Enabling the Decade of S-100 Implementation
• 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
• Currently on Edition 4.0.0
• Approved Product Specifications

<table>
<thead>
<tr>
<th>Product ID</th>
<th>Name</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-101</td>
<td>Electronic Navigational Chart</td>
<td>1.0.0</td>
</tr>
<tr>
<td>S-102</td>
<td>Bathymetric Surface for Navigation</td>
<td>2.0.0</td>
</tr>
<tr>
<td>S-111</td>
<td>Surface Currents</td>
<td>1.0.0</td>
</tr>
<tr>
<td>S-122</td>
<td>Marine Protected Areas</td>
<td>1.0.0</td>
</tr>
<tr>
<td>S-123</td>
<td>Marine Radio Services</td>
<td>1.0.0</td>
</tr>
<tr>
<td>S-129</td>
<td>Under Keel Clearance Management</td>
<td>1.0.0</td>
</tr>
</tbody>
</table>
S-100 SHOWCASE TOPICS

• 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
DATA CENTRIC APPROACH – S-100 OPERATIONAL

- **S-101 ENC**
  - Gridded service updated with new information
  - 3 collections
  - Expanded vector coverage in Canada
  - CARIS HPD output

- **S-102 Bathymetry**
  - Automated gridded service (48h updates)
  - 3 resolutions
  - Master surface (deconflicted)
  - CARIS BDB output

- **S-104 Water levels**
  - Automated gridded service (24/7)
  - 3 resolutions
  - Observations and modeled data (NEMO)
  - High Performance Computing

- **S-111 Surface Currents**
  - Automated gridded service (24/7)
  - 3 resolutions
  - Modeled data (NEMO)
  - High Performance Computing

Cloud

RENC/Other
KEY AREAS FOR HIGH RESOLUTION S-100 SERVICES

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
INTEROPERABLE DATASETS
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. SeaIQ (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

2. S-102 Bathymetry Data Service in the Cloud (From survey to use within 24 hours)


4. PRIMAR S-57/S-101 Dual-Fuel Service Distribution
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.
Operational test 3

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

Length: 345m  
Beam: 41m  
Draught: 10.2 m
Operational test 3
Operational test 3
Operational test 4

4. Pilotage assignment – Anchoring operations.
PRIMAR SCOPE

S-102 Production

PRIMAR

Validation
Quality Control

Standardization

S-100
S-101
S-102
S-129

Distribution

Wms
Full dataset distribution
Extracted data distribution
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.
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 HOs datasets commercially available

• Meets IMO e-Navigation developments and MSPs

• Developed IHO S-100 Data Protection Scheme Administrator (SA) application
S-100 Showcase

S-111 Surface Current Production at NOAA

C.3 – IHO Secretariat, Monaco, 15-17 October 2019
• 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 an 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 SURFACE CURRENTS AT NOAA - SPECIFICS

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

Description: Current magnitude & Direction
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 3rd, 2018
Lower Chesapeake Bay

Description: Current magnitude & Direction
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 3rd, 2018
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 3rd, 2018
• 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
SURFACE CURRENT RESEARCH TO S-111 OPERATIONS

Current S-111 Portrayal

Potential S-111 Portrayal

*Not S-111 portrayal - compliant*
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

C.3 – IHO Secretariat, Monaco, 15-17 October 2019
IHO S-100 Working Group Test Framework

Goals
- Address future navigational needs
- Lessons learned from S-57 & ECDIS

IHO S-100 Testing
- Needed to complete standards
- Validate operational use
- Multiple product interaction

Framework System Components as Phases
- Catalogues
- Data
- ECDIS
US KEY CONTRIBUTIONS TO DATE

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
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
S-100 VIEWER DISPLAYING S-101 PRODUCT
• Cell symbolization based on depth (no sun shading)
• Symbolization based on current magnitude (with direction)
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
US WAY-AHEAD SUPPORTING IHO S-100

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
S-100 WEB TESTING PROCEDURE

WG (Develop standard) → Draft 1.0.0 submit → HSSC (Approval) → Ed. 1.0.0* register → S-100 Registry (Open for testing)

* Test version

Feedback

Test Bed 1, Test Bed 2, ...

IHO
International Hydrographic Organization
**S-100 WEB TESTING PROCEDURE**

- **S-100 Registry**
  - Product Specification
  - Test Data Sets (S-101, S-102, S-111, ...)

- **Documents**
  - Data Structure

- **Portrayal**
  - Easy to access
  - Open to all
  - Keep the history look (versioning)
  - Interoperable products
  - User friendly checks
  - Various options for portrayals

**ECDIS**

**Offshore ECDIS**

**WEB**
S-100 WEB VIEWER

S-100 Web Viewer

S-100 GI registry
1) Register Feature Catalogue and Portrayal Catalogue
2) Upload Test Data Sets
3) S-100 Web Viewer

Click Here
• S-100 Sea Trial
  • Date: 27\textsuperscript{th} August, 2019
  • Route: Port Busan ↔ Geoje Island
  • Participants: IHO WG’s Charis (S-100WG, ENCWG, NIPWG), Mariners, Pilots, ECDIS Trainers, Data producers, System developer
S-100 SEA TRIAL

• 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

<table>
<thead>
<tr>
<th>Name</th>
<th>Specification</th>
<th>Image</th>
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<tbody>
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<td>Total tonnage : 2,161</td>
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<td></td>
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<tr>
<td></td>
<td>Cruising distance : 14,000mile</td>
<td></td>
</tr>
</tbody>
</table>
THANK YOU FOR YOUR ATTENTATION

KHOA

www.khoa.go.kr
infokhoa@korea.kr
S-100 – ON THE HORIZON

• 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
## Components

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<tr>
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<tr>
<td>Main Documentation</td>
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<td>Feature Catalogue</td>
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<tr>
<td>Portrayal Catalogue</td>
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<tr>
<td>Data Classification and Encoding Guide</td>
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<tr>
<td>Full Test Data Sets for Type approval</td>
<td>Partial</td>
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<td>✓</td>
</tr>
</tbody>
</table>

**Notes**

- **SRL = S100 Readiness Levels**
  - 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)
  - Operational Edition (SRL =4)
• Continue to refine the product specification to enable transition from S-57 to S-101
  • Optimize S-57 data for transition to S-101

<table>
<thead>
<tr>
<th>S-57 Acronym count</th>
<th>S-101 Feature Matching count</th>
<th>Complete count</th>
<th>Converting ratio</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>118</td>
<td>131</td>
<td>106</td>
<td>81%</td>
<td>S-101 side</td>
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<tr>
<td>Ignored INFORM, NINFOM to Nautical Information</td>
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<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>S-57 Acronym count</th>
<th>S-101 Feature Matching count</th>
<th>Complete count</th>
<th>Converting ratio</th>
<th>Note</th>
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<tr>
<td>118</td>
<td>131</td>
<td>127</td>
<td>97%</td>
<td>S-101 side</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Result</th>
</tr>
</thead>
</table>
| • 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 HD. |

KHOA ENC use 118 objects of S-57.
S-100 TESTBED FOR EVERYONE

- NWIC Viewer
  - Shore based ECDIS

- KHOA Viewer
  - Web Based

- S-57 to S-101 Data Convertor
• 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
HSSC REQUESTS

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