



# Enabling the Decade of S-100 Implementation

C.3 – IHO Secretariat, Monaco, 15-17 October 2019



IHO

# INTRODUCTION – S-100 THE IHO BUILDING BLOCKS

International  
Hydrographic  
Organization

- Provides the **data framework** for the development of the next generation Electronic Navigational Charting products, as well as other digital products required by the hydrographic, maritime and GIS communities





# IHO S-100 TODAY

International  
Hydrographic  
Organization

- Currently on Edition 4.0.0
- Approved Product Specifications

Product ID	Name	Version
S-101	Electronic Navigational Chart	1.0.0
S-102	Bathymetric Surface for Navigation	2.0.0
S-111	Surface Currents	1.0.0
S-122	Marine Protected Areas	1.0.0
S-123	Marine Radio Services	1.0.0
S-129	Under Keel Clearance Management	1.0.0



**IHO**

## **S-100 SHOWCASE TOPICS**

International  
Hydrographic  
Organization

- Canada – A Data Centric Approach
- Norway (PRIMAR) – S-100 Development and Distribution
- United States (NOAA) – S-111 Surface Currents Operationalization
- United States (NGA) – S-100 Test Bed Development
- Republic of Korea – S100 Web Viewer and Sea Trial



## **S-100 Showcase**

# **Canadian Hydrographic Service**

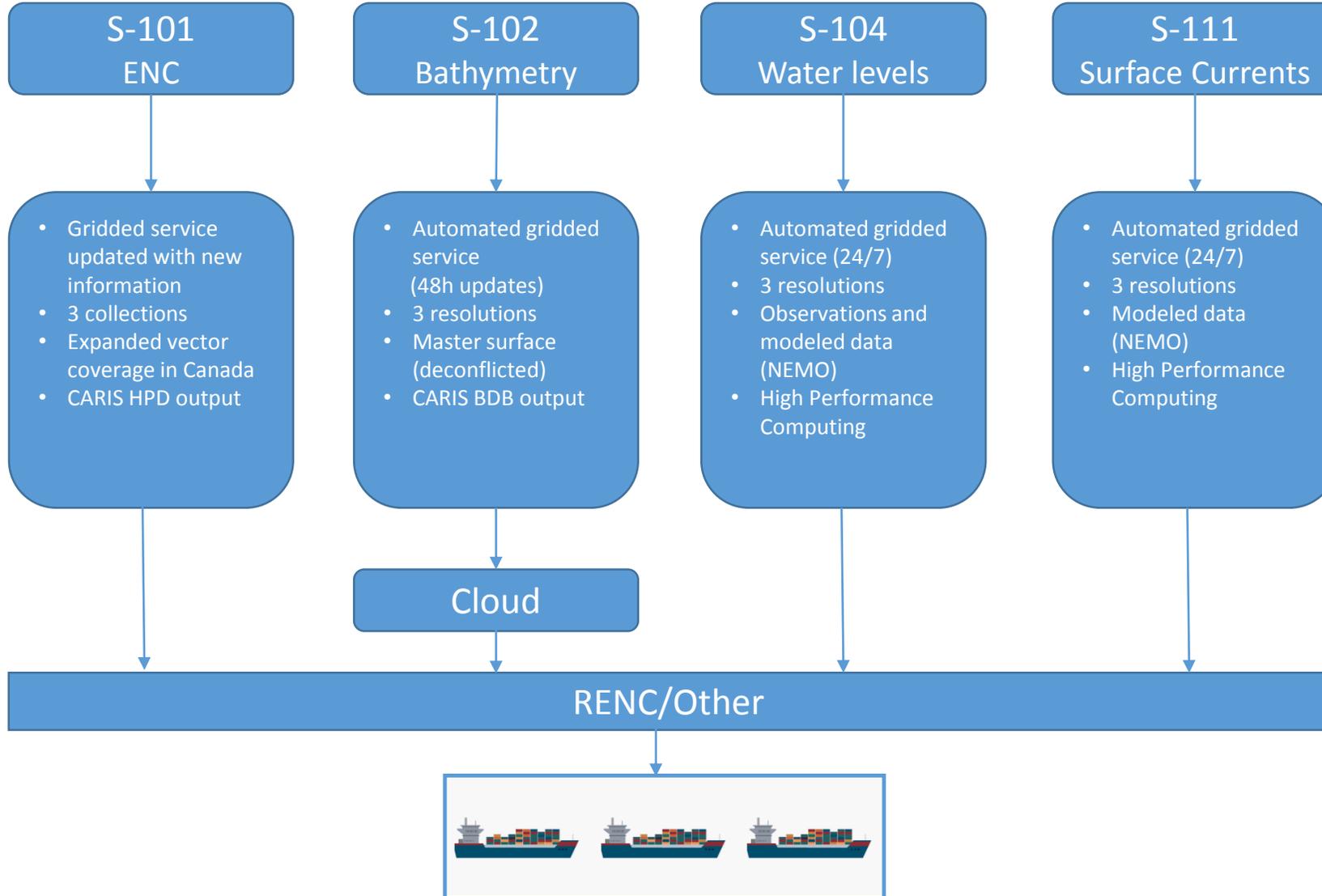
C.3 – IHO Secretariat, Monaco, 15-17 October 2019



IHO

# DATA CENTRIC APPROACH – S-100 OPERATIONAL

International  
Hydrographic  
Organization

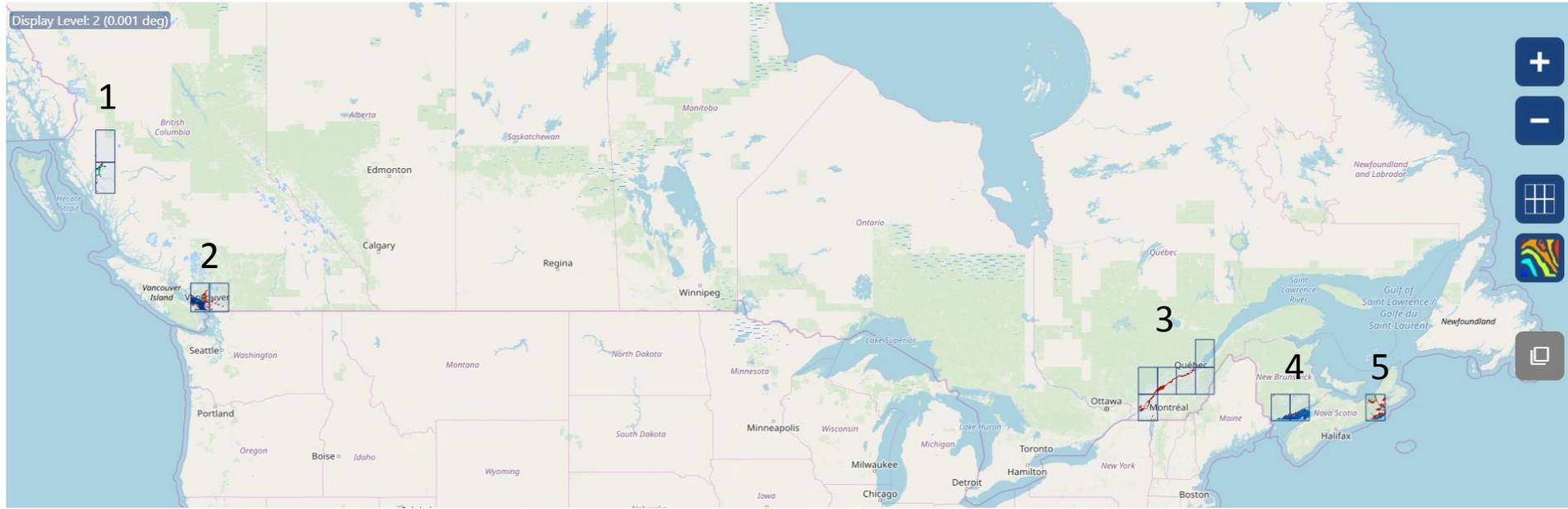




IHO

# KEY AREAS FOR HIGH RESOLUTION S-100 SERVICES

International  
Hydrographic  
Organization



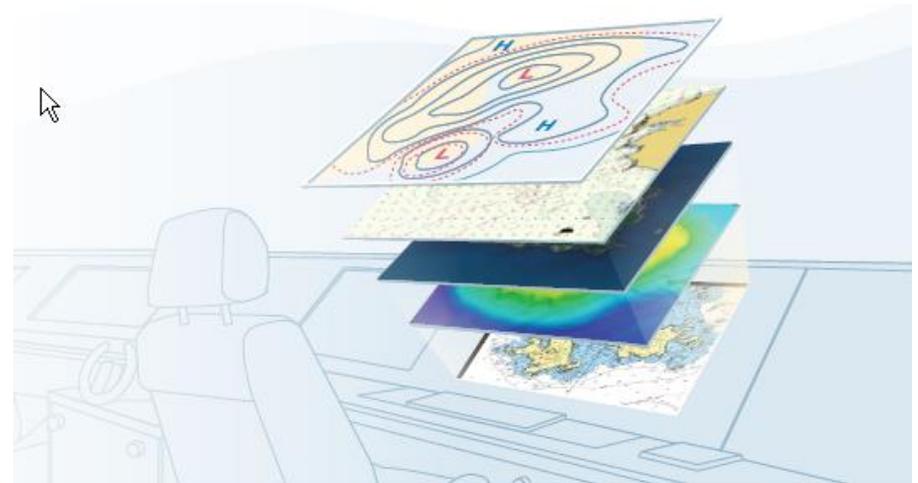
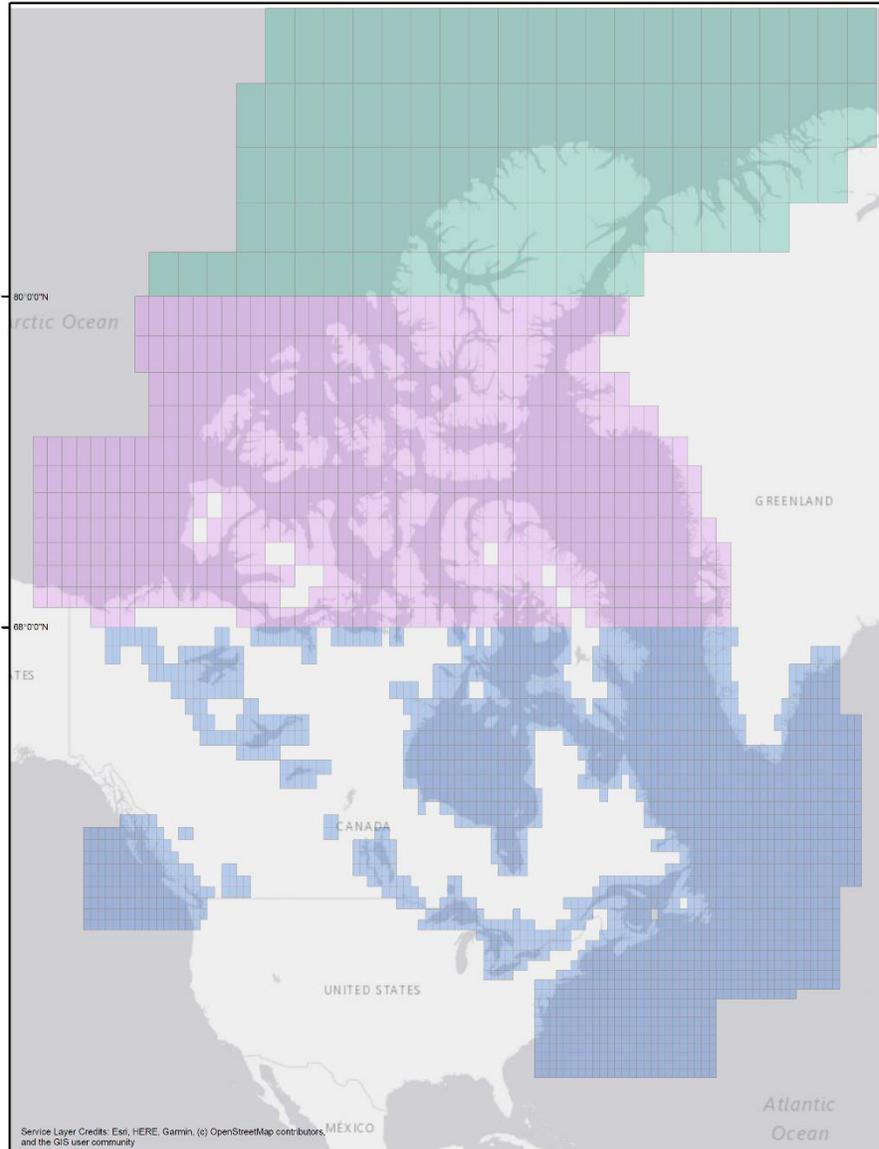
1. Kitimat, British-Columbia
2. Port of Vancouver and Fraser river
3. Saint-Lawrence River between Quebec City and Montreal
4. Saint-John, New-Brunswick
5. Port Hawkesbury, Canso Strait



IHO

# INTEROPERABLE DATASETS

International  
Hydrographic  
Organization

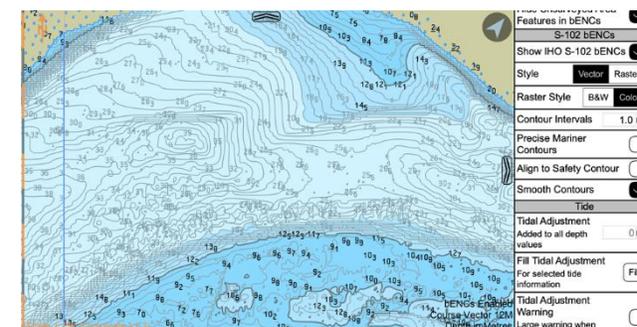
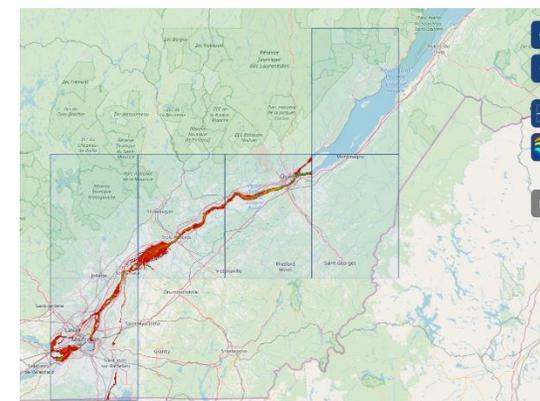
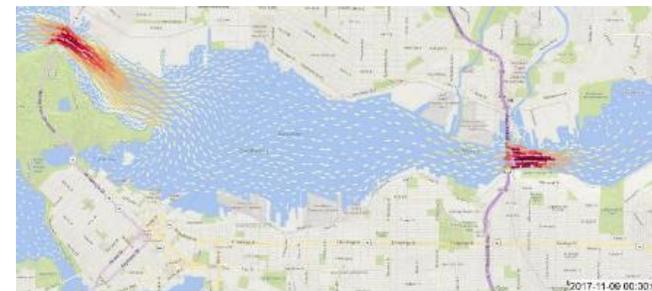




IHO

# S-100 ONGOING PROJECTS IN CANADA

1. Dynamic Hydrographic Products, started in 2017
  - Ocean protection plan (OPP) project (S-102, S-104, S-111)
2. CARIS-PRIMAR Project – Data dissemination project, started in 2018
  - User trials planned to start November 2019 to March 2020
  - Involves different type of users: Port authority, Pilotage authorities, and Waterways Management.
3. SealQ (PPU) development for S-102, started in 2019
  - Currently in trials, will last until end of March
4. International participation
  - KHOA S-100 Sea Trials, S-100 Standard and specification development





## **S-100 Showcase**

# **PRIMAR – S-100 Development and Distribution**

C.3 – IHO Secretariat, Monaco, 15-17 October 2019



# IHO PRIMAR S-100 PROJECTS

International  
Hydrographic  
Organization

1. Research project: S-102 Demonstrator (S-102 in an operational environment and PRIMAR S-102 Distribution Service).
2. S-102 Bathymetry Data Service in the Cloud (From survey to use within 24 hours)
3. Research project: S-100 Demonstrator (S-101, S-102, S-104, S-111, S-129).
4. PRIMAR S-57/S-101 Dual-Fuel Service Distribution



IHO

# S-102 DEMONSTRATOR

International  
Hydrographic  
Organization

## The Project Team



ELECTRONIC CHART CENTRE



KONGSBERG

## Partners & Operational Test Team



KYSTVERKET  
NORWEGIAN COASTAL ADMINISTRATION



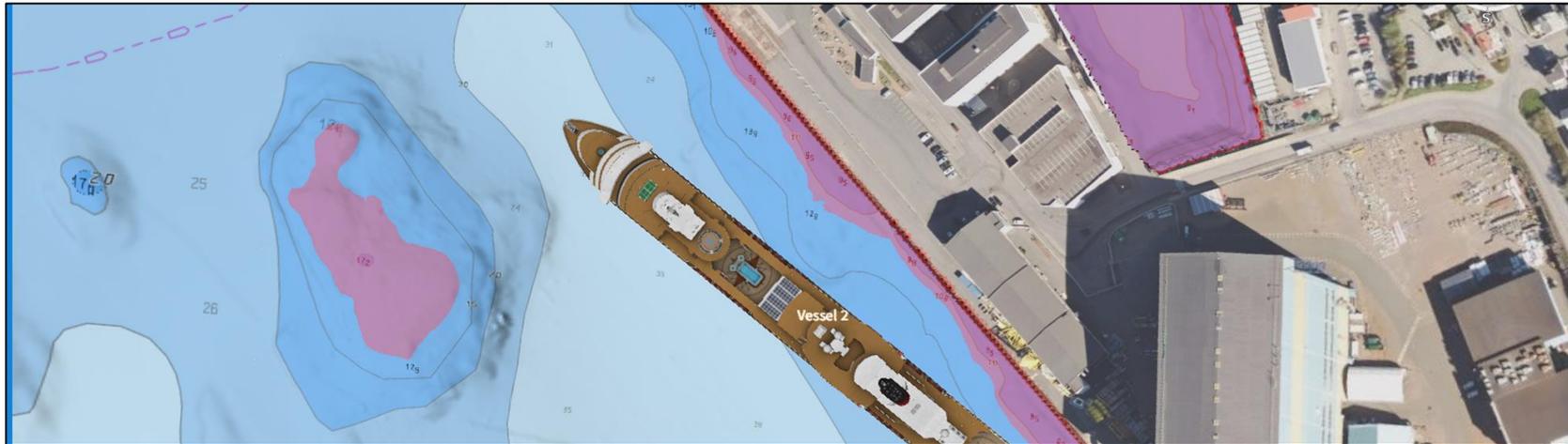
PRIMAR®



## Financial Support



With funding from  
The Research  
Council of Norway

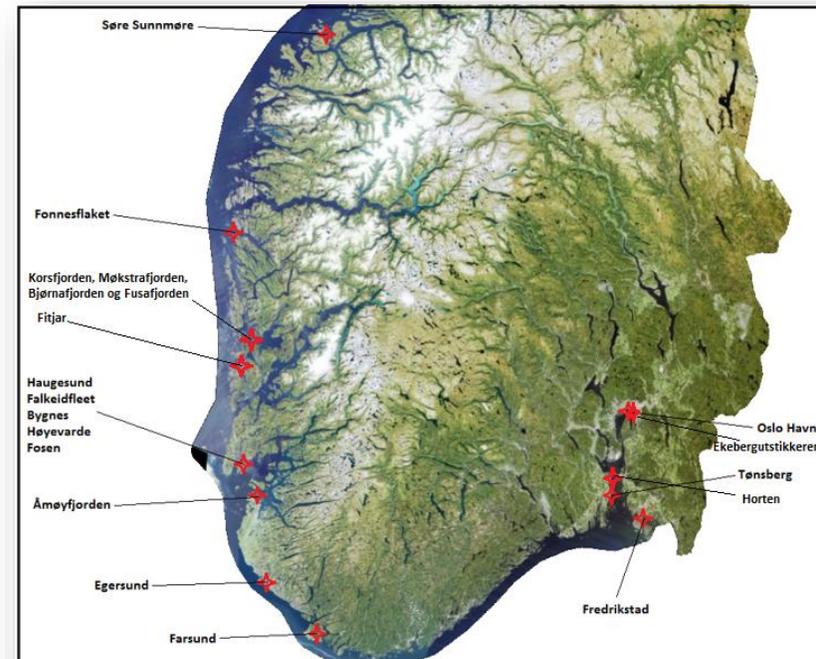




# IHO MAIN OBJECTIVES

International  
Hydrographic  
Organization

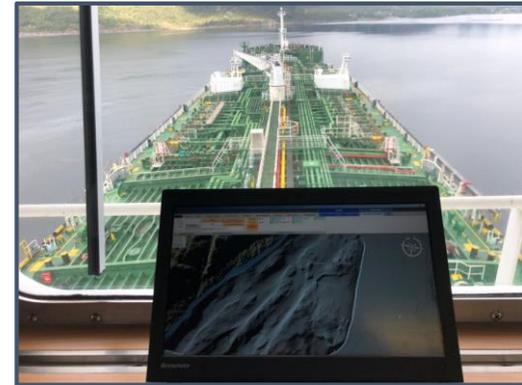
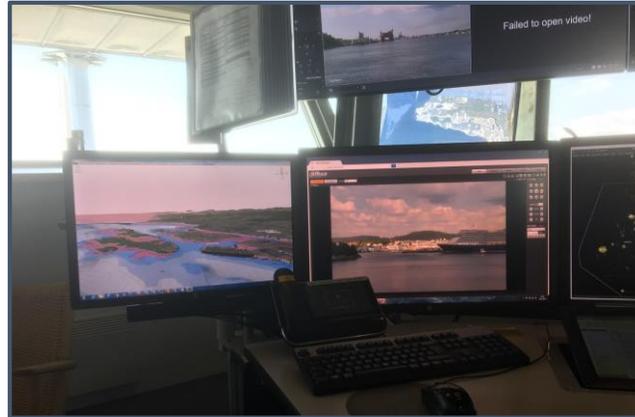
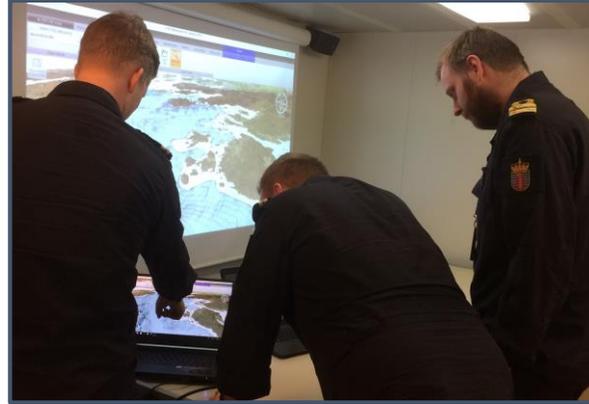
1. Identify distribution model.
2. Data production
3. Identify specific use cases and geographical locations.
4. Operational use through operational tests.
5. Develop a demonstrator.
6. Input IHO S-102 standardization.





# IHO OPERATIONAL TESTS

International  
Hydrographic  
Organization

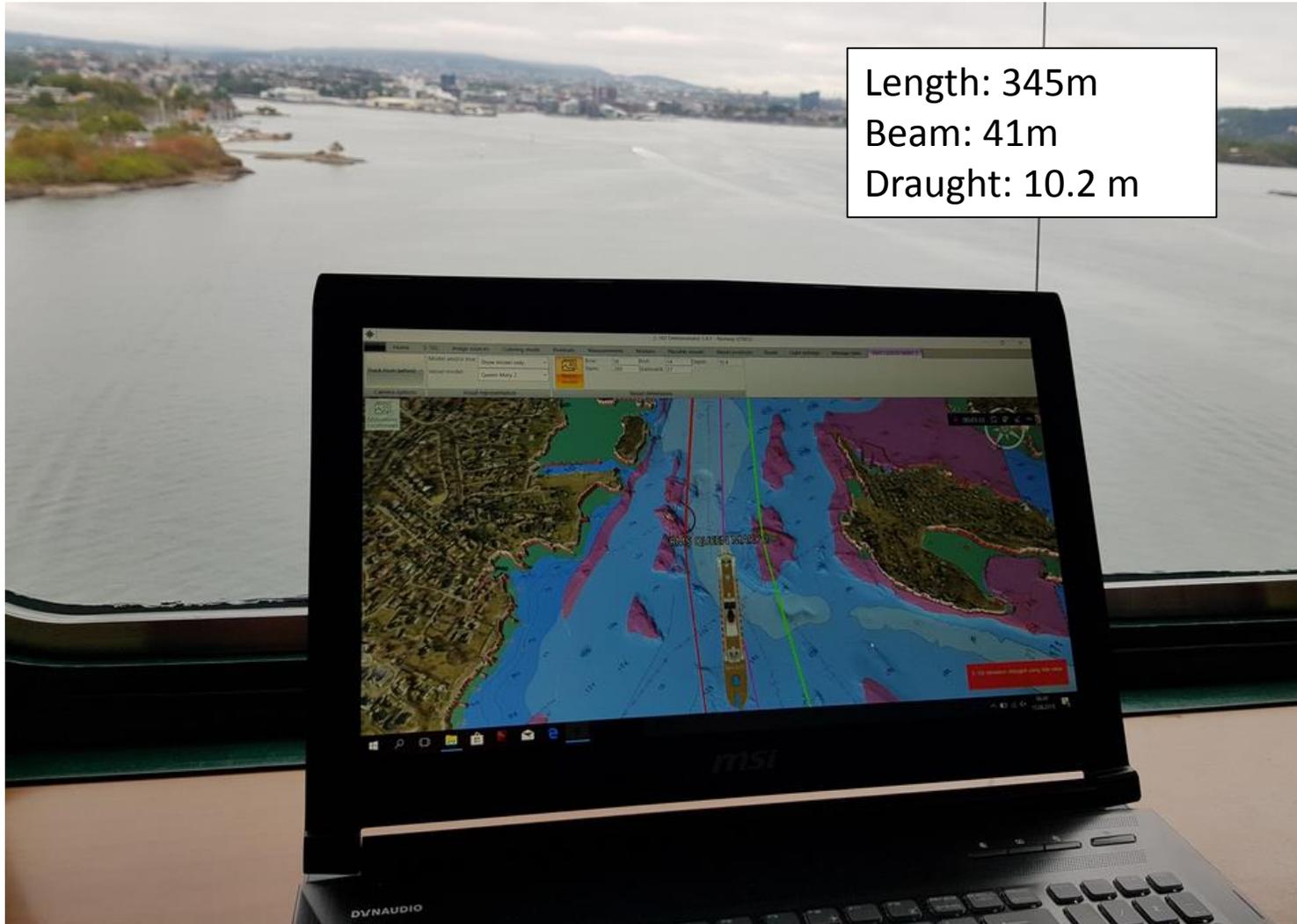




IHO

# Operational test 3

## 3. Pilot assignment – Approach of MS Queen Mary 2 to Oslo Harbour.

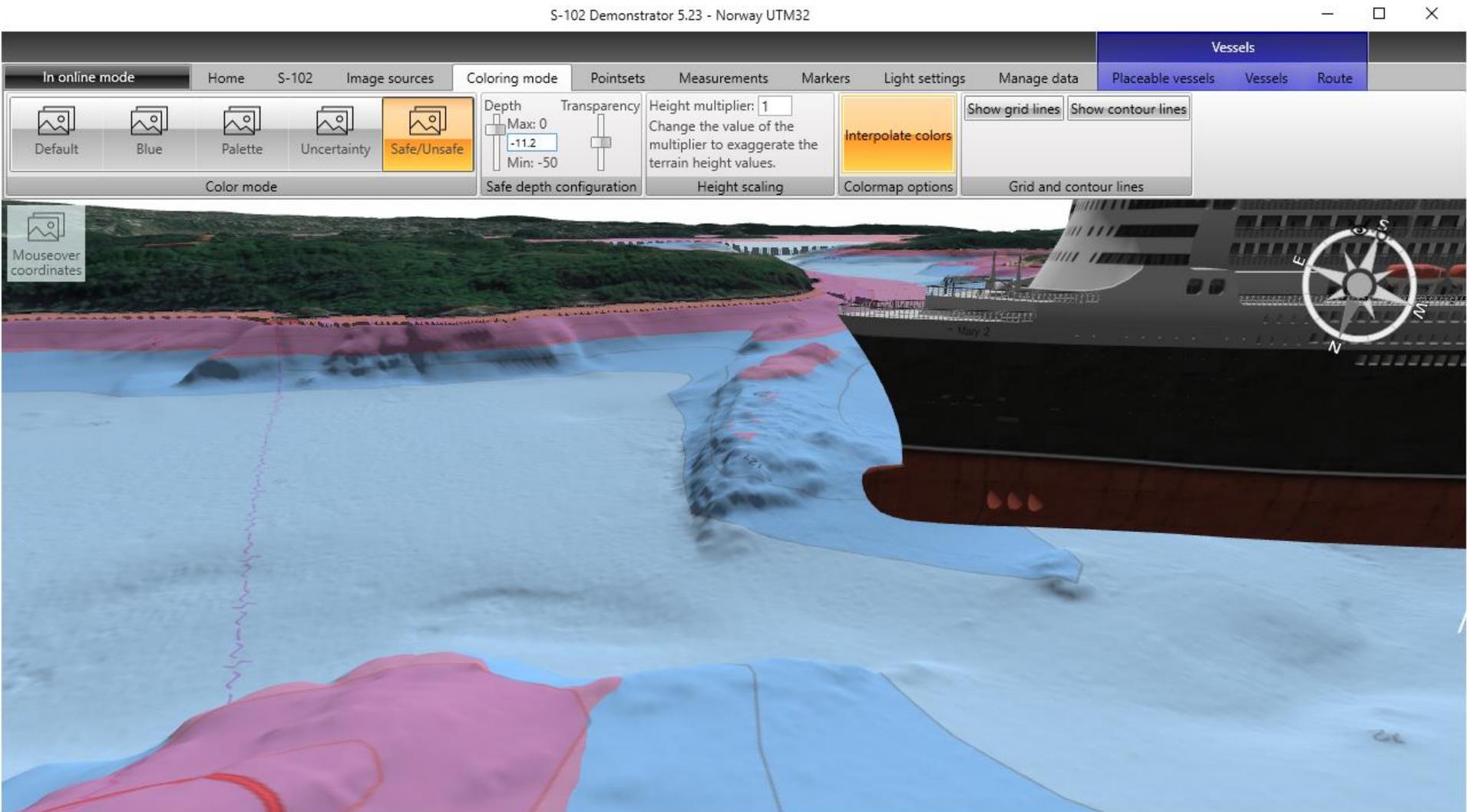




IHO

# Operational test 3

International Hydrographic Organization

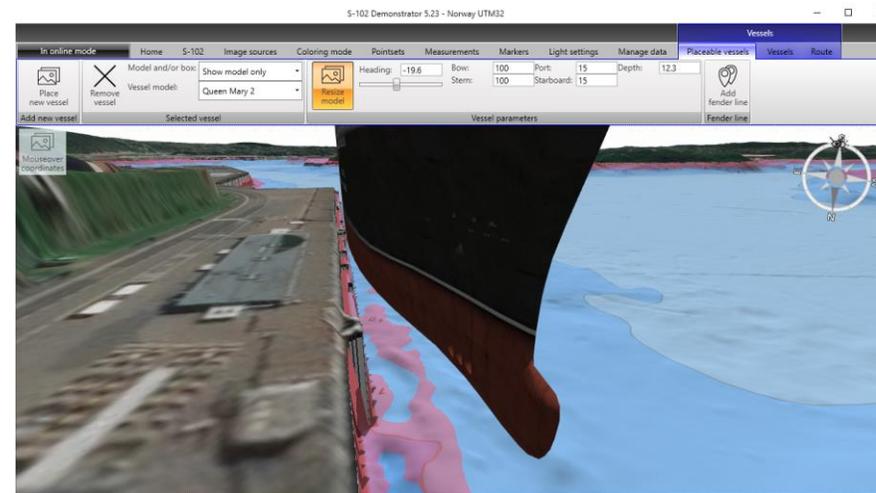
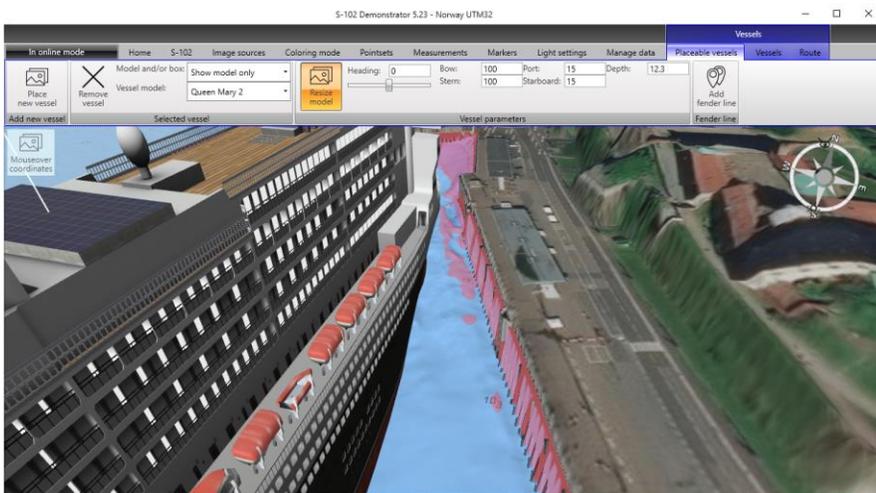
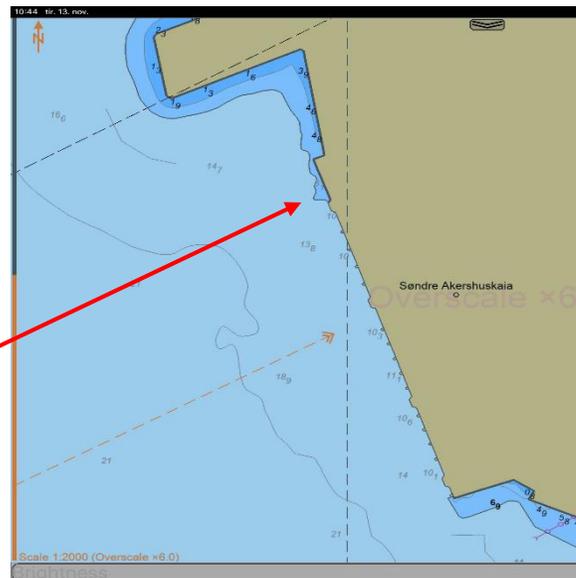
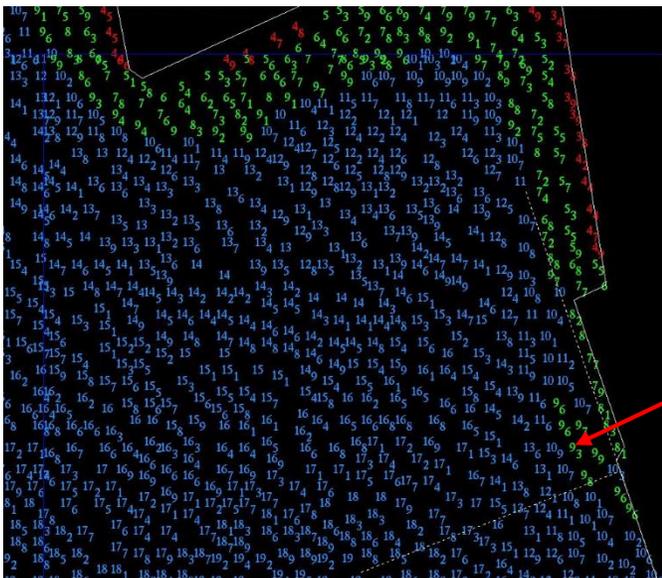




IHO

# Operational test 3

International Hydrographic Organization

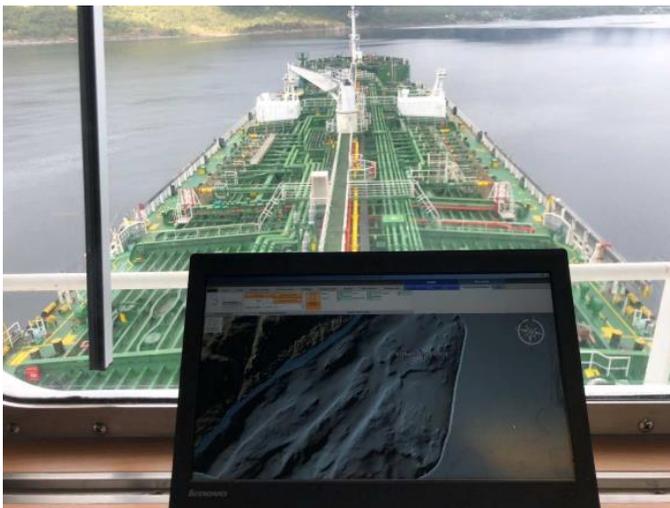




IHO

# Operational test 4

## 4. Pilotage assignment – Anchoring operations.

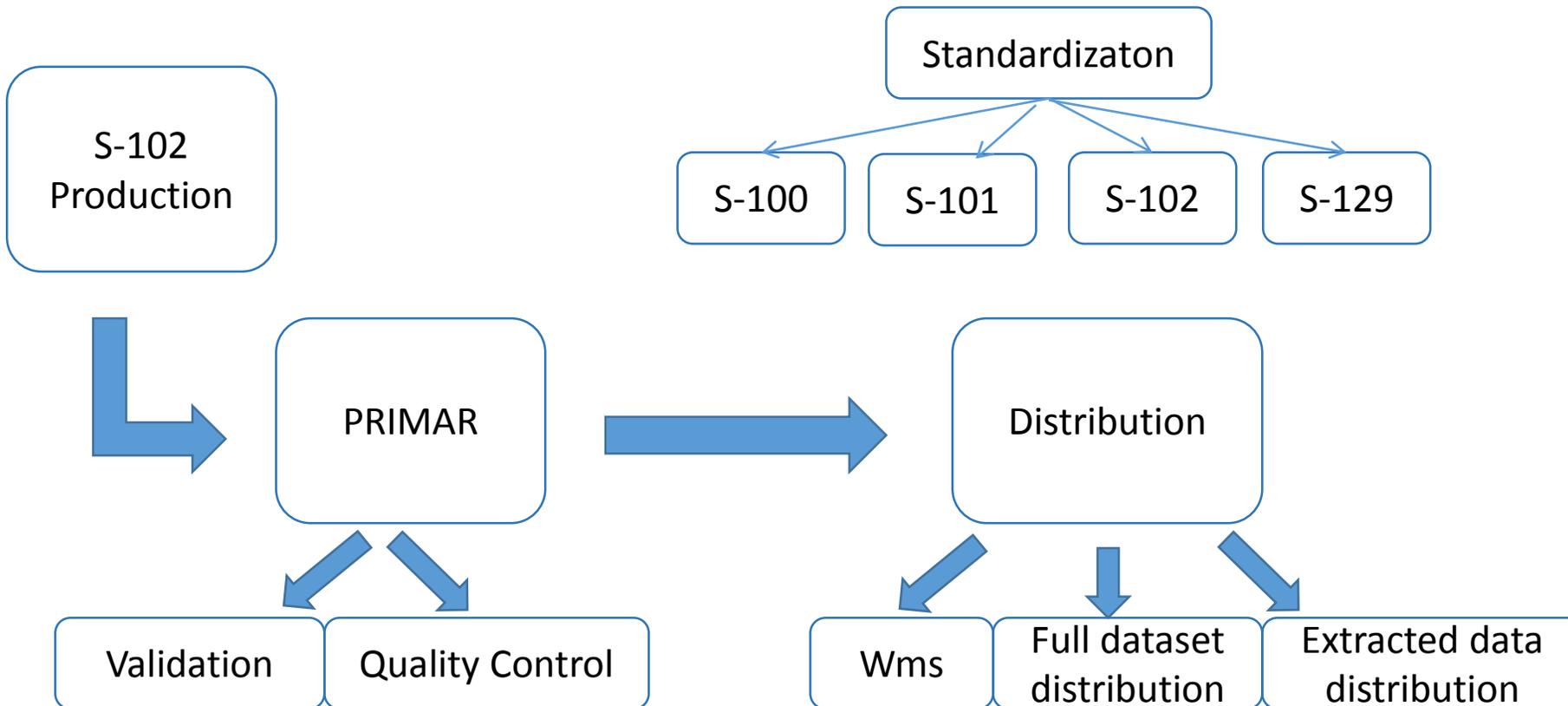




IHO

International  
Hydrographic  
Organization

# PRIMAR SCOPE





IHO

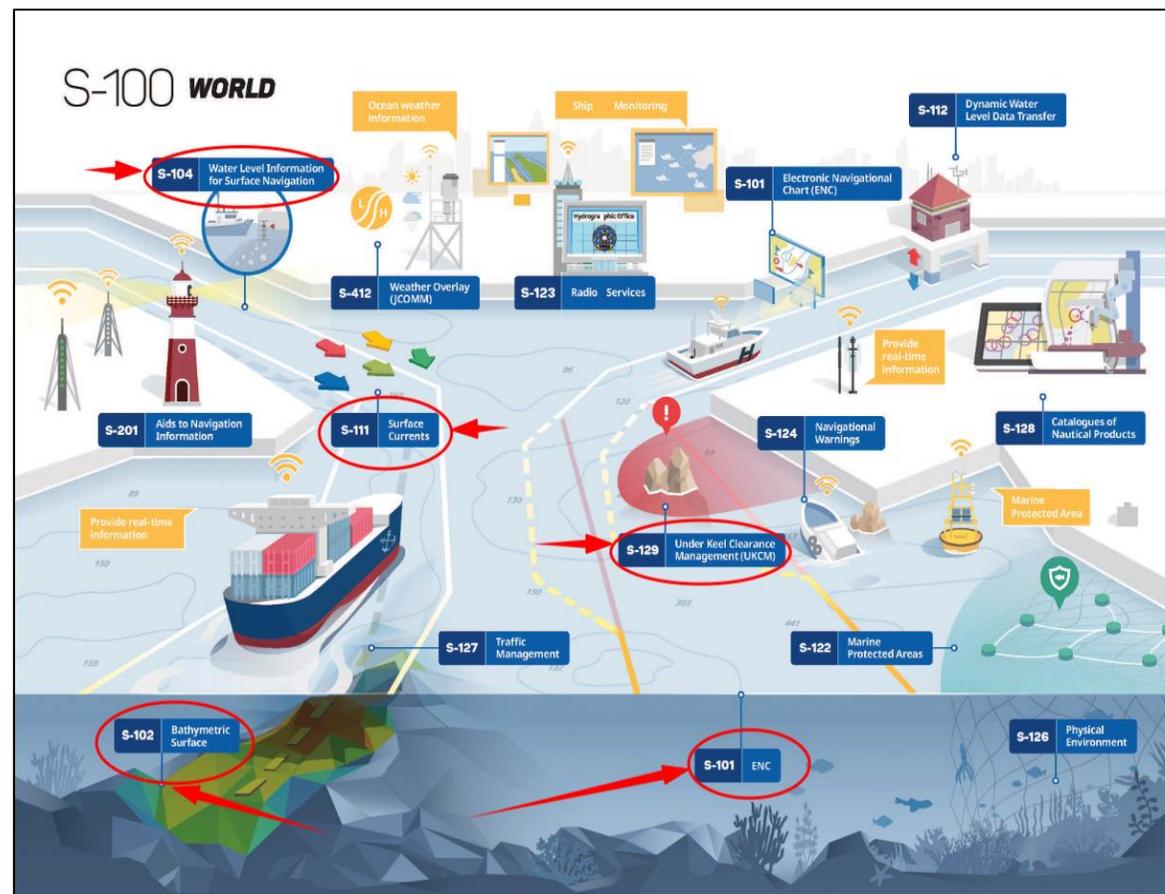
# S-100 DEMONSTRATOR

International  
Hydrographic  
Organization

- S-101 (ENC)
- S-102 (Bathymetri)
- S-104 (Tidal)
- S-111 (Surface Currents)
- S-129 (UKCM)

## Project objectives:

To define **how** the new standards, **combined**, can improve **safe** and **effective navigation** and how new & improved products and business **opportunities** can be designed & developed **based on the new standards**.





IHO

International  
Hydrographic  
Organization

## PRIMAR S-101 IMPLEMENTATION



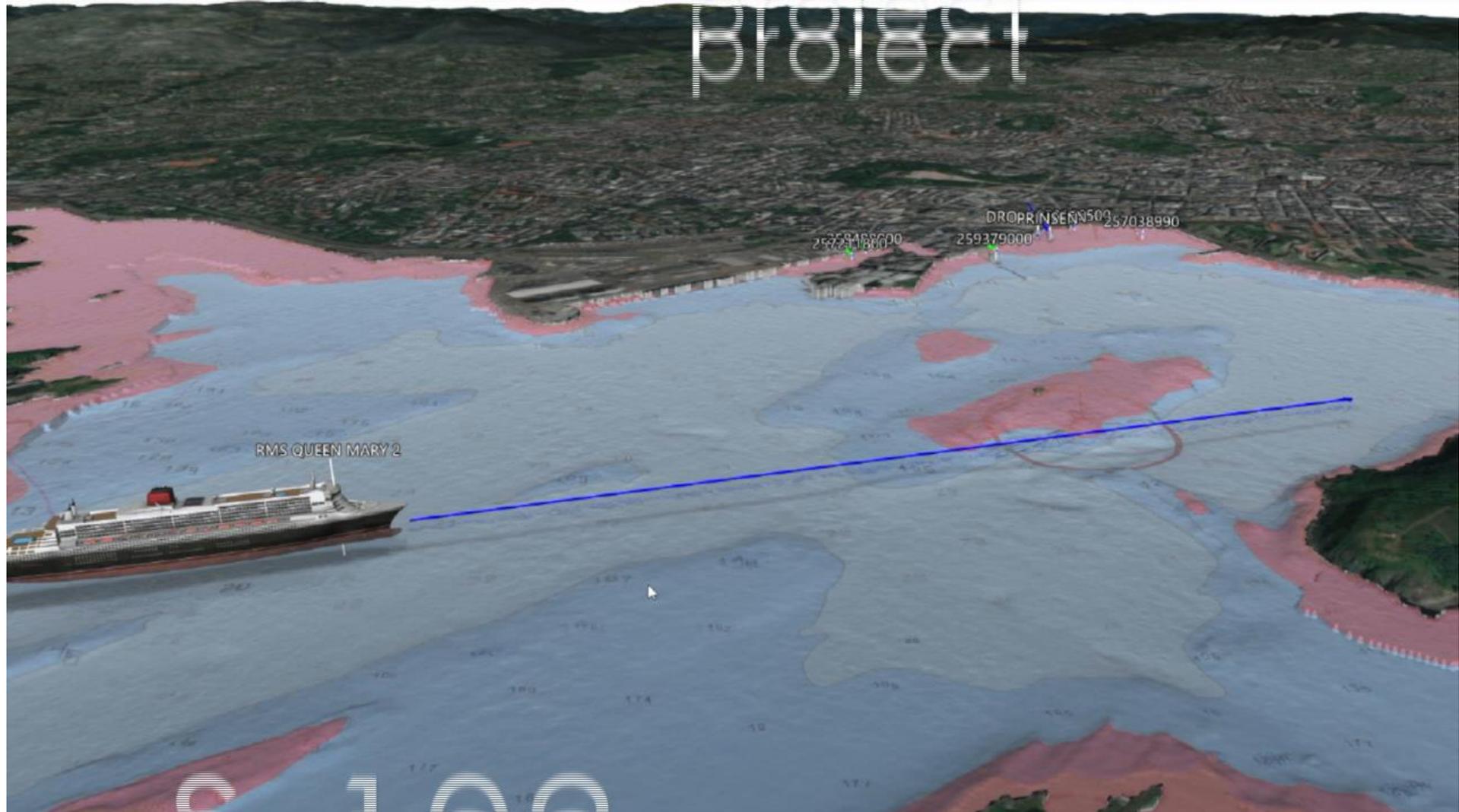
- PRIMAR Member States have agreed to fund a project to develop dual-fuel S-57 and S-101 ENC distribution service
- Offer PRIMAR Member States training and operational experience with S-101 services and Quality Control (PRIMAR TEWG, Oct 2019)
- Provide feedback to IHO and their WGs on standards
- Promote IHO S-100 based standards and provision of testdata and services to stakeholders
- Dual-fuel ENC service operational when first HO's datasets commercially available
- Meets IMO e-Navigation developments and MSPs
- Developed IHO S-100 Data Protection Scheme Administrator (SA) application



**IHO**

# S-102 DEMONSTRATOR PROJECT SUMMARY

International  
Hydrographic  
Organization



<https://s102.no/>



## **S-100 Showcase**

# **S-111 Surface Current Production at NOAA**



IHO

## S-111 SURFACE CURRENTS - DESCRIPTION

International  
Hydrographic  
Organization

- S-111 Edition 1.0.0 was adopted by HSSC in 2018 and is based on the S-100 framework
  - Designed for interoperability for use in Electronic Navigation Systems
- NOAA is developing a **open source** process to convert native surface current data into S-111 format
- NOAA is developing a service to disseminate S-111 data
  - Operational targeted for February 2020
- S-111 will be an integral component of NOAA's Precision Navigation Cloud Environment



**IHO**

# **S-111 SURFACE CURRENTS AT NOAA - SPECIFICS**

International  
Hydrographic  
Organization

<b>Variable</b>	<b>Value</b>
IHO Specifications	S-100 Edition 4.0.0 S-111 Edition 1.0.1
Format	Hierarchical Data Format 5 HDF5
Operational Forecast System Parameters	Surface Currents
Frequency	4 times per day (0, 6, 12, 18 UTC)
Time Resolution, Duration	Hourly to 72 hours
Time Zone	UTC
Resolution	~500 m (regular grid), 20-100 m HDef
Depth	4.5 m below surface
Data Coverage	Atlantic Ocean, Pacific Ocean
Hydrodynamic Models	Regional Ocean Modeling System
Product Boundary	Leverage the new NOAA ENC Grid Scheme



**IHO**

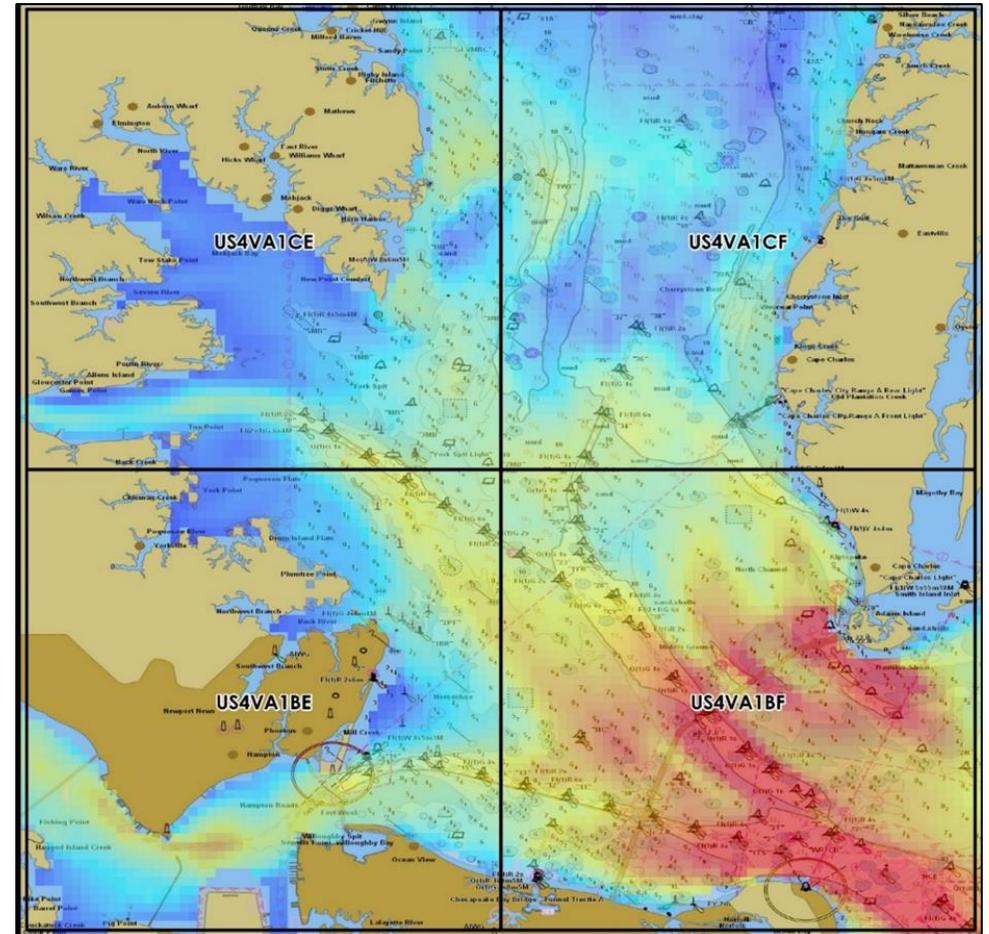
# S-111 SURFACE CURRENTS – LOWER CHESAPEAKE BAY

International  
Hydrographic  
Organization

## Lower Chesapeake Bay

<b>Description:</b>	<b>Current magnitude &amp; Direction</b>
<b>ENC Band:</b>	<b>4</b>
<b>Format:</b>	<b>S-111 encoding</b>
<b>Grid Resolution:</b>	<b>0.01 deg, 500 m</b>
<b>Parameter:</b>	<b>Surface currents</b>
<b>Coordinate System:</b>	<b>WGS 84</b>
<b>Dataset:</b>	<b>72 hrs, 1 hr intervals</b>
<b>Time Zone:</b>	<b>UTC</b>
<b>Date:</b>	<b>December 3<sup>rd</sup>, 2018</b>

Native Forecast Data





IHO

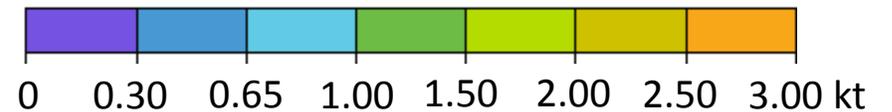
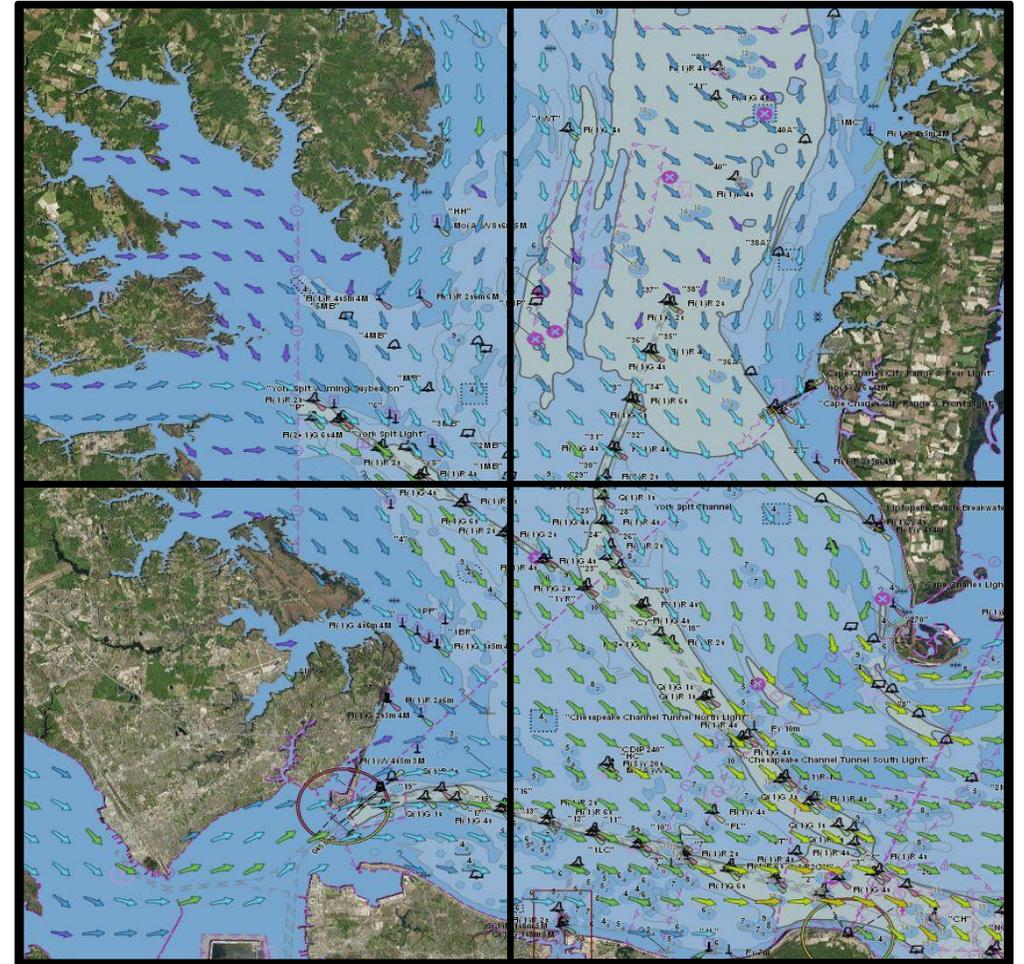
# S-111 SURFACE CURRENTS – LOWER CHESAPEAKE BAY

S-111 Implementation

International Hydrographic Organization

## Lower Chesapeake Bay

<b>Description:</b>	<b>Current magnitude &amp; Direction</b>
<b>ENC Band:</b>	<b>4</b>
<b>Format:</b>	<b>S-111 encoding</b>
<b>Grid Resolution:</b>	<b>0.01 deg, 500 m</b>
<b>Parameter:</b>	<b>Surface currents</b>
<b>Coordinate System:</b>	<b>WGS 84</b>
<b>Dataset:</b>	<b>72 hrs, 1 hr intervals</b>
<b>Time Zone:</b>	<b>UTC</b>
<b>Date:</b>	<b>December 3<sup>rd</sup>, 2018</b>





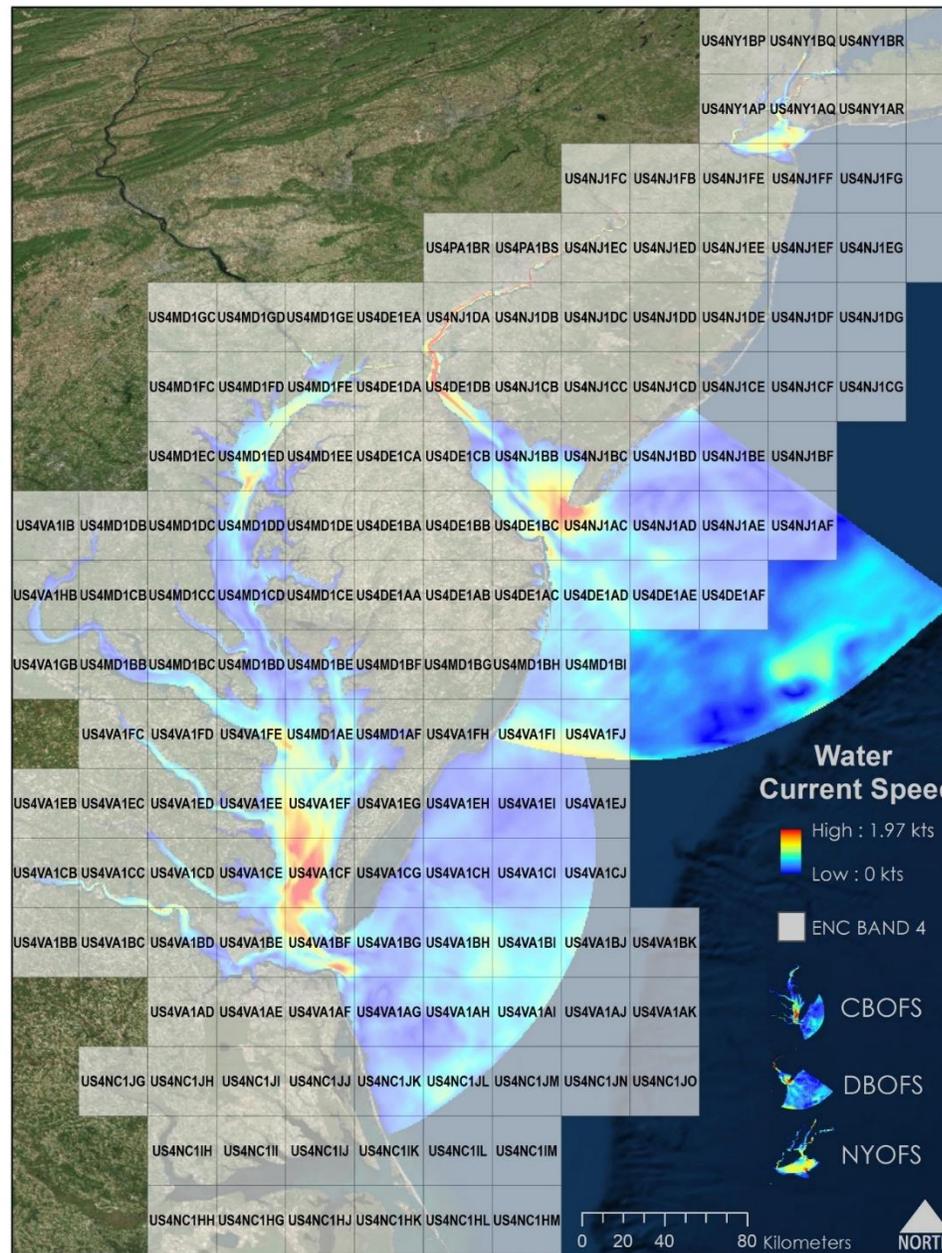
IHO

# SAMPLE S-111 SCHEME BASED ON REVISED NOAA ENC SCHEME

International Hydrographic Organization

## Mid-Atlantic Region

**Description:** ENC Re-scheming  
**ENC Band:** 4  
**Format:** S-111 encoding  
**Grid Resolution:** 0.01 deg, 500 m  
**Parameter:** Surface currents  
**Coordinate System:** WGS 84  
**Dataset:** 72 hrs, 1 hr intervals  
**Time Zone:** UTC  
**Date:** December 3<sup>rd</sup>, 2018



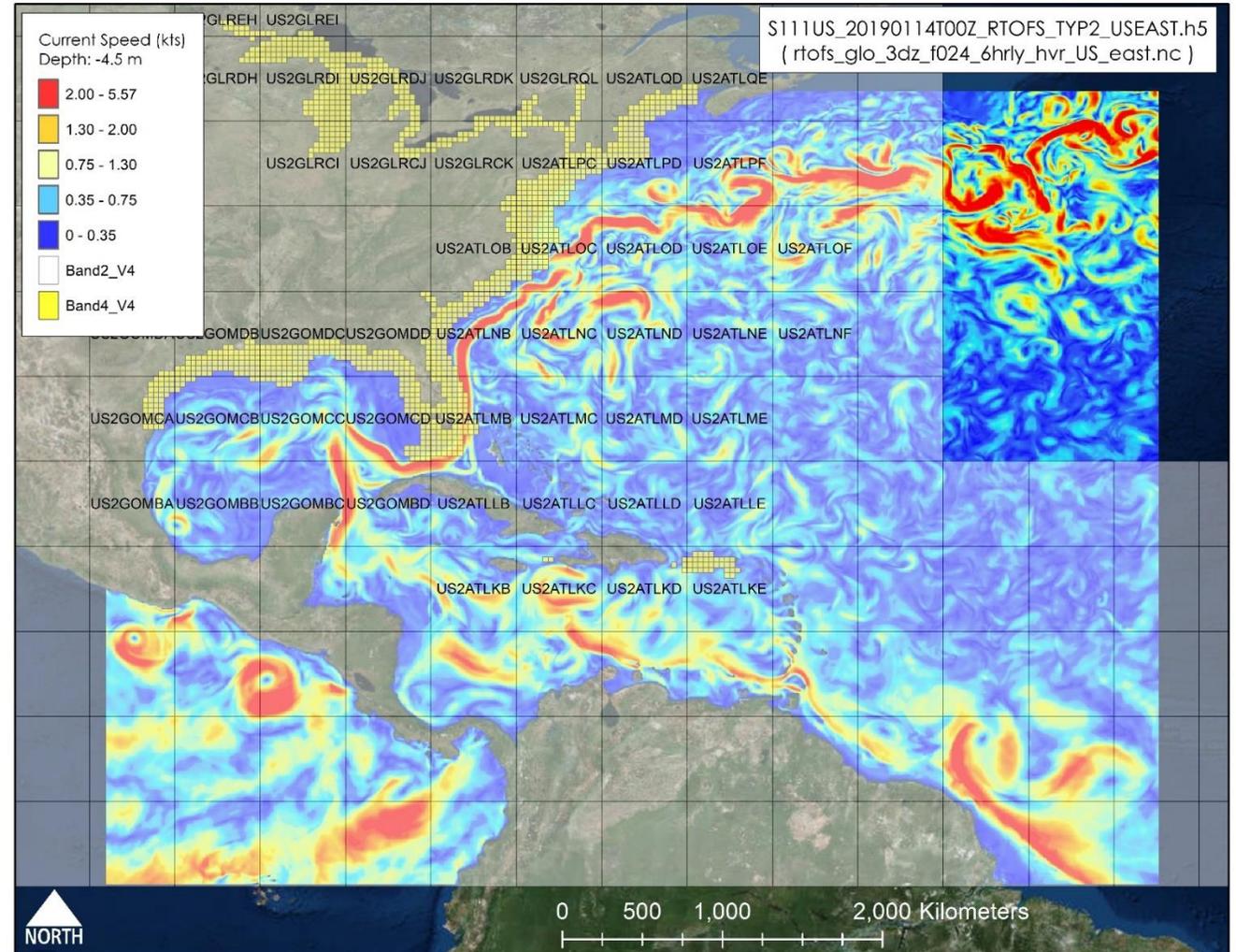


IHO

# ABILITY TO PROVIDE GLOBAL COVERAGE

International  
Hydrographic  
Organization

- Can leverage the same methodology to expand surface current beyond coastal coverage
  - Global Real-Time Ocean Forecast System
  - Suitable for showing the Gulf Stream and other global currents



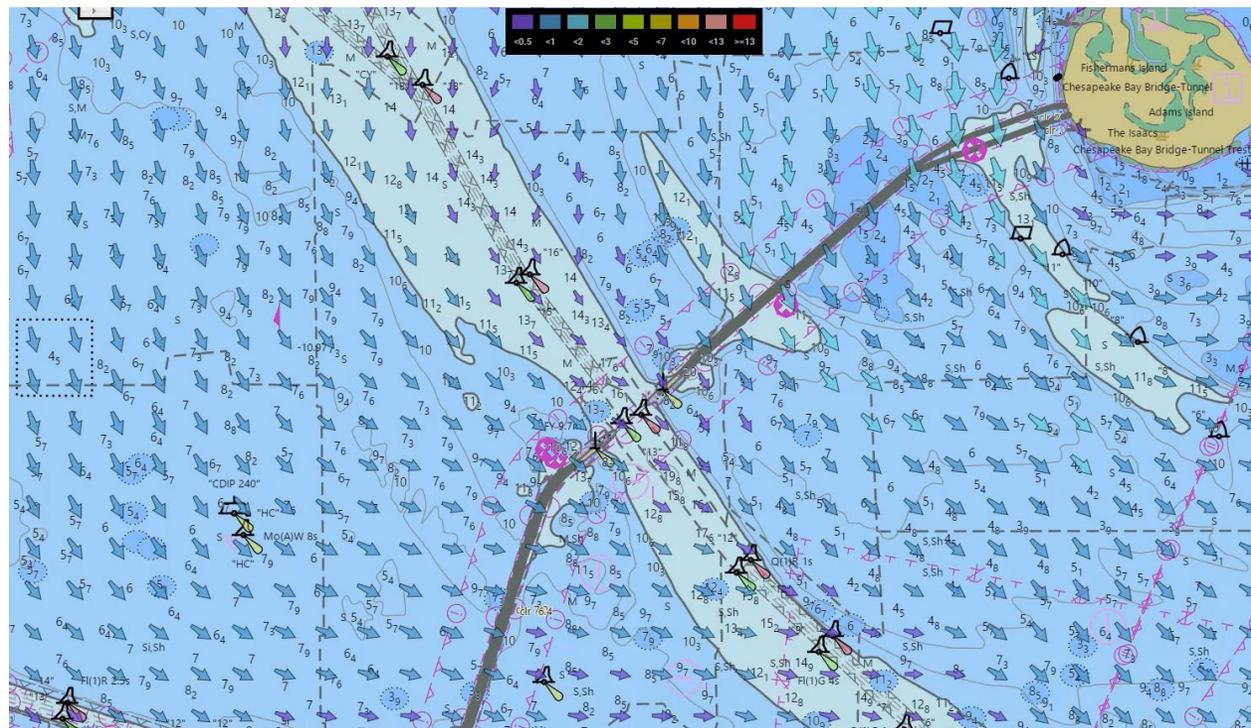


IHO

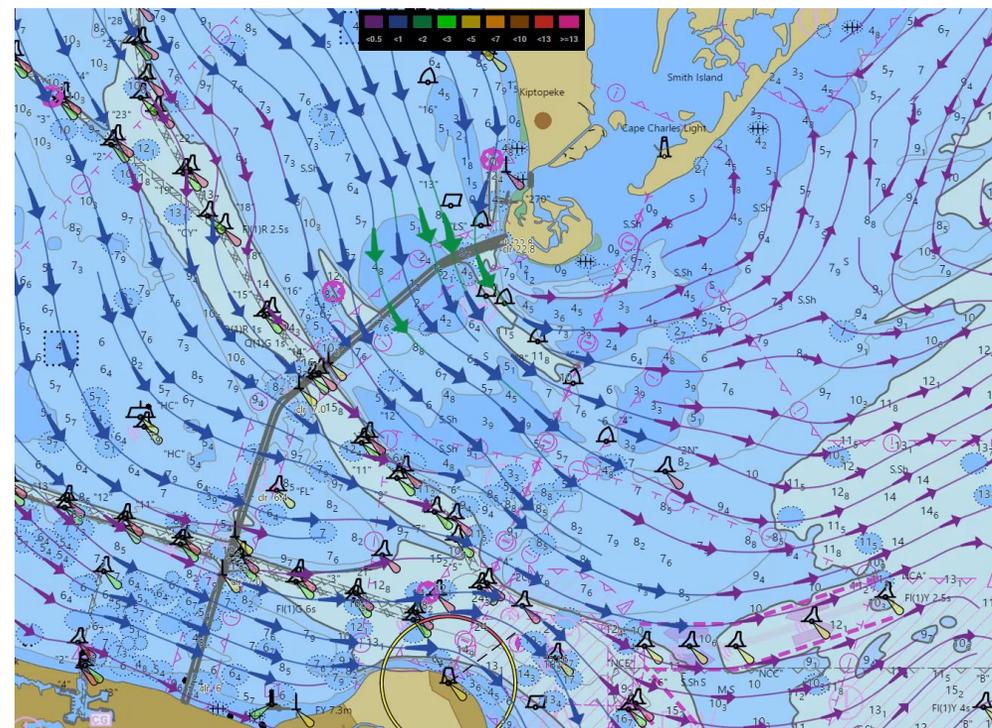
# SURFACE CURRENT RESEARCH TO S-111 OPERATIONS

International  
Hydrographic  
Organization

Current S-111 Portrayal



Potential S-111 Portrayal





IHO

## FUTURE EFFORTS

International  
Hydrographic  
Organization

- NOAA will be releasing its S-111 conversion scripts for use by the wider community
- This same code base can be leveraged for S-104 water levels
- S-111 is a cornerstone for NOAA's Precision Navigation Effort
  - Operational for selected regions in February 2020
  - Ability to use algorithms to optimize routes
    - Increased fuel efficiency
    - Potential carbon reduction



## **S-100 Showcase**

# **United States Support NIWC (formerly SPAWAR) S-100 Development**



## IHO S-100 Working Group Test Framework

Goals

IHO S-100 Testing

Framework System  
Components as Phases

Address  
future  
navigational  
needs

Lessons  
learned  
from S-57 &  
ECDIS

Needed to  
complete  
standards

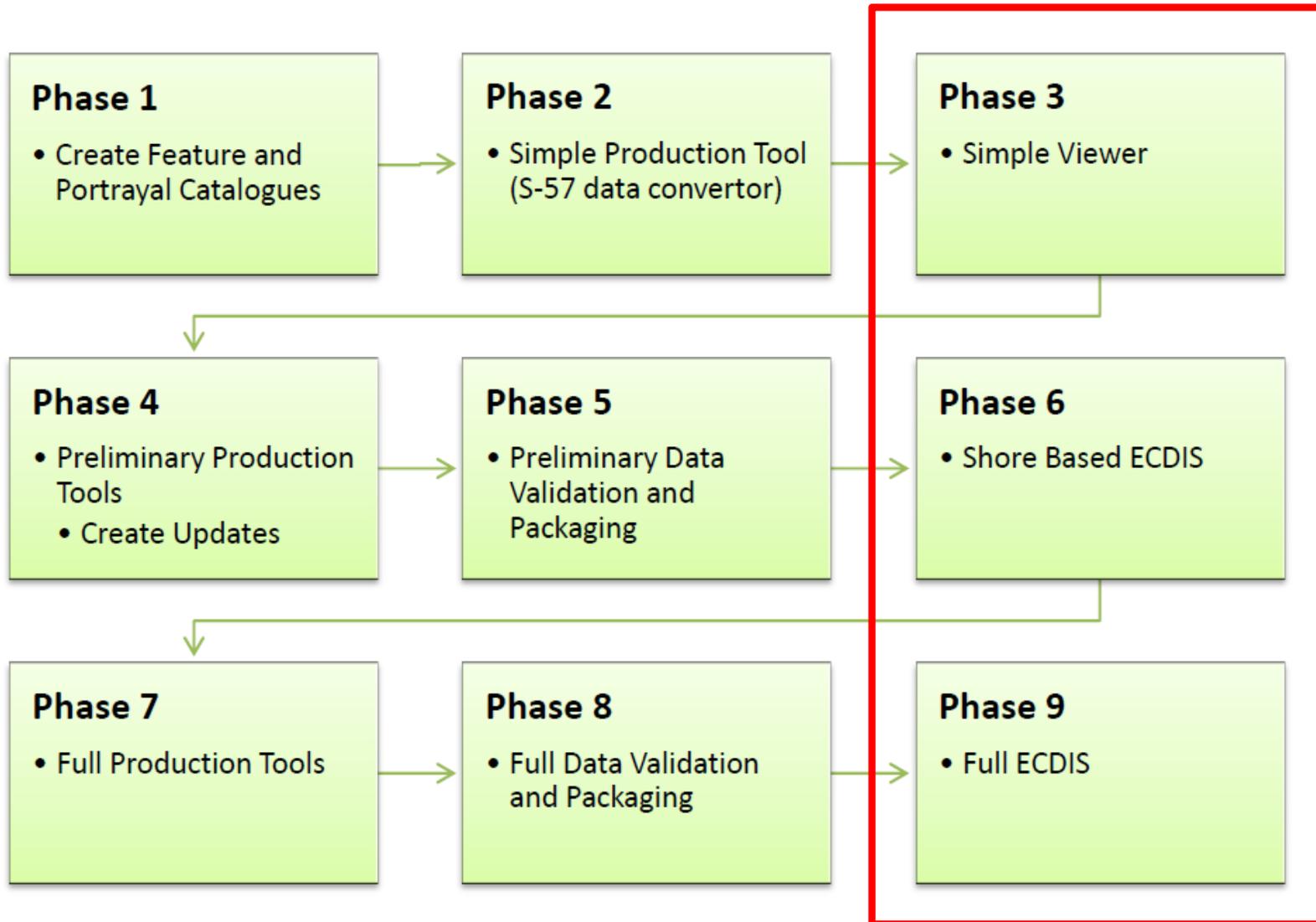
Validate  
operational  
use

Multiple  
product  
interaction

Catalogues

Data

ECDIS



US  
NIWC  
Focus  
Areas  
(3,6,9)



IHO

# US KEY CONTRIBUTIONS TO DATE

International  
Hydrographic  
Organization

## S-100 Standard (Framework)

- Model realization in software
- Enhancing portrayal with open standard scripting (Lua)
- Ensuring machine readability for Equipment Manufacturers
- Refining S-100 Encoding

## S-100 Product Specifications Support (To Date)

- S-101 Electronic Navigational Chart (ENC)
- S-102 Bathymetric Surface
- S-122 Marine Protected Areas



IHO

# US S-100 VIEWER (PHASE 3) MAIN FEATURES

International  
Hydrographic  
Organization

## Feature Catalogue Browser

## Encoded Dataset Browser (tabular)

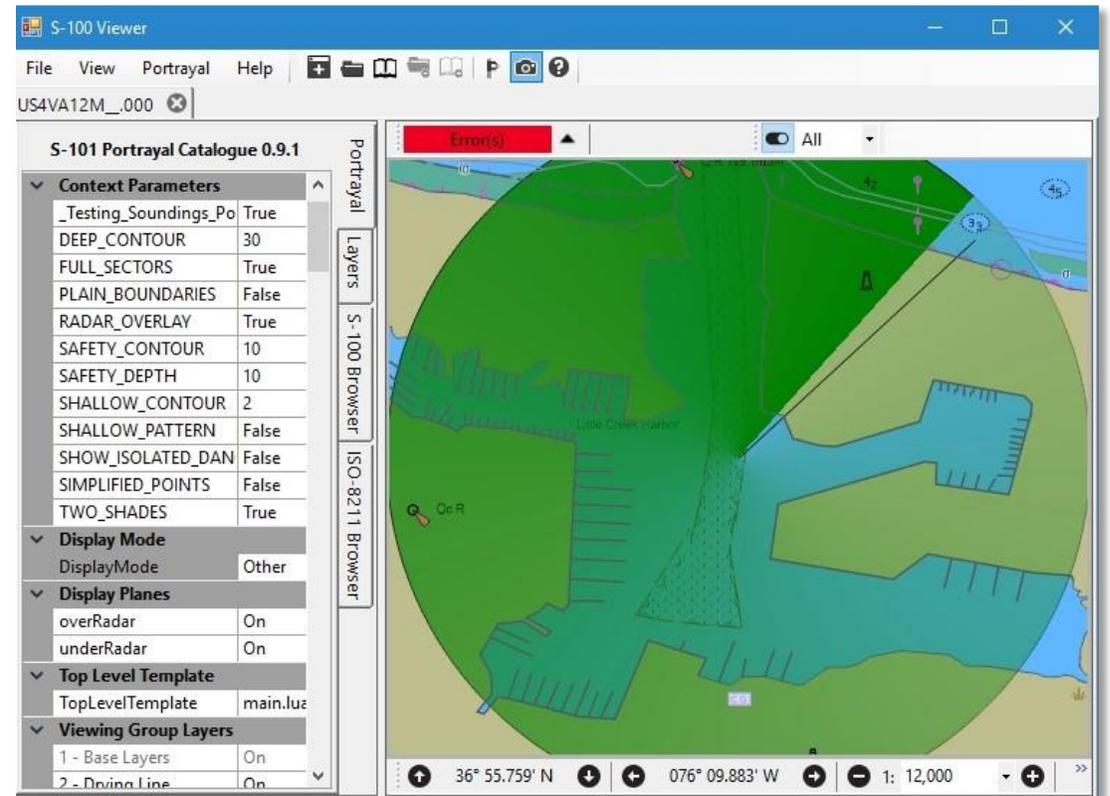
- ISO-8211, GML (partial), HDF5 (partial)

## S-100 Dataset Browser (tabular)

- Encoded dataset -> S-100 general data model
- Validates against feature catalogue

## Portrayal

- XSLT and Lua
- Interact with settings exposed by portrayal catalogue
- Monitor size calibration
- Zoom / Pan / Rotation
- Mercator / Lambert Conformal / Polar Stereographic

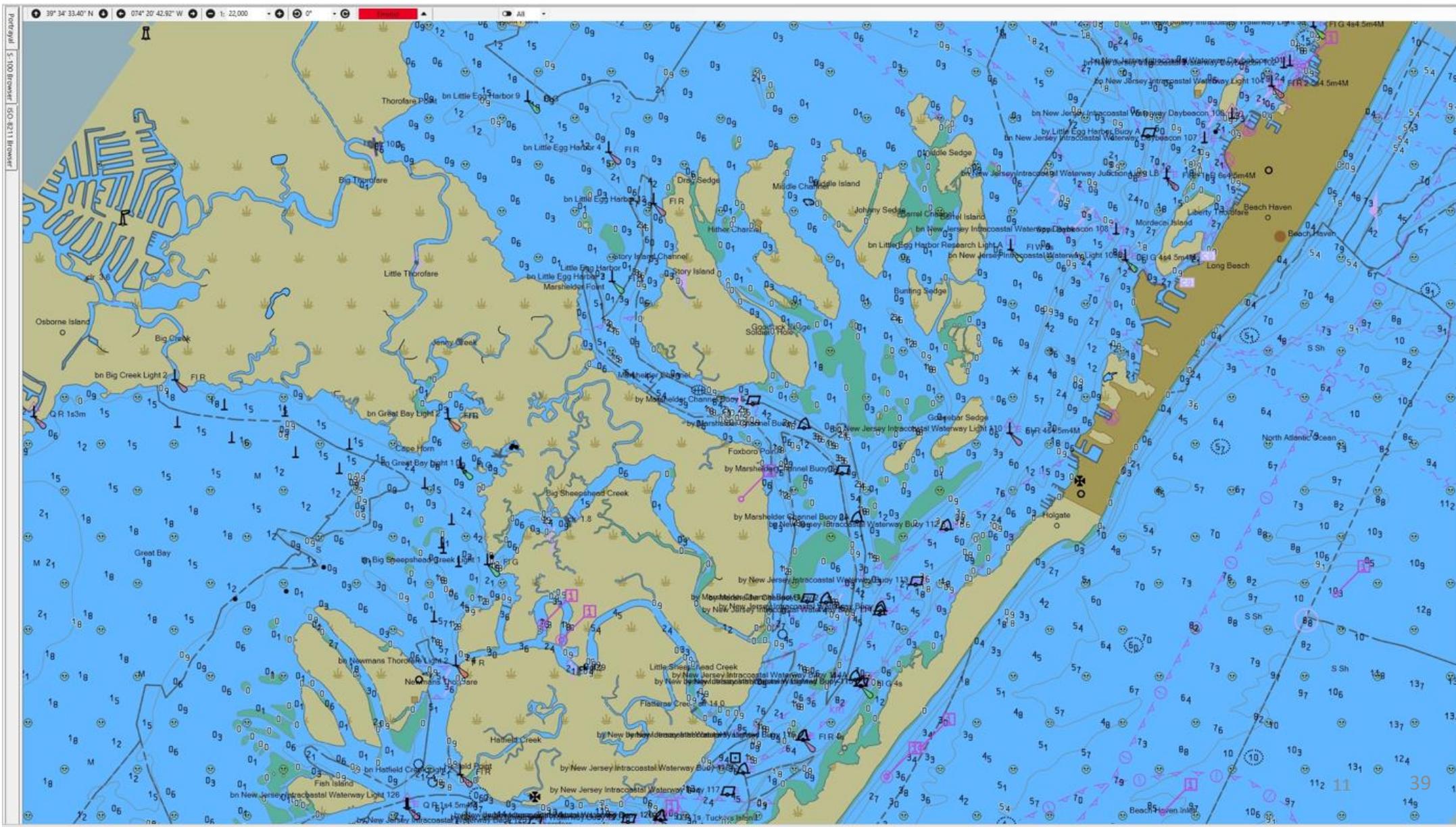




IHO

# S-100 VIEWER DISPLAYING S-101 PRODUCT

International  
Hydrographic  
Organization



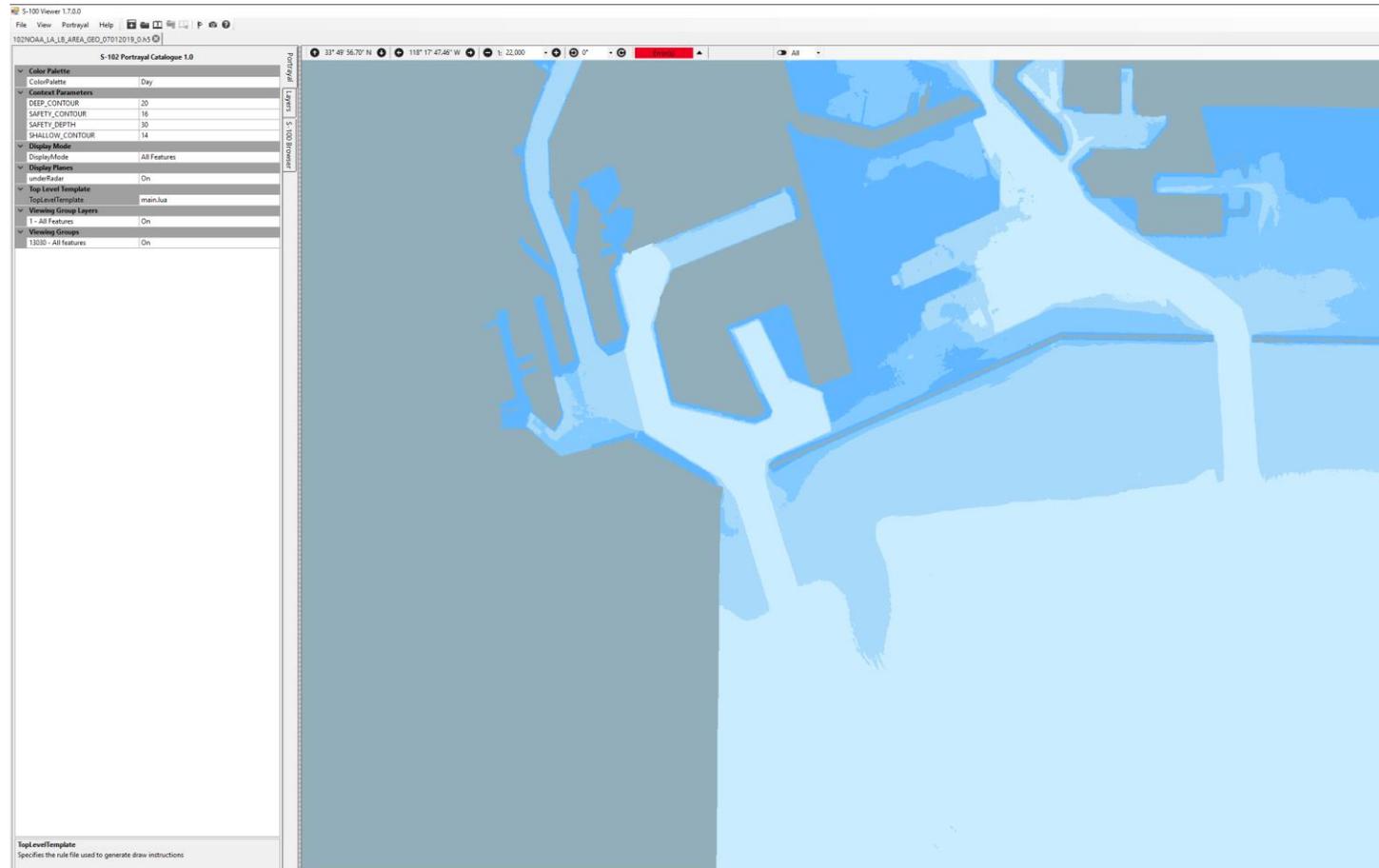


IHO

# S-102 BATHYMETRIC SURFACE PORTRAYAL

International  
Hydrographic  
Organization

- Cell symbolization based on depth (no sun shading)





IHO

# S-111 SURFACE CURRENT SYMBOL PORTRAYAL

International  
Hydrographic  
Organization

- Symbolization based on current magnitude (with direction)

S-100 Viewer 1.7.0.0

File View Portrayal Help

S111US\_MIKAN\_CUSTOM.h5

S-111 Portrayal Catalogue 1.0

Color Palette	Day
Display Mode	All Features
Display Planes	
underRadar	On
Top Level Template	main.xsl
Viewing Group Layers	
1 - All Features	On
Viewing Groups	
13030 - All features	On

Portrayal S-100 Browser

39° 20' 34.76" N 075° 46' 06.33" W 1: 45,000 0° Warning(s)



## Viewer works on a per-product basis

- Performs Feature catalogue validation
- Realization of associated portrayal catalog

## Demo of 3 products

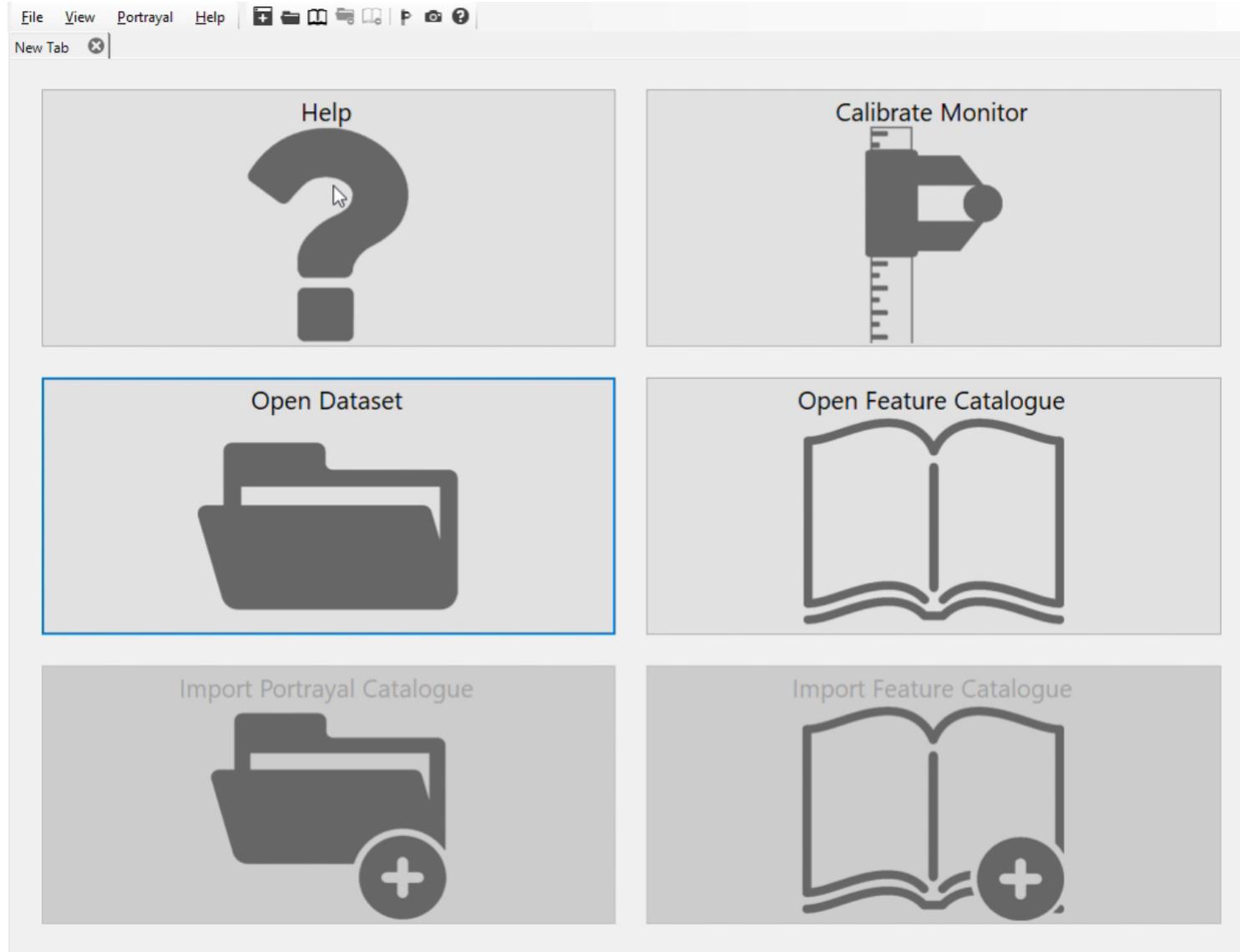
- S-102
- S-111
- S-101



IHO

# US S-100 VIEWER VIDEO DEMO

International  
Hydrographic  
Organization





**IHO**

# **US WAY-AHEAD SUPPORTING IHO S-100**

International  
Hydrographic  
Organization

## Fully implement S-101 Edition 2.0.0 (Goal 2022)

- Main document
- Feature & Portrayal catalogue validation
- Encryption
- Alerts & Indications
- Test Dataset for Type Approval

## Full S-101 implementation

- Part of Phase 6 Shore Based ECDIS efforts
- Supports operational transition to full ECDIS



# **S-100 Web Viewer and Sea Trial**

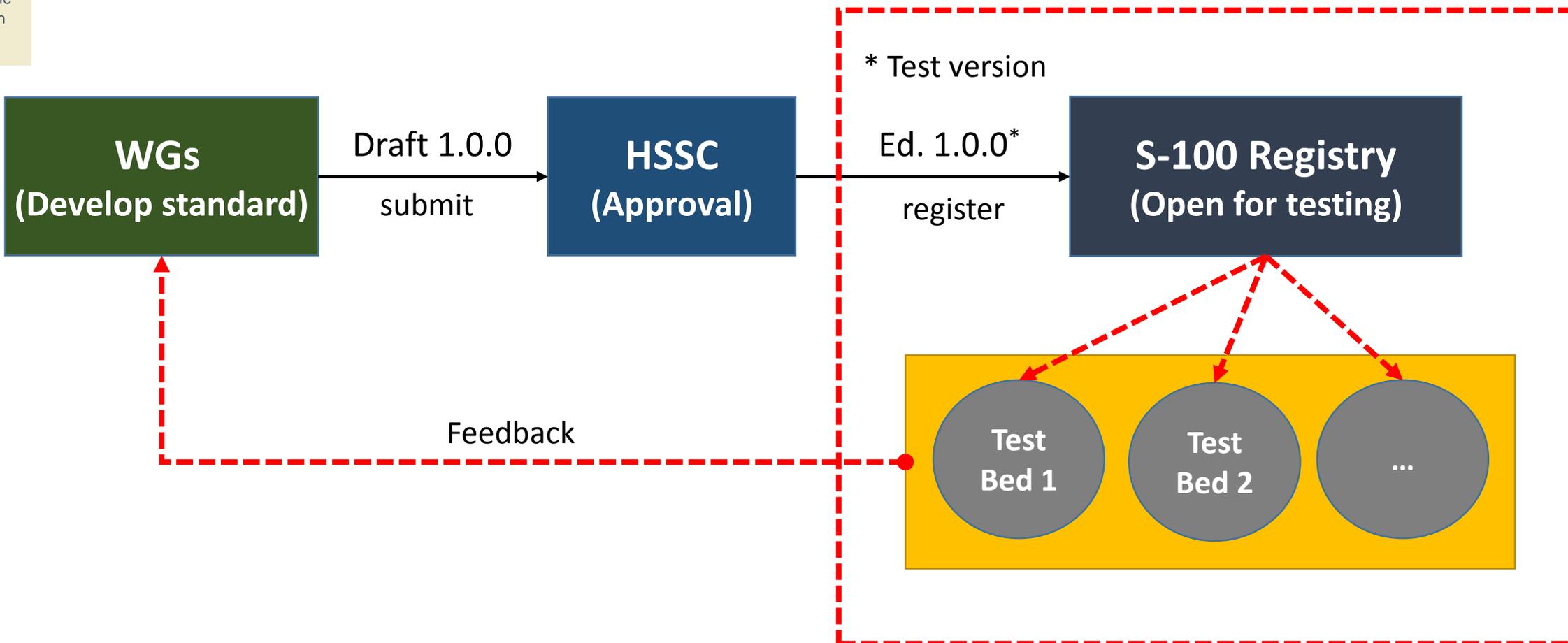
**Presented by KHOA, Rep. of Korea**



IHO

# S-100 WEB TESTING PROCEDURE

International  
Hydrographic  
Organization

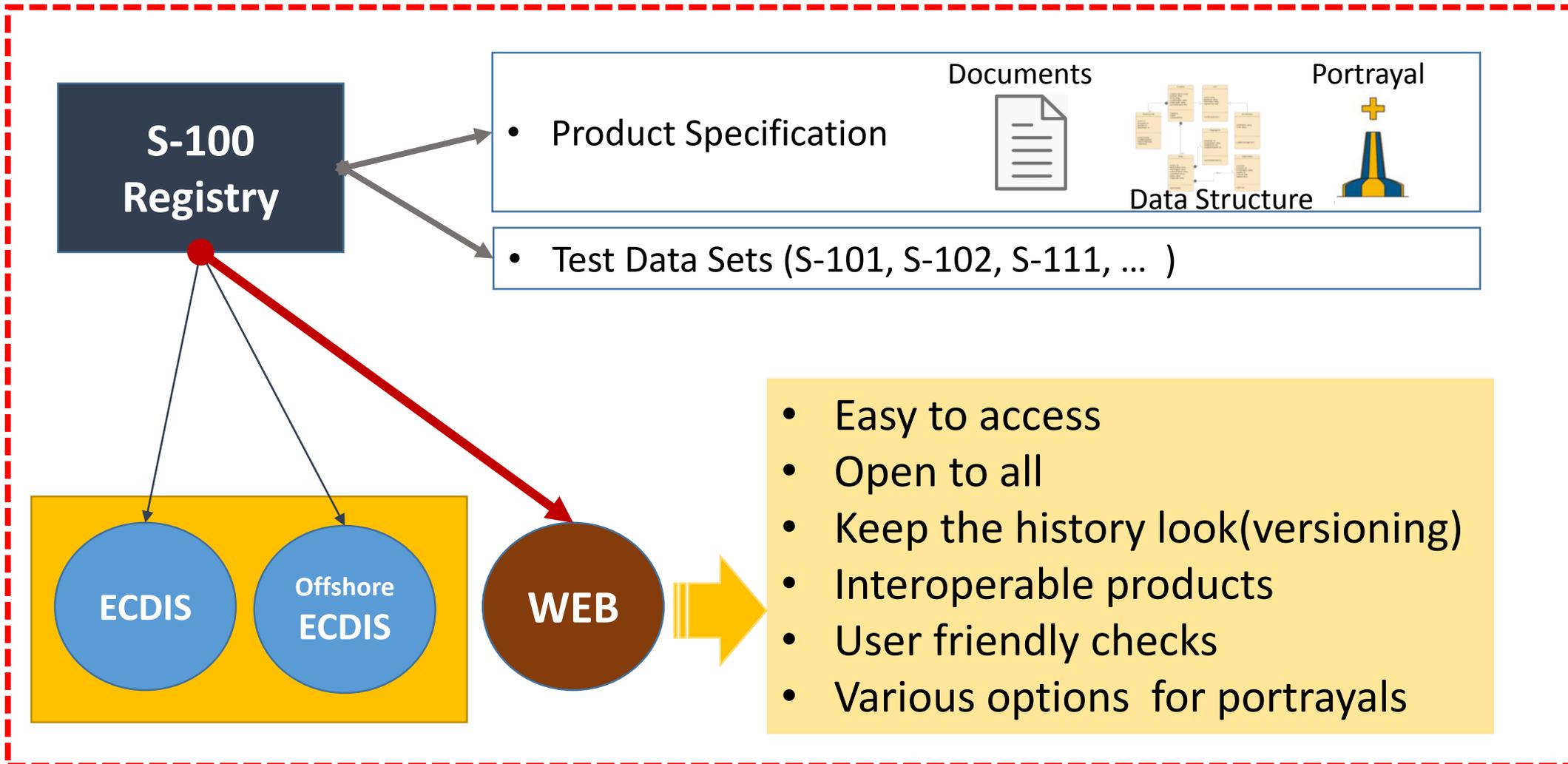




IHO

# S-100 WEB TESTING PROCEDURE

International  
Hydrographic  
Organization





IHO

# S-100 WEB VIEWER

International Hydrographic Organization

**S-100 Geospatial Information Registry**

**TEST BED**

Home / TEST BED / TEST BED

Welcome to the S-100 Test Bed.  
Purpose of the Test Bed are as below.

1. Provide a framework and infrastructure
2. Receive feedback by relevant stakeholders
3. Share outcomes of the test bed

No	ID	Name
+ 1	S-100	Universal Hydrographic
+ 2	S-101	Electronic Nautical Charts
+ 3	S-102	Bathymetric
+ 4	S-104	Water Level
+ 5	S-10X	Product Sample
+ 6	S-111	Surface Current
+ 7	S-122	Marine Protected Areas
+ 8	S-123	Radio Services
+ 9	S-124	Navigational Warnings
+ 10	S-127	Marine Traffic Management
+ 11	S-412	Weather and Oceanographic Data
+ 12	S-888	Marine Traffic

Showing 1 to 12 of 12 rows

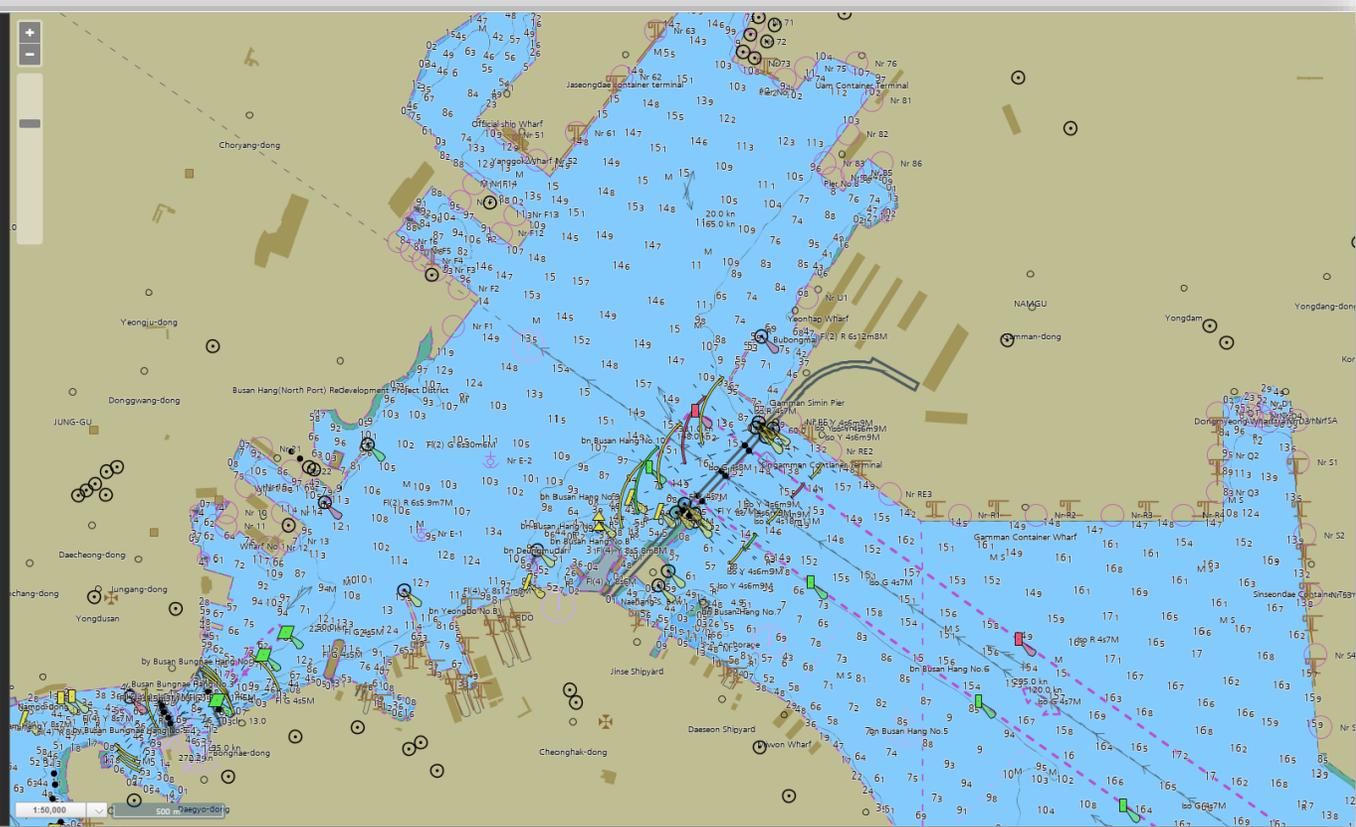
**S-100 Products and Services**

- S-101 Electronic Charts **Ed. ON**
  - Republic of Korea
  - United States of America
  - Germany
  - Singapore
  - Italy
  - Canada
  - France
  - Hong Kong
  - Estonia
  - Nederland
- S-102 Bathymetric Surface **Ed. OFF**
  - Canada
  - Estonia
- S-104 Water Level
- S-111 Surface Currents **Ed. OFF**
- S-122 Marine Protected Areas
- S-123 Marine Radio Services
- S-124 Navigational Warnings
- S-126 Physical Environment
- S-127 Marine Traffic Management
- S-128 Catalog of Nautical Products
- S-57 Electronic Charts **Ed. OFF**

Interoperability  
Portrayal Harmonization  
Setting

KHOA Republic of Korea

## S-100 Web Viewer



S-100 GI registry



**IHO**

# **S-100 WEB VIEWER DEMO**

International  
Hydrographic  
Organization

**1) Register Feature  
Catalogue and Portrayal  
Catalogue**



**2) Upload Test Data Sets**



**3) S-100 Web Viewer**

***Click Here***

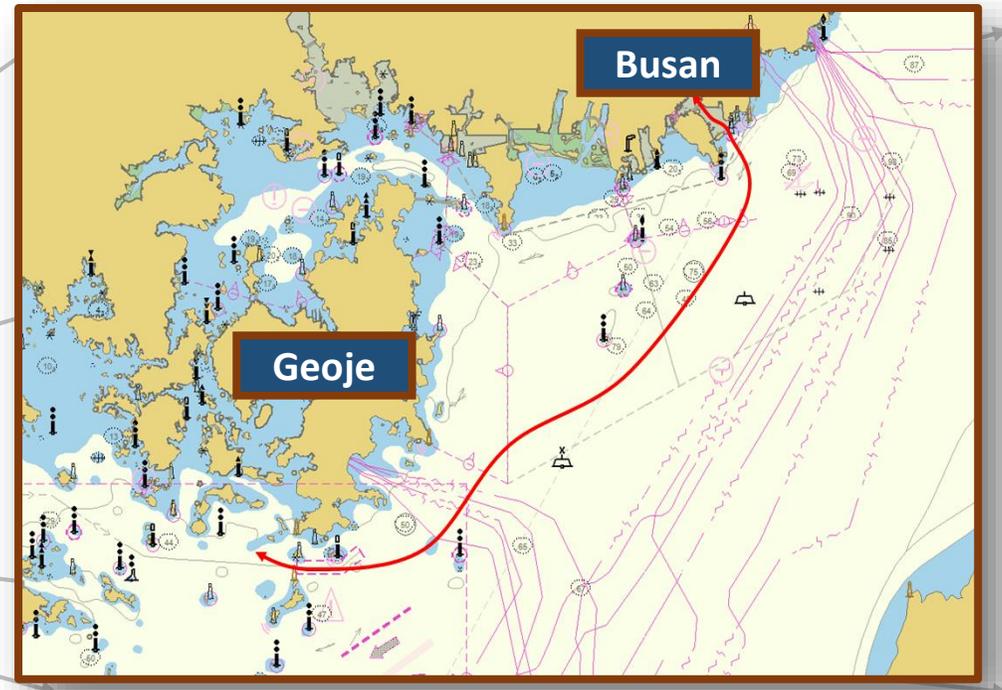
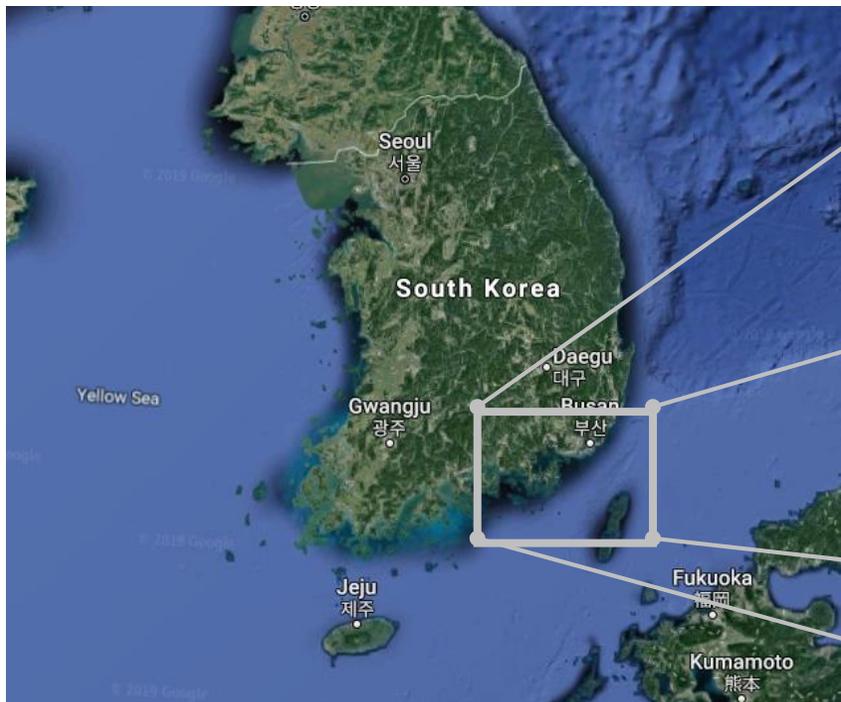


IHO

# S-100 SEA TRIAL

International  
Hydrographic  
Organization

- S-100 Sea Trial
  - Date: 27<sup>th</sup> August, 2019
  - Route : Port Busan  $\longleftrightarrow$  Geoje Island
  - Participants: IHO WG's Charis (S-100WG, ENCWG, NIPWG), Mariners, Pilots, ECDIS Trainers, Data producers, System developer





IHO

# S-100 SEA TRIAL

International  
Hydrographic  
Organization

- Test environment

- Install S-100 test system, AIS receiver, GPS receiver in the Sea trial vessel
- Install 2 S-100 test systems in bridge
- Install a separate S-100 test system in the data analysis room
- Sea trial vessel

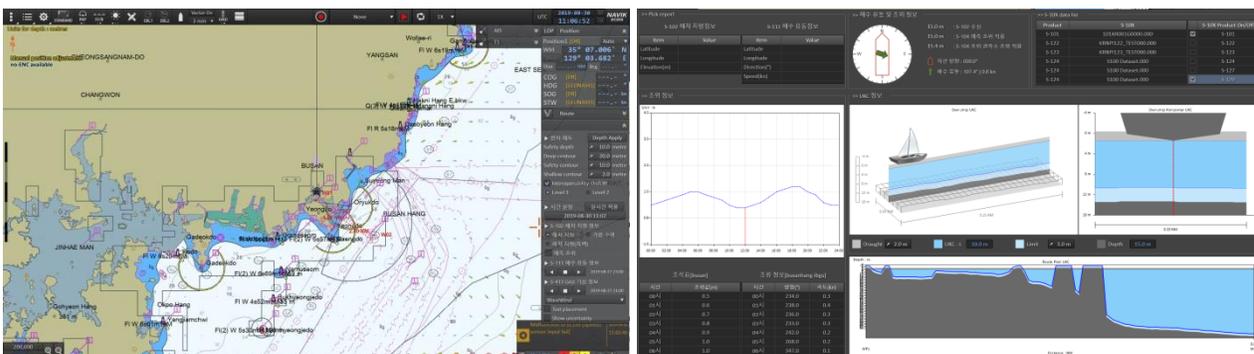
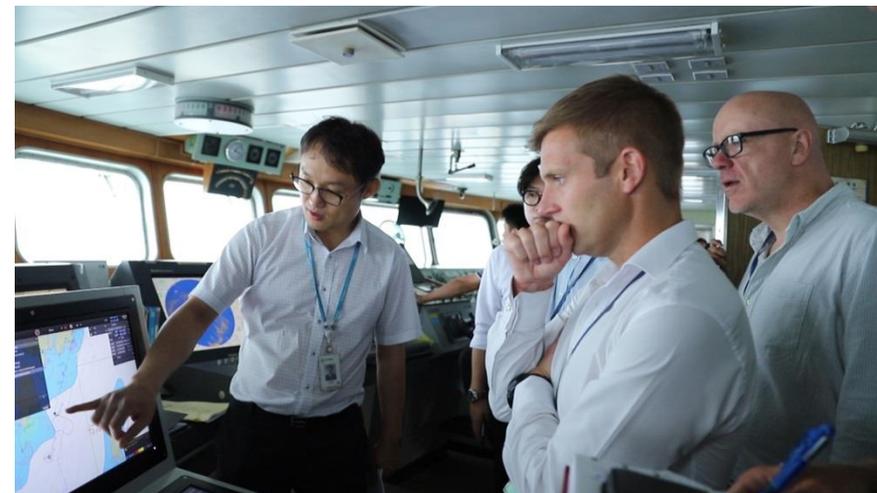
Name	Specification	Image
Haeyang2000	Total tonnage : 2,161 Length : 89.2m Width : 14.0m Engine : 3,020HP×2 Cruising distance : 14,000mile	



IHO

# S-100 SEA TRIAL

International  
Hydrographic  
Organization



[Sea Trial \(click here\)](#)



**IHO**

International  
Hydrographic  
Organization

**THANK YOU FOR YOUR ATTENTION**

**KHOA**

[www.khoa.go.kr](http://www.khoa.go.kr)  
[infokhoa@korea.kr](mailto:infokhoa@korea.kr)



## **S-100 Showcase**

# **The Way Forward**



**IHO**

# **S-100 – ON THE HORIZON**

International  
Hydrographic  
Organization

- S-98 Interoperability of [Products to be used in] Navigation Systems
  - Framework for capturing interoperability rules
  - Refining the scope to concentrate on activities in relation to navigation (planning and monitoring)
  - Harmonized Portrayal across the data stack
  - KHOA Interoperability Video



# IHO S-101 – ON THE HORIZON

International  
Hydrographic  
Organization

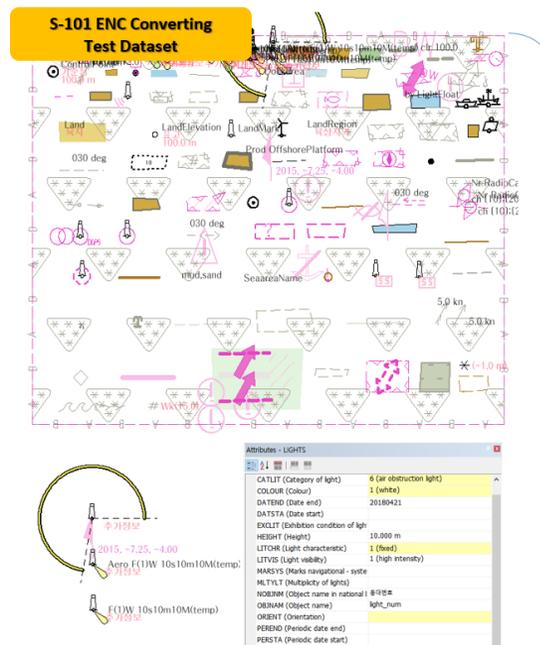
Components	Edition 1.0.0 (2018)	Edition 1.X.X (2020-21)	Edition 2.0.0 (2022)
Main Documentation	✓	✓	✓
Feature Catalogue	✓	✓	✓
Portrayal Catalogue	Partial	✓	✓
Validation	Partial	✓	✓
Data Classification and Encoding Guide	✓	✓	✓
Encoding Format	✓	✓	✓
Encryption		✓	✓
Alerts and Indications		✓	✓
Full Test Data Sets for Type approval		Partial	✓
<b>Notes</b> <b>SRL = S100 Readiness Levels</b>	Portrayal will be limited to S-52 rules translated to LUA (SRL =1)	Edition 1.X.X refines all the additional rules (SRL =2-3)	<b>Operational Edition (SRL =4)</b>



# IHO S-101 – ON THE HORIZON

International Hydrographic Organization

- Continue to refine the product specification to enable transition from S-57 to S-101
  - Optimize S-57 data for transition to S-101



KHOA ENC use 118 objects of S-57.

**<S-101 Converter 1.0.0.5 (S100WG) 2018.10>**

S-57 Acronym count	S-101 Feature Matching count	Complete count	Converting ratio	Note
118	131	106	81%	S-101 side
Ignored INFORM, NINFOM to Nautical Information				

**<S-57 Composer 3.1.1 (Customized by UST21) 2018>**

S-57 Acronym count	S-101 Feature Matching count	Complete count	Converting ratio	Note
118	131	127	97%	S-101 side

**Result**

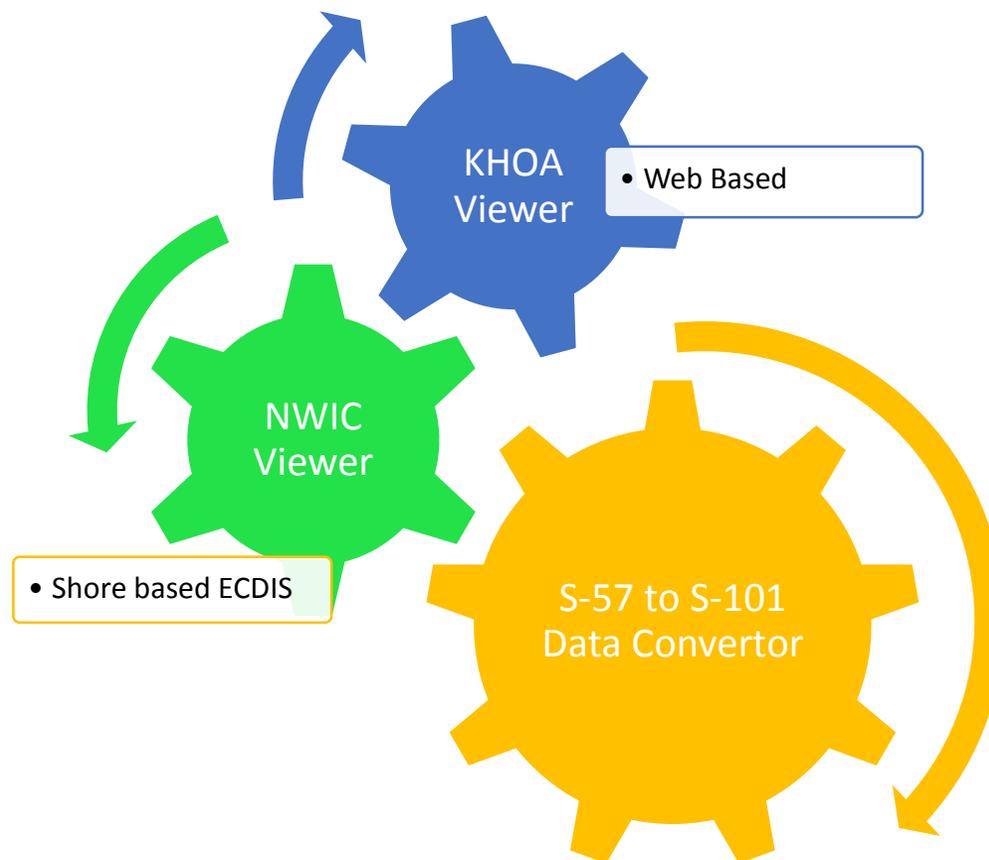
- Both tool did not lose critical feature and attribute.
- S-101 Converter can automatically conversion the relation set.
- S-57 Composer allows editing of converting rules so that it can be optimized for ENC conversion of each HO.



**IHO**

# S-100 TESTBED FOR EVERYONE

International  
Hydrographic  
Organization





# IHO S-100 KEY TAKEAWAYS

International  
Hydrographic  
Organization

- S-100 is the framework that underpins the future of navigation and modeling of maritime and hydrographic data
  - Harmonization of data
  - Improved Interoperability
- S-100 has come a long way from just a conceptual idea into reality
  - Wider community has started reference implementations to help resolve issues prior to operational release
    - Primar/CHS project on S-102
    - NOAA project on S-111
    - NWIC/ROK viewers for use in operational settings



# IHO HSSC REQUESTS

International  
Hydrographic  
Organization

## To endorse the concept of an S-100 Showcase for the Assembly

