

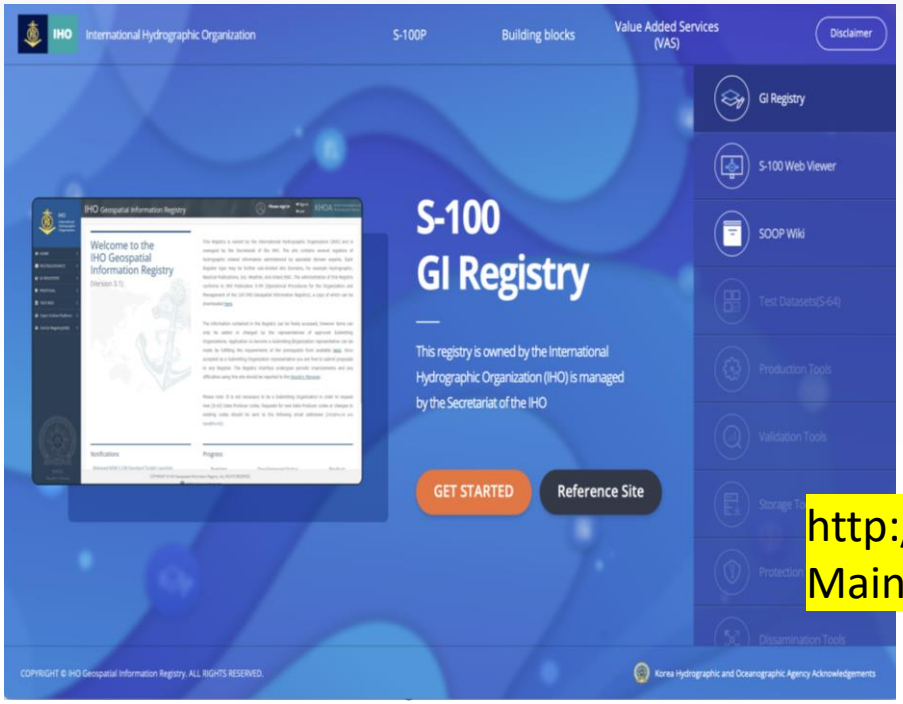


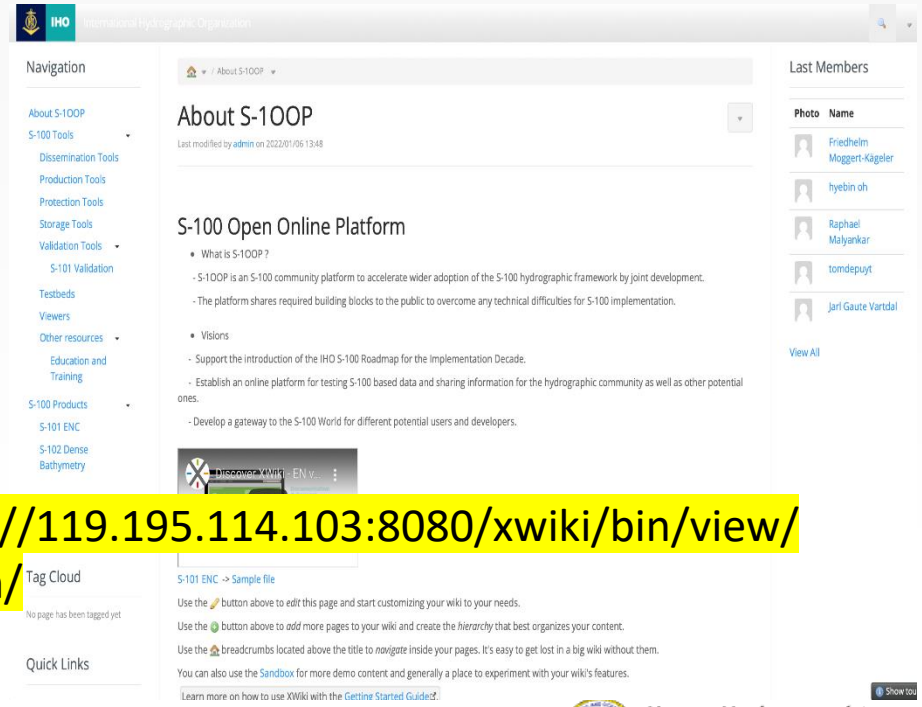
https://github.com/S-100ExpertTeam/OpenS100



02 Status

- **Sharing platform of S-100 knowledge and resources**
  - S-100 Open Online Platform
    - Web Community to Support S1OOP Project
    - Share S-100 related data, tools, technology, etc. released in Building Blocks (10 Blocks including Validation, Protection, Data Viewing etc)
    - Wiki for discussion support for various topics of S1OOP activity





http://119.195.114.103:8080/xwiki/bin/view/Main/

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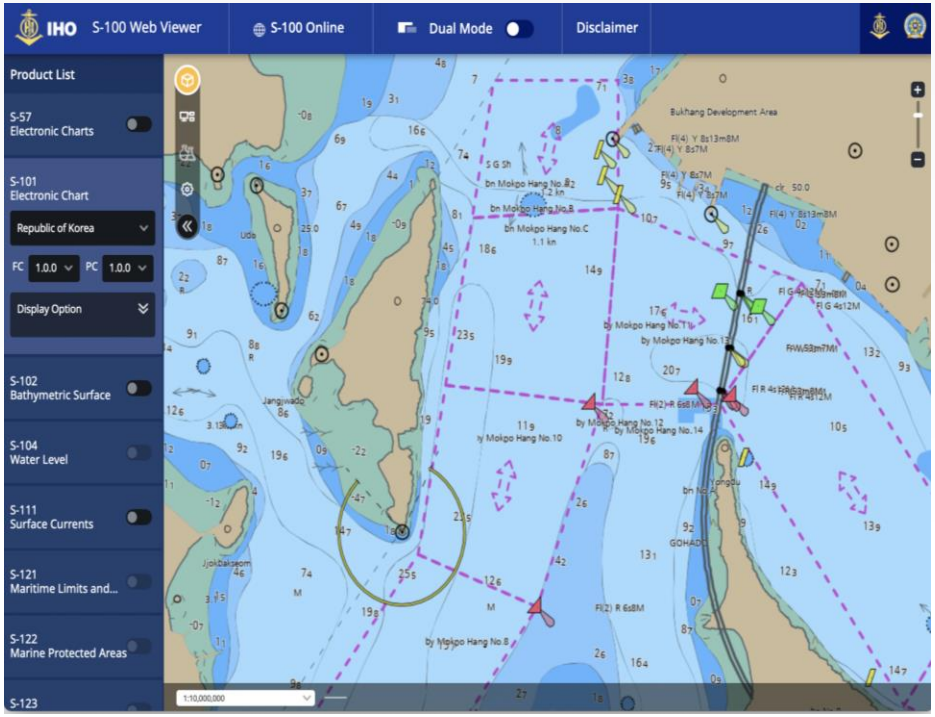
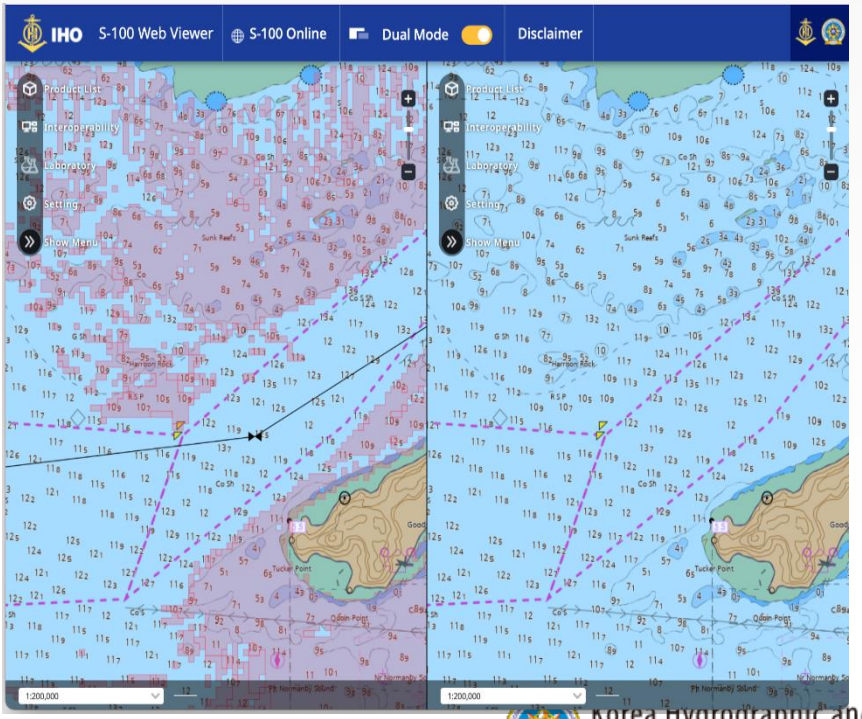
02 Status

- **Sharing platform of S-100 knowledge and resources**
  - S-100 Web Viewer
    - Support to simultaneously test data from the S-100 products being developed
    - Based on S-101 ENC, overlap or compare other S-100 products
    - Plan to expand various S-100 products and S-98





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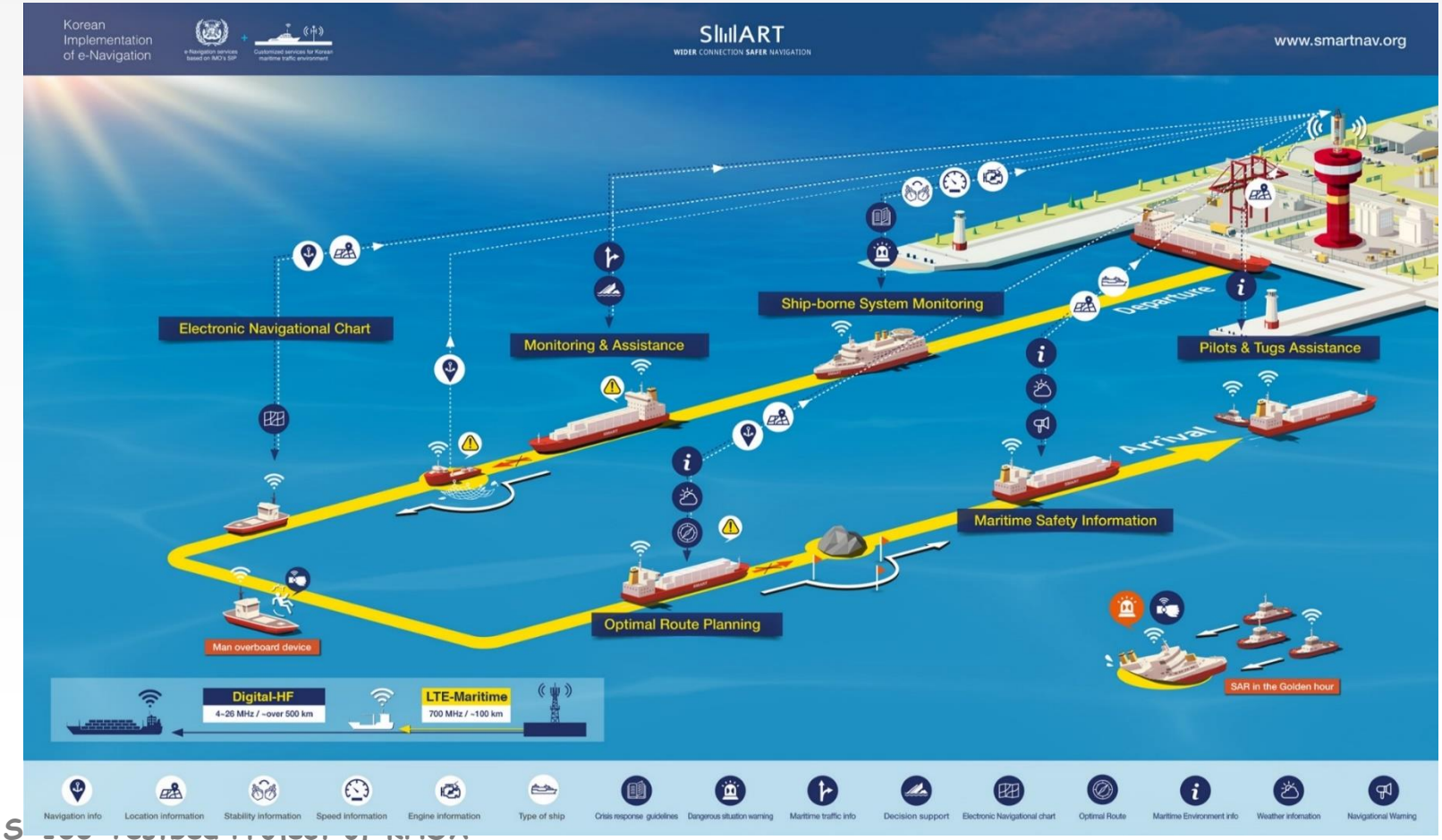
- S-100 data service for domestic e-Navigation project
  - S-101, S-102, S-104, S-111, S-122, S-123, S-127



- **S-100 data service for domestic e-Navigation project**
  - S-101, S-102, S-104, S-111, S-122, S-123, S-127

ID	Service	Target Vessels	Communication Method
WP1 (NAMAS)	SV1-Navigation Monitoring & Assistance Service	Vulnerable vessels	LTE-Maritime VDES/D-HF
WP2 (SBSMS)	SV2-Ship-borne System Monitoring Service	Korean passenger ship (Domestic/International) Upon request	LTE-Maritime VDES/SAT
WP3 (SORPS)	SV3-Safe & Optimal Route Planning Service	Korean passenger ship (Domestic/International) Upon request	LTE-Maritime VDES/SAT
WP4 (REDSS)	**SV4 – ENC Distribution & Streaming Service for Non-SOLAS Vessel**	Domestic Costal vessel	LTE-Maritime
WP5 (PITAS)	SV5-Pilot & Tugs Assistance Service	Pilots and Tugs	LTE-Maritime
WP6 (MESIS)	SV5-2-Maritime Environment and Safety Information Service	Upon request	LTE-Maritime VDES/D-HF/SAT

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- **S-100 data service for domestic e-Navigation project**
  - ECS performance standard

ECS Standard for SMART Navigation

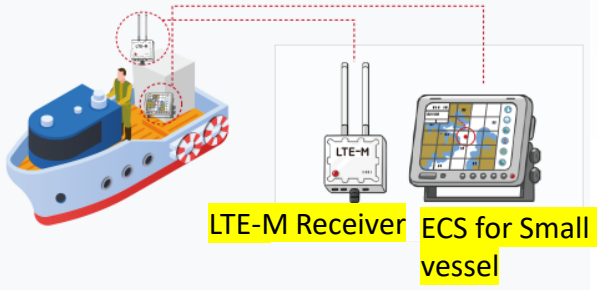
This Standard specifies the minimum operational, performance and technical requirements and methods of testing for SMART Navigation compliant ECS

- IEC 60945 (General requirements)
- IEC 61174 (ECDIS requirements and testing method)
- Class B level of ECS and Additional Requirements
- IEC 62288 (Presentation of navigation related info)
- IEC 61162-1, 61162-2 (Digital interfaces)

ECS

DATA	S-101 ENC S-10X data E-Navigation service data
Standard	Environmental tests Interface tests Performance tests

S-101 and S-10X datasets	SMART Navigation Service Based on S-100	Interoperability Requirement	LTE-M Router Interface
▸ S-101 ENC ▸ S-104 Water level for Navigation ▸ S-111 Surface Current ▸ S-124 Navigational Warnings ▸ S-12X Nautical Publications	▸ Message service for collision and grounding accident ▸ Optimal route planning service ▸ ENC service ▸ Marine information service	▸ Interoperability catalogue ▸ Files describing how an ECS must combine data products conforming to different product specifications for display purposes	▸ Define the digital interfaces to link to the LTE-M Router



- **Composition of national S-100 committee**
  - Various national stakeholders
    - maritime administrations, research institutes and industry in the fields of nautical publications, aids to navigation, e Navigation and marine weather
  - Regular meetings, ad hoc meetings and seminars
- **Activities**
  - share the status of the development of S-100 standards,
  - actions nationally executed by domestic organizations,
  - product distribution connections between organizations
  - other S 100 related topics from international meetings

- **Composition of national S-100 committee**
  - Understand the progress on the development of different standards and create an opportunity to encourage discussion and cooperation.
  - A plan for cooperation among different fields
  - If there are other IHO MSs who run similar committees,
  - it would be useful to share such activities so that many MSs can make preparations for the implementation of S-100.

03 Stakeholders

- **S-100 GI Registry and tools**
  - IHO secretariat, WG and PT, PS developers
- **S-100 Testing System (Viewer and ECDIS)**
  - S-100 dataset producers
  - S-100 SW developers
  - S-10X product specification developers
- **Sharing platform of S-100 resources**
  - Anyone who wants to know and use S-100
  - S-100 SW developers for open source code
- **Domestic e-Navigation Project**
  - Small vessel, Fishery vessel, On-shore service provider
- **National S-100 committee**
  - Aton domain, Hydro domain, VTS domain, MASS domain, Shipping and harbor logistics domain, e-Navigation domain, etc

04 Challenges

- **S-100 GI Registry and tools**
  - GI Registry has been stable, but S-100 tools need to be updated based on S-100 5.0
  - Difficult to support every requirements for S-100 tools like commercial software
  - S-100 Tools need to be harmonized and focused for maintenance
- **Production of S-100 data for e-Navigation service needs**
  - The version of S-10X FC is various
  - The workflow of S-10X data production was not harmonized
  - Validation rule and process is not ready
  - Existing production system does not support S-100 5.0
- **S-100 Test System (Viewer and ECDIS)**
  - The standards development like S-10X 2.0 and S-164 is still ongoing
  - Stakeholders don't know the KHOA Viewer well
  - Difficult to meet whole improvements of S-100/S-98 discussed by S-100WG, TSM and WGs

04 Challenges

- **Sharing platform of S-100 resources**
  - S100P project was not active, Open S-100 is not well known
  - WIKI pages need to be updated and require more active involvement
  - Online viewer aims to share S-100 testing data, but Copyright issues were discussed, and data sharing was not actively pursued
- **Domestic e-Navigation project**
  - The S-100 data have been produced according to the specific version of S-10X PS (Edition 1.x.x) which is not the operational version
  - Machine readability and Plug and Play concept was not fully introduced
  - Interoperability and S-98 was not introduced strictly
  - When the operational versions are ready, the e-Nav service needs to be updated
- **National S-100 committee**
  - Non-hydro domains understood the benefits of S-100, but no action
  - Need to explore what specific co-operations are needed
  - More demo and training on S-100 is required to the Non-hydro domain

05 Project management

- **Management of KHOA project**
  - Managed on an annual basis
  - Most activities are related to IHO's S-100 development and the results of each activity are reported as an agenda at IHO meetings
- **GI Registry and S-100 Tools**
  - Works with IHO Secretariat closely
  - Updates of S-100 tools reports S-100WG and TSM
- **S-100 Testing System (KHOA Viewer and ECDIS)**
  - Update major improvements like S-98/S-128/DF-mode
  - Research on measuring the efficiency of S-100 data service
  - Report to HSSC and Council meetings
- **Cooperation platform**
  - VTC, Ad-hoc meeting for each topics
  - Report to S-100WG, HSSC, WGs

06 Lessons learnt

- **S-100 implementation plan**
  - S-100 ECDIS is legal from 2026 and mandatory for new system from 2029
  - Production of S-100 data service should be adjusted based on the operational versions of S-1XX PS
  - Workflow should be harmonized to produce S-10X products
  - Considering the S-100 implementation plan, most mariners don't know the S-100 well
  - Activities should be done to ensure that stakeholder groups have a better understanding of improvements and benefits of S-100
- **Sharing information and resources**
  - S-100 testbed participants and IHO meetings attendees are limited
  - Lack of sharing and dissemination of S-100 knowledge and resources
  - Efforts to understand the benefits of S-100 and share related information are important

07 Recommendations

- **Use of KHOA S-100 testbed**
  - Invited to use KHOA S-100 Viewer and Open S-100 (Open source)
  - Provide any comments on the KHOA S-100 testbed project
  - Use the user feedback repository like Github for S-100 tools
  - Conduct the S-100 test project jointly
- **Sharing platform of S-100 resources**
  - Invited to join the S-100 Open Online Platform project
  - Share S-100 information and knowledge
- **National S-100 Committee**
  - Report to IHO meetings on the progress of national meetings
  - Share which cooperation can be conducted between different domains
  - S-100 implementation plan and e-Navigation strategy

THANK YOU

Korea Hydrographic and Oceanographic Agency