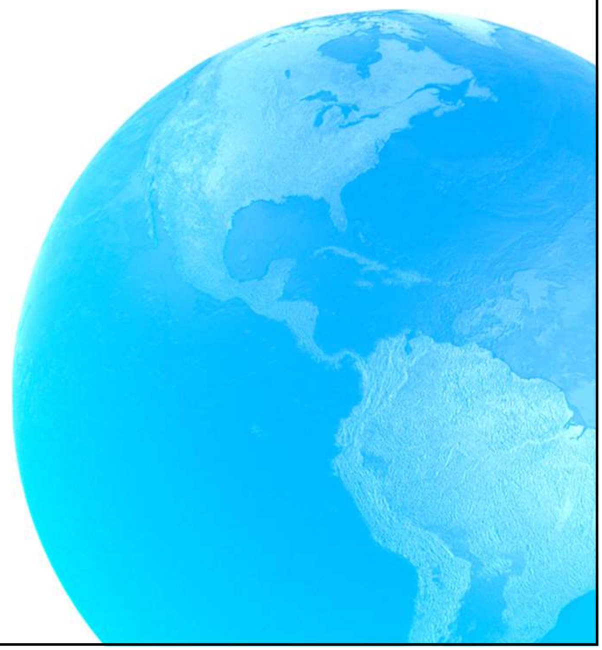
OGC – Marine Domain

IHO MSDI WG (14)
OGC Marine DWG
-UN-GGIM MWG (4)
ISO – Marine/Maritime Elements

Date and Location: January 30-Feb 3, 2023, Genoa, Italy



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Agenda

- Welcome and Introduction - Glenn Laughlin (Pelagis) ,Rafael Ponce (ESRI), Jonathan Pritchard (IIC Technologies) -Marine DWG Co-chairs
- Introduction to OGC – Trevor Taylor, OGC
- Unlocking the Value of Marine Data – Marine DWG Co-chairs
  - FMSDI Pilot project(s)
  - Testbed 18 outputs
  - Way forward
- ISO and the Marine Domain - Peter Parslow , ISO TC211
- APIs, FAIR and HOs – Trevor Taylor OGC, Jonathan Pritchard,
- MDWG way forward– Jonathan Pritchard
- Close

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Introduction to OGC

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The Open Geospatial Consortium (OGC)

Community – Innovation – Standards

Community: 550+ Members

- 230+ members from industry
- 120+ government agencies
- 185+ universities & research orgs
- 70+ standards
- 100+ working groups

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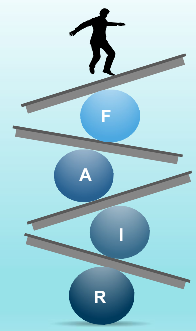
The Open Geospatial Consortium (OGC)

Practical Collective problem solving – Findable, Accessible, Interoperable and Reusable (FAIR)

Community: 550+ Members

Problem solvers & innovators



Creating value with geospatial

Open Standards

Best Practices

Proof of Concepts

Deliverables to the world

https://www.ogc.org/standards

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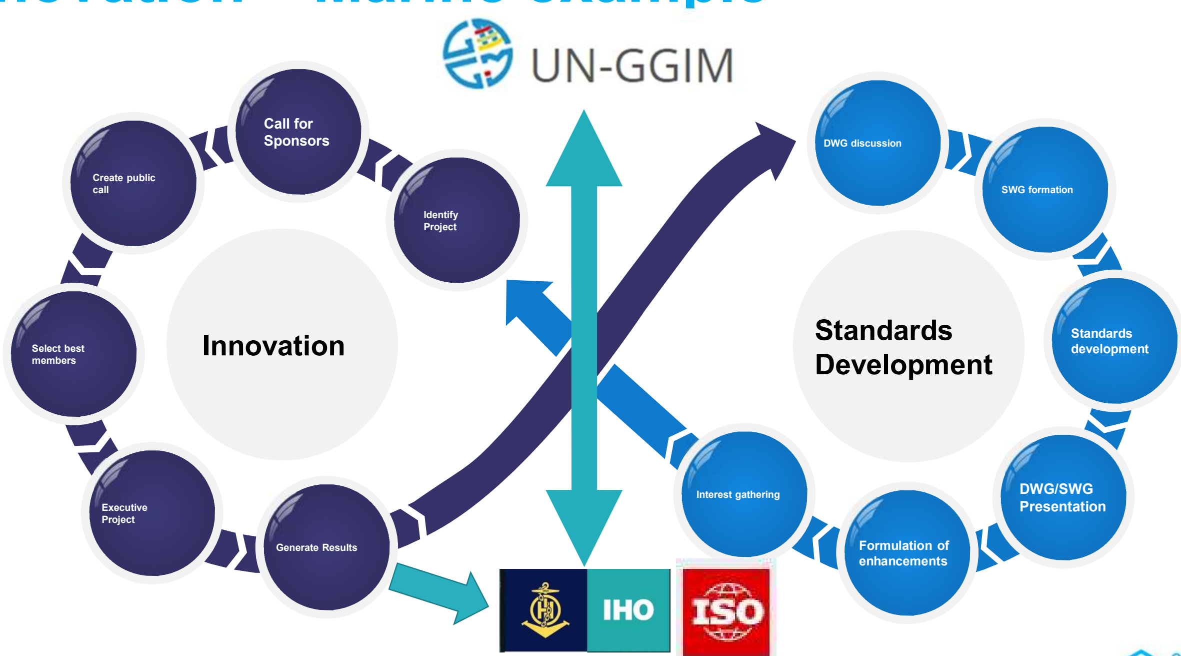
Innovation – Marine example



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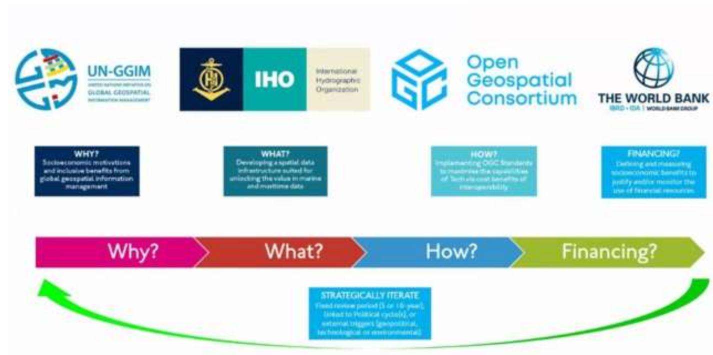
Partnerships – Critical!

- Collective Problem Solving – Innovation
- Multiplier effect + reduce redundant work
- Maximize Investments
- Long History on collaboration – which is accelerating
- ISO Will be added



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Active Initiatives

There are more!
https://www.ogc.org/projects/initiatives/active

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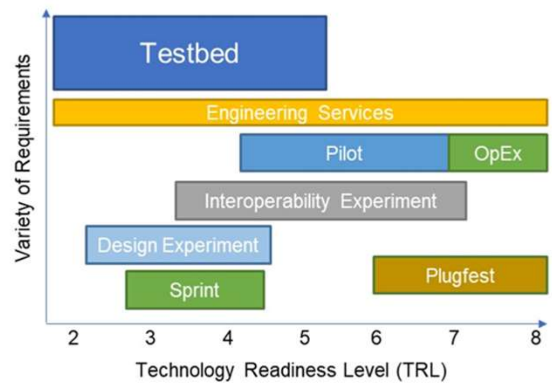
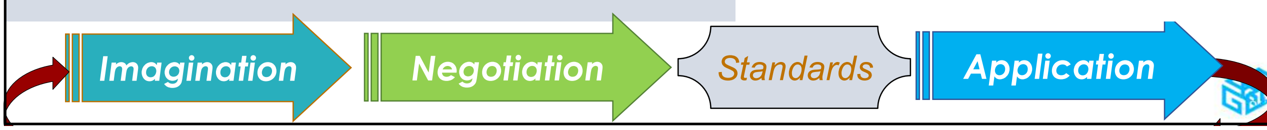
OGC Innovation Program

- Data to Decisions
- Somewhere -> Location -> Place
- Right Information to the Right Person at the Right Time
- Balancing Present and Future





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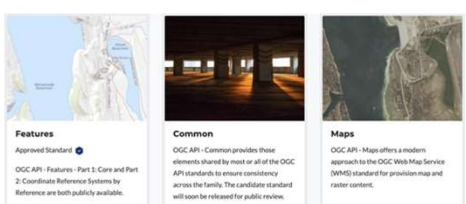
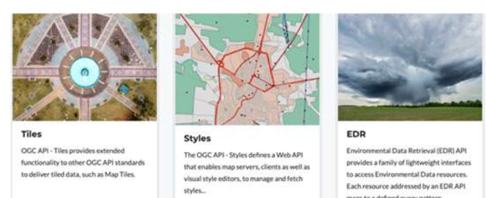
Based on Building Blocks, Now and the Future





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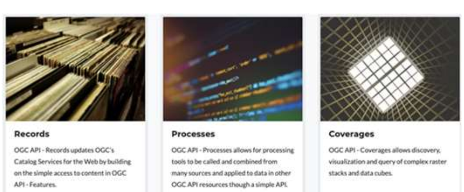

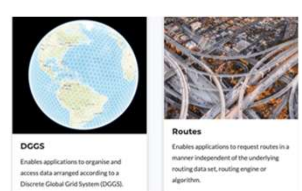

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Legacy OGC Web Service Standards

Discover via CSW

Multiple Maps with common semantics - Interoperability (Source: Joan Maso)

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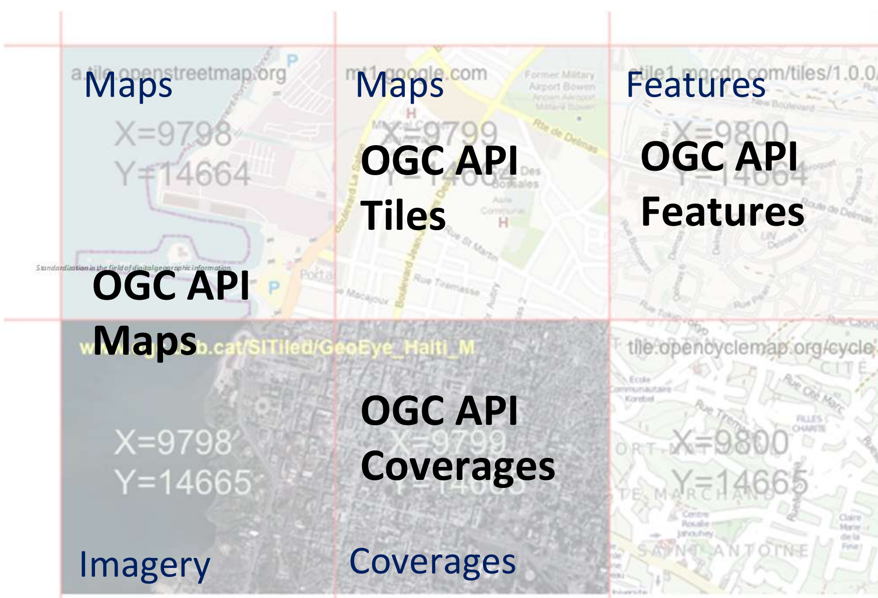
OGC API Standards



Discover via OGC API - Records

Multiple Maps with common semantics - Interoperability (Source: Joan Maso)

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OGC APIs - https://ogcapi.ogc.org/

- “Building blocks” that can be used to assemble novel APIs for web access to geospatial content
- Ultimately will replace and enhance the existing OGC Web Service standards – but – backwards compatible
- Defined with OpenAPI and published in discrete, easily implementable parts
- Ensure that geospatial data are “web ”
- Easy to implement for any developer -

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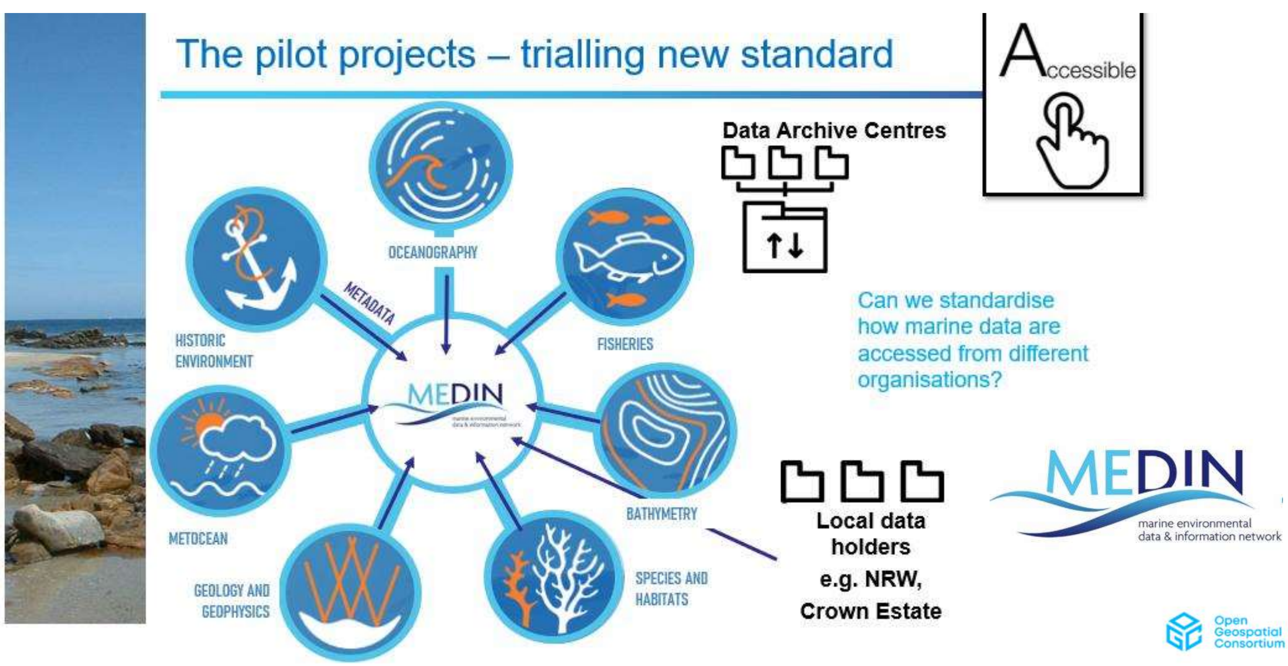
Example Work MEDIN (FAIR Mission –OGC EDR API)



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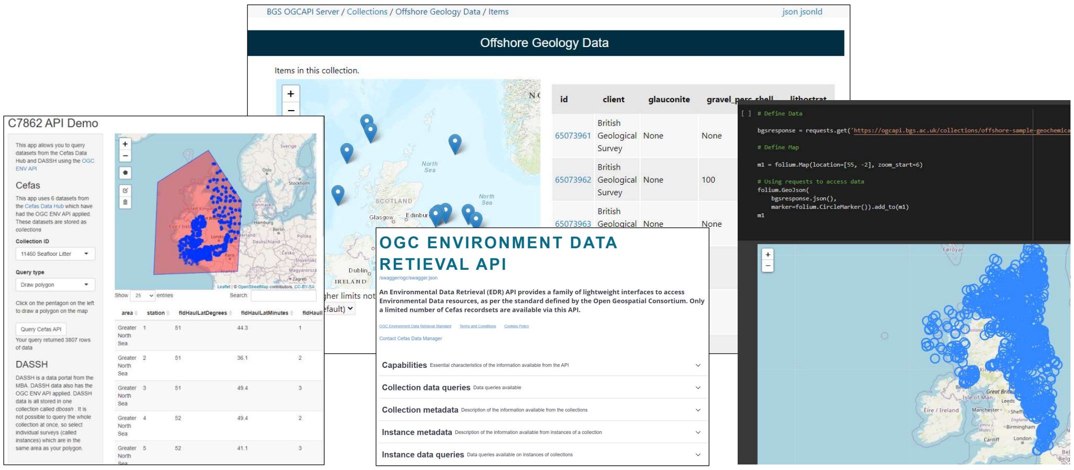
The pilot projects – results!

Learn more about the results on Monday February 20th at the next OGC Member Meeting in Frascati, Italy, hosted by ESA/ESRIN (Remote attendance available), Where MEDIN will present a summary of all 3 projects



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Important!
Web Services to OGC APIs
Will work together!

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- Overview of FMSDI initiative
- FMSDI Phase 1 Results and Lesson Learned
- FMSDI Phase 2 Results and Lesson Learned
- FMSDI Phase 3 Status and Lesson Learned
- OGC Testbed 18 – Marine Elements
- FMSDI Phase 4&5 and Future Plans

For more information you can see OGC FMSDI Phase 1&2 and FMSDI Phase 3 Web Pages

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FMSDI Initiative

Demonstrate aspects of multi-country/region Federated Marine Spatial Data Infrastructures:

- **Stakeholders** - Inclusivity – future focus on less developed regions
- **Delivery** - Demonstrate how federated Marine SDI can provide simple, secure access using modern standards based approaches (OGC APIs, IHO S-1XX), ISO);
- **Areas of interest -** Baltic and North Sea, Arctic, South East Asia , Caribbean

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Timeline - Marine Domain

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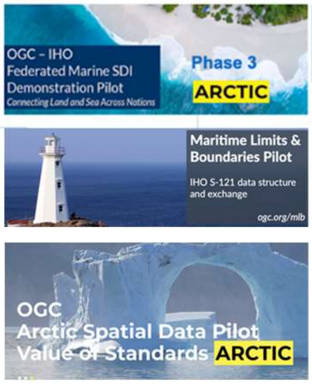
FMSDI Initiative



Phase 1 (Sep-Dec 2021)	Phase 2 (Jan-June 2022)	Phase 3 (Jul-Dec 2022)
Understand status quo	**Demonstrate marine protected areas at OGC API endpoints** **UNGGIM-IGIF derived maturity model for Marine SDIs**	**Extend to the Arctic** **Add more data, more services to address more complex scenarios**

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FMSDI Phase 1-3 Initiative Sponsors

Danish Geodata Agency

UK Hydrographic Office

NGA
NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

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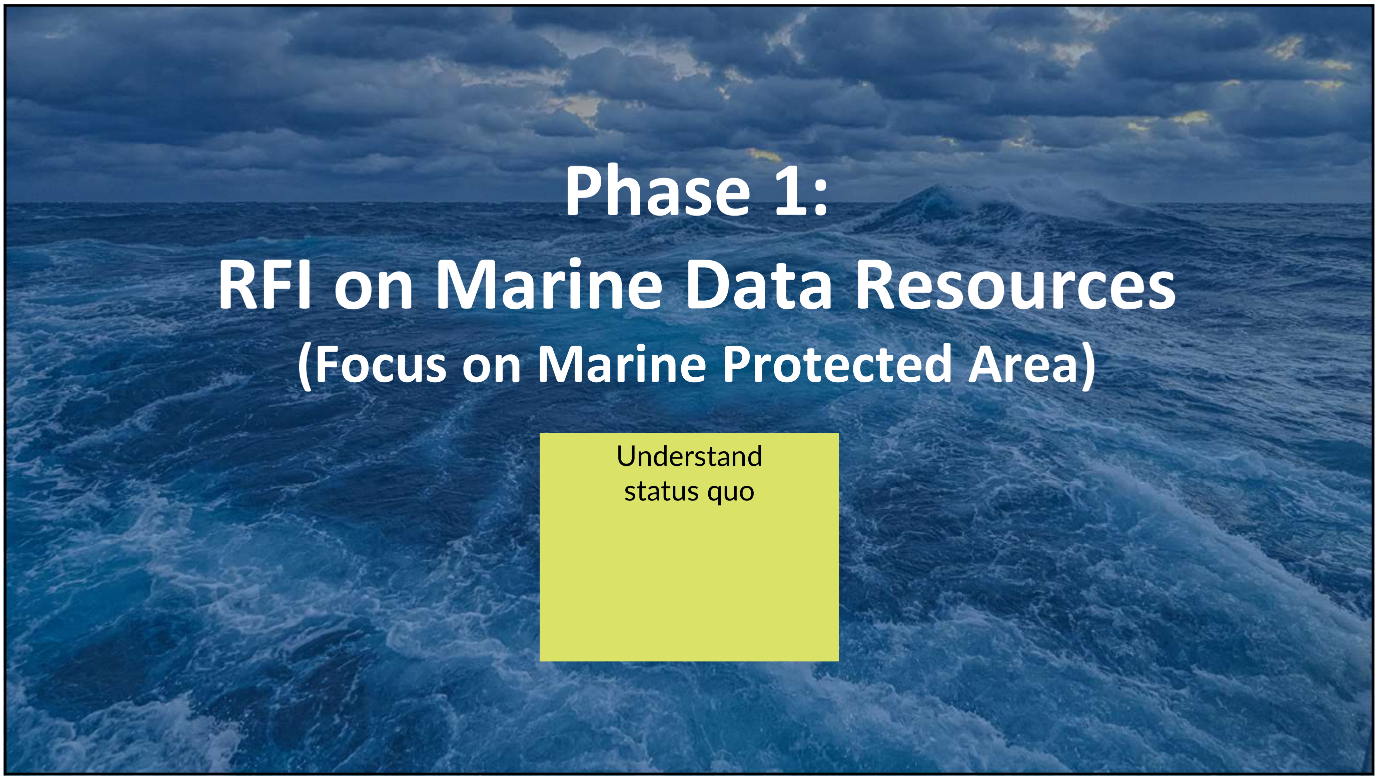

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RFI Responders

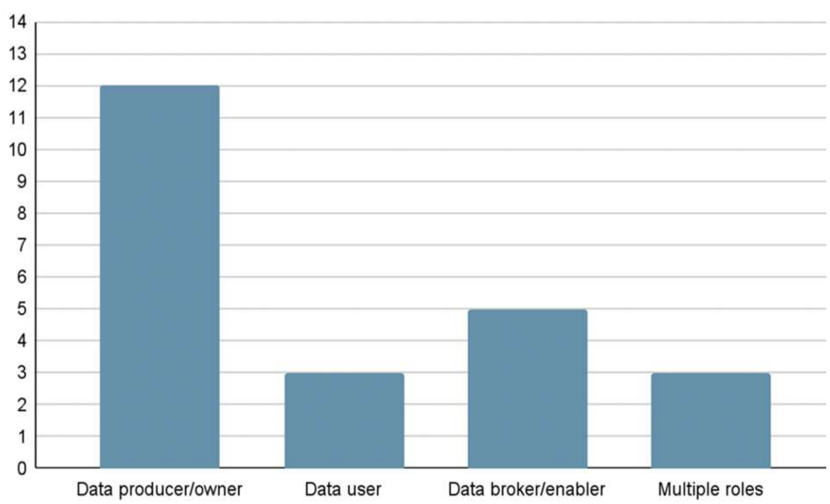

Figure A.2 — Summary of the 14 responses received to the question regarding their role as a data "producer/owner", or "user" or "broker/enabler" or have a "multiple roles"

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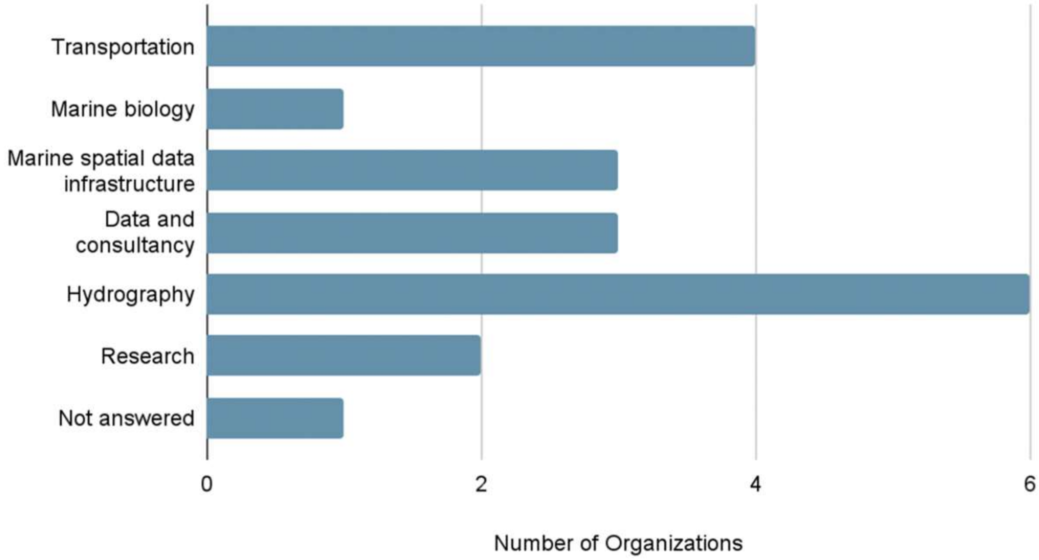
RFI Responders



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RFI: What data is served at what API?

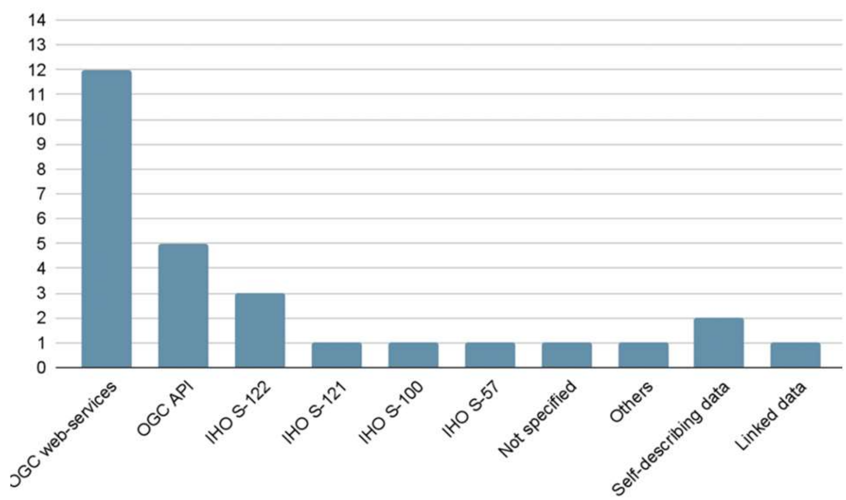

Figure A.8 — Summary of the answers from 14 respondents regarding what current and/ or emerging open international standards they employ within the context of an MSDI.

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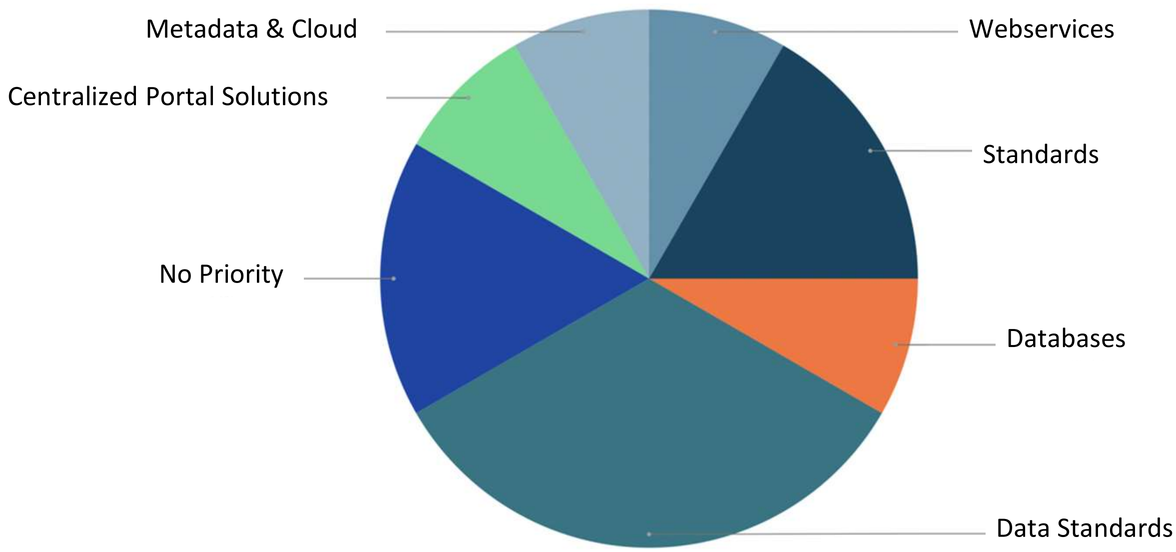
RFI: Key SDI Technology



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RFI: Results and Summary

1. The need for international collaboration in the FMSDI is prominent
2. A regional approach for the FMSDI may be best
3. As these regional MSDIs become established, they can coordinate with neighboring regions to ensure interoperability and share best practices.

RFI is documented in Annex A of the [Engineering Report]

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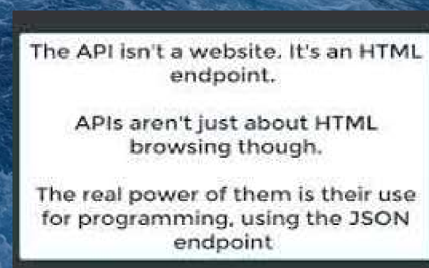
Phase 2:
IHO and OGC Standards Applied to Marine Protected Areas

Demonstrate marine protected areas at OGC API endpoints

UNGGIM-IGIF derived maturity model for Marine SDIs



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Phase 2: Summary & Participants

- Demonstrate access to **Baltic/North Sea Federated Marine Protected Area** (MPA) data for a wider **variety of end users** outside of the traditional MSDI domain.
- Demonstrate marine data infrastructure **beyond S-1xx data** (greater fidelity, mobility, and variety of data and standards (e.g. terrestrial, meteorological, earth observation, online sensors, etc.))
- Test and improve marine data accessibility and analysis with modern **OGC APIs**

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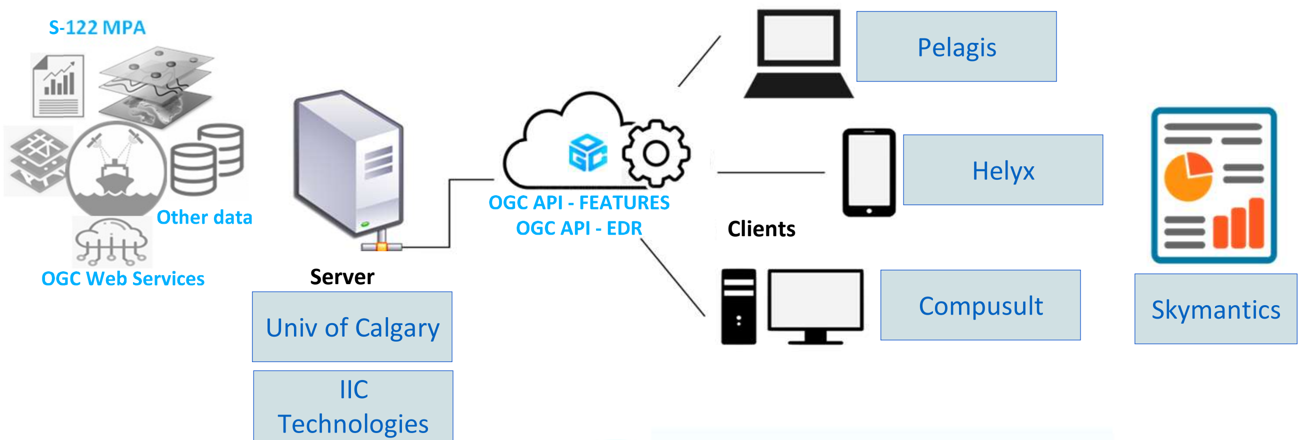
Phase 2: Summary & Participants



Phase 2 Demo Videos are available at the Youtube.

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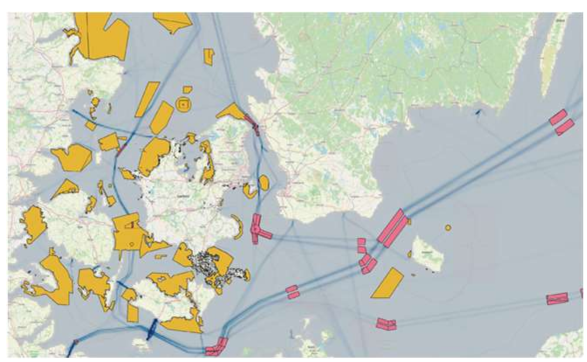
Phase 2: Demo Result

IIC Technologies Server (Demo link)

- To ingest the MPA data from various sources of the Baltic/North Sea providers, transform the data to comply with the S-122 standard, and offer it through Modern OGC APIs.
- Proposed **enhancements to IHO S-122 model** to encompass broader uses of MPA data
- Query Endpoint supporting **complex queries on data**.
- **GeoJSON encoding of S-100 data**.



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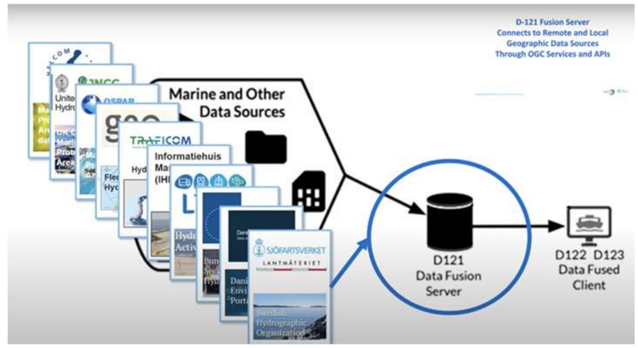
Phase 2: Demo Result

UCalgary Server (Demo link)

- Fusion server that integrates multiple data sets
- Uses DGGS with support for raster and vector data
- DGGS-powered server exposes OGC Environmental Data Retrieval (EDR) API



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Phase 2: Demo Result

Helyx Client (Demo link)

- Ingest MPA data from server
- DDIL (Disconnected, Disrupted, Intermittent, Low-bandwidth) viewpoint

Scenario

- Vessel at sea needs to query what MPA features exist within 5NM of a given route

Previous work addresses compensating mechanisms

- Caching
- Data compression
- Geopackages

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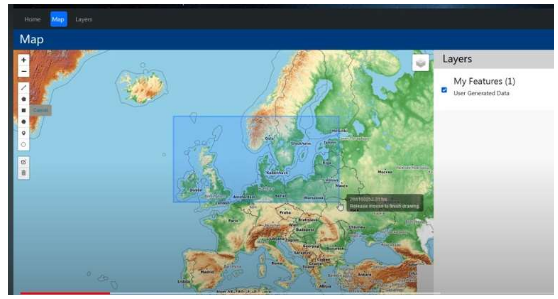
Phase 2: Demo Result

Compusult Client Demo [(Demo link)]



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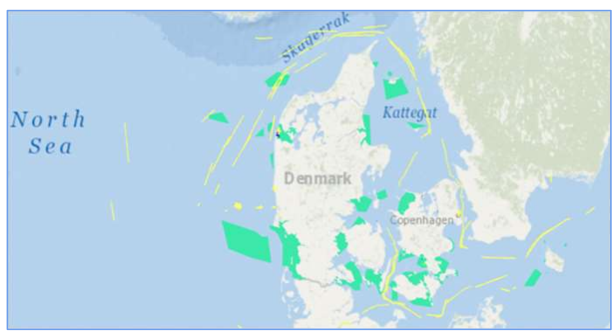
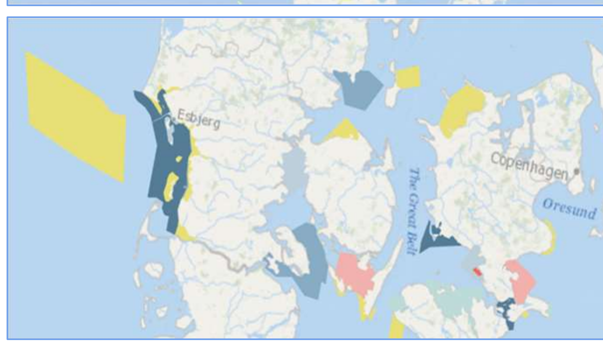
Phase 2: Demo Result

Pelagis Client

- Provided MPA server for Baltic and North Sea
- Integrates data from multiple agencies
- Focus was on different views on the data, represented as dedicated collections for direct consumption by consumers





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Engineering Report of Phase 1&2

Towards A Federated Marine SDI: IHO and OGC Standards Applied to Marine Protected Areas

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Phase 2: Engineering Report

Engineering Report is now accessible!

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Phase 2 ER: OGC Standards

- **Using OGC API — Features to Serve MPA Data**: The implementations of OGC API standards were found to be of great use because of their ability to retrieve data from the authoritative sources, the ease of automation by client services, the format-neutrality of such APIs and the fine control over retrieval which is not present in file based encodings. This allows for simple filters on data fields, compound and spatial queries, as well as simpler queries against bounding boxes.
- **Accessing MPA Data Through OGC API — Features**: Requesting all MPA features proved to be expensive from a computing perspective. Authentication and authorization was identified as not explored sufficiently.
- **Spatial Filtering Using a Bounding Box Query**: The `bbox` spatial filter, which is specified in Part 1 of the OGC API — Features standard, returned unnecessary data back to clients which can be a challenge for users operating in low connectivity environments where bandwidth is at a premium.

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Phase 2 ER: OGC Standards

- **Using Bounding Boxes to Represent Features in Denied, Degraded, Intermittent, or Limited Bandwidth (DDIL) environments**: Bounding boxes were created for some of the feature collections to reduce the complexity and size of the MPAs in order to make them suitable for DDIL environments.
- **EDR API and Discrete Global Grid System (DGGS)**: While the EDR API has been shown in the pilot project to provide a naïve client with the tools to successfully “explore” DGGS data, any client that requests a location from a DGGS server must understand the DGGS geometry it is receiving.

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Phase 2 ER: OGC Standards

- **Features API vs. EDR API**: While the Features API proved to do a great job serving distinctly identifiable entities like ships, routes, lakes, zones, among others, the EDR API provided a great way of accessing data that is not easily mapped to identifiable entities such as subsets of data about an area of interest.
- **Common Query Language (CQL) Support in Service Metadata**: The lack of information about CQL support in the API Service Metadata proved to be a downside.
- **Filtering Complex Features**: Searching Data from complex features was found to complicate the filtering processes for the clients.
- **Feature Styling in Features and EDR API**: The lack of styling support by both the Features and EDR API was found to be not ideal.

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Phase 2 ER: IHO Standards

- **Many agencies have extensive, detailed in-house databases** which are far more sophisticated than S-100/S-122, or that which is required for data exchange
- **The S-100/S-122 Model from a server perspective**: The current S-122 model was found to be fairly basic in terms of its representation of MPA data. This encoding, whilst a good fit for maritime use cases, did not seem to currently reflect the broader application of MPAs in different geospatial agencies and the richer attribution required for those uses.
- **S-100 needs a way of structuring the transformation of data** from one feature catalogue into another
- **Several suggestions** to S-122 content and structure enhancements made
- **Lack of support for providers** of Marine Protected Area networks noted
- **Developing an API** would allow internal/external interfaces to be expressed and data exchange to be defined. It would allow agencies to implement an S-100 "model" internally and transform data to/from S-122

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Phase 2: GeoJSON and OGC API-Features

- FMSDI2 has implemented a **GeoJSON encoding for S-100** data. The intention is to publish this as a formal document within the OGC. Once published, such an encoding would harmonise with OGC API Features and allow for seamless integration between S-100 data and OGC API Features.
- **CovJSON vs. GeoJSON**: For an EDR service, Coverage JSON would represent the data better instead of GeoJSON.

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Phase 3: Connecting Land and Sea to Protect the Arctic Environment

- Learn more about current capabilities and gaps of marine data & services offered by various Arctic Marine Spatial Data Infrastructures, Web portals, and directly accessible cloud/native data:
  - **Test interoperability** of international standards
  - **Showcase the value** of a data rich environment to stakeholders to further understand and respond to impacts of climate change and human activity
  - Support **building a data rich Federated Marine/Arctic SDI**
  - Allow for **better informed decisions**
  - Opportunity to **build on past efforts** and help advance technology and guide standards to increase interoperability

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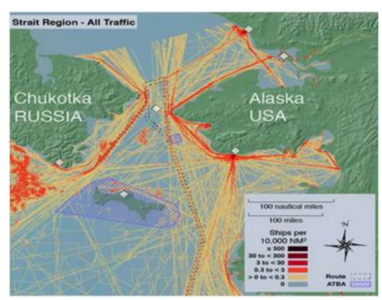
Phase 3: The Overarching Scenario

- In the last 12 years there have been a significant increase in shipping traffic (as is the risk of accidents)
- A sea-based, transportation, health and safety scenario incorporating the land/sea interface in Alaska
- Expedition ship runs aground in Kotzebue Sound, north of Nome Alaska
- Voyaging to Kangerlussuaq, Greenland, with approx. 200 passengers and crew on board
- Interoperability between land and marine data that is necessary to understand coastal erosion
- This area includes national parks and a number of Large Marine Ecosystems (LMEs) with challenging navigation conditions



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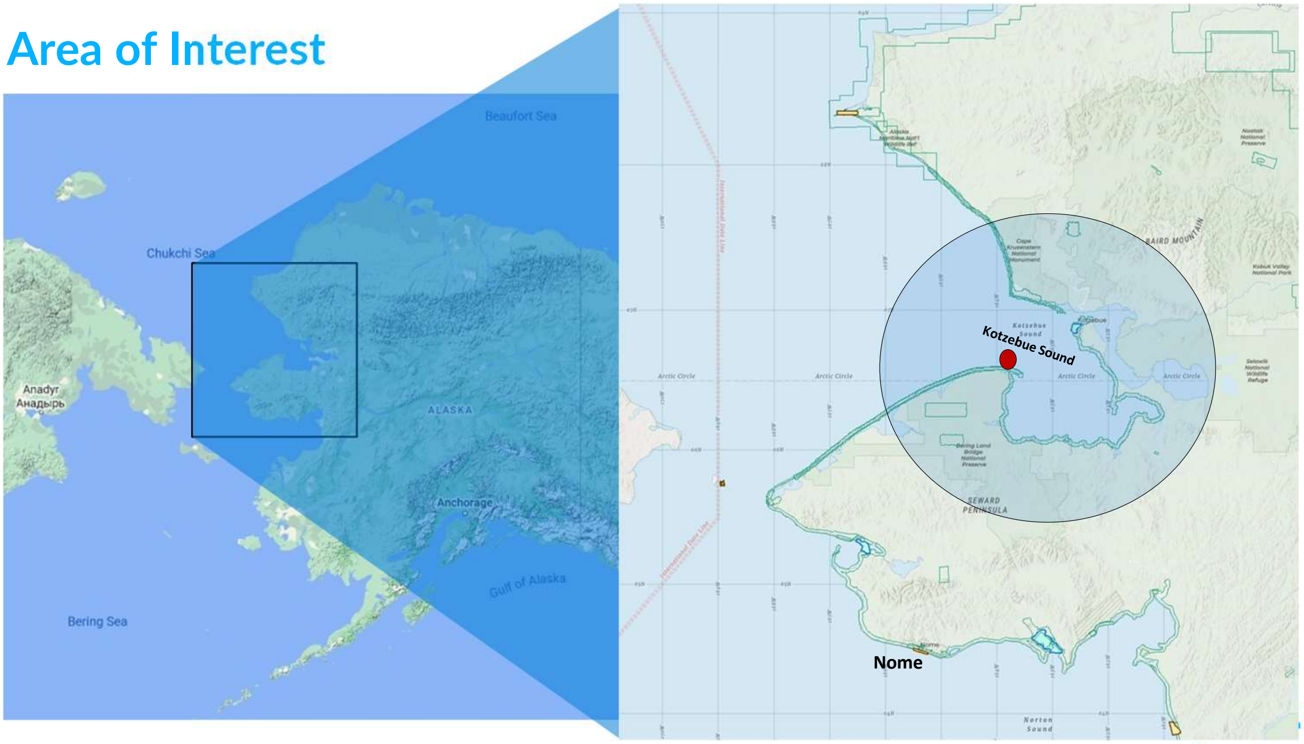
Area of Interest



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Sub-scenarios

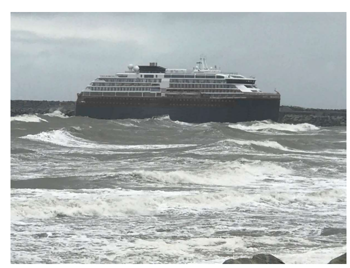
Development of Participant Sub-scenarios

All participants developed sub-scenarios within the context of the overarching scenario. Sub-scenarios workflows were linked to the overarching scenario through:

- **The Event - Vessel grounding** (weather and/or mechanical issues and/or coastal erosion)
- **Moving the vessel** - combination land (heavy equipment) & sea (tug boats) access
- **Rescuing / transferring passengers** and crew (immediate transfer of any injured)
- **Ecological impact prediction and mediation** (both on land and in the ocean)

End-to-end sub-scenario demonstrations:

- The exposure of existing data via OGC APIs.
- Consumption and interoperability of available data by OGC APIs and IHO standards.
- A focus on the marine / terrestrial boundary.
- Discovery of data and services metadata and integration into the overall incident.
- The binding to, or the portrayal of data and services via a variety of clients and/or GIS application.



Expedition cruise ship, Discovery - grounded

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Sub-scenarios

- Supporting **emergency operations and potential threats to the surrounding marine ecosystems** in the arctic – Compusult Ltd
- Blending of **a diverse IHO S-100 content with OGC APIs** for **marine rescue activities**. - IIC Technologies
- Consuming and testing the **performance and compatibility of datasets** to develop an **Arctic Voyage Planning Guide in the search and rescue scenario**. - ESRI Canada
- **Anthropogenic and environmental areas affected from an oil spill** when the vessel is **recovered and towed to a suitable port -** Helyx Secure Information System Ltd
- **OGC DGGS API,** and **coastal erosion, rising sea levels and navigational hazards -** University of Calgary
- Demonstrate the **use of 3D DGGS** in performing **analytics related to coastal flooding and erosion** - Ecere Corporation
- Demonstrate a cross-cutting, server/client solution **leveraging cloud infrastructure and real-time data** - Tanzle -

Expedition cruise ship, Discovery - grounded

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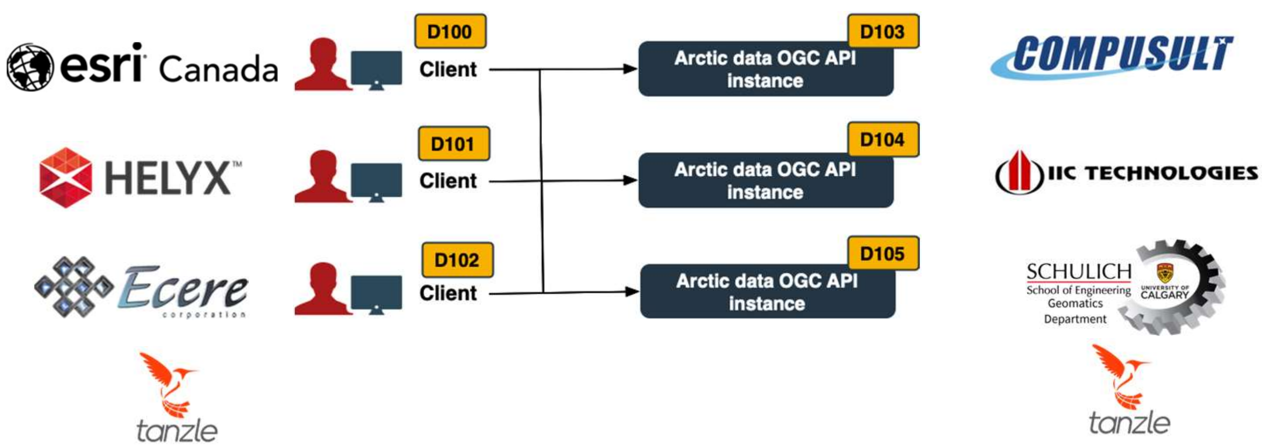
Phase 3: Tasks and Participant



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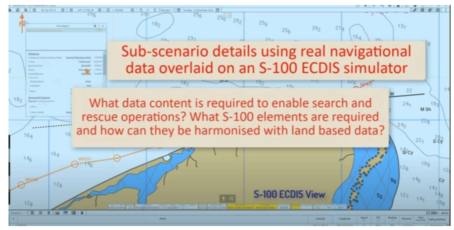
IHO S-100 and OGC APIs for Marine Rescue Activities

IIC TECHNOLOGIES

- **Created a detailed scenario of a grounding incident of a cruise vessel in the test area, together with search and rescue responses.**
  - The grounding incident was as detailed as possible and realistic in its conception.
  - Details attempted to ensure scenarios for land/sea integration and data interoperability were key to the responses.
- **An aggregation of various S-100 datasets to support the incident response, scenarios for their use and distribution**
  - Prepared from existing navigational publications where it did not already exist. This included both pre-prepared data already extant in the region, e.g. NOAA approach charts of the area and data prepared/digitised specially for the scenario
- **OGC API Features endpoints of the prepared, demonstration data to examine the applicability of API access to such S-100 data**
  - Aggregations of Chart Features
  - Land Areas
  - Depth Areas, Dredged Areas and Soundings
  - Routing
  - Vessel Traffic Management and regulated areas
  - Aids to Navigation and significant features.
  - Radio Signals and Communications
  - Land Infrastructure / Runways and Land Region
- API endpoints were aggregated **using definitions from the IHO geospatial registry with coverage and meaningful descriptive metadata**. The APIs were encoded using an S-100 General Feature Model (GFM) JSON encoding which was drafted during the project. pygeoapi provided the endpoint functionality



Demonstration Video

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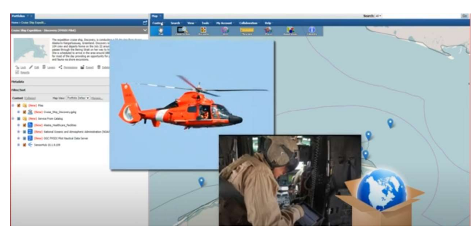
Emergency Operations for Threats to Marine Ecosystems

COMPUSULT

- **Interoperable Technologies:** OGC API - Features, Coverages, Styles, OGC Catalog, OGC SensorThings API (IoT),OGC services (WMS, WMTS)
- **Data and Platforms –** Accessed via OGC API - Features and OGC WMS
- AIS Ship Traffic (API Features)
- Live flight information
- Daily Polar Sea Ice
- Metar Weather Reports
- NOAA ship and buoy data
- Accessing the following data through local OGC API – Coverages
- NOAA GRIB Weather Data

Challenges and Lessons Learned

- The results of this **pilot showed the lack of data in the subject area**. The Arctic Voyage Planning Guide provided a significant amount of data through much of the Arctic region but only a small subset of the layers contained data in the subject area.
- **Lack of styling rules and legends**. Without styling and legends it was difficult to put the data in the right context for the end user.
- Compusult overcame the styling problem with its own API and client **by extending the OGC API - Features to induce references to SLDs** that were utilized in Leaflet through the open source addition of Leaflet.sld.js.



Demonstration Video

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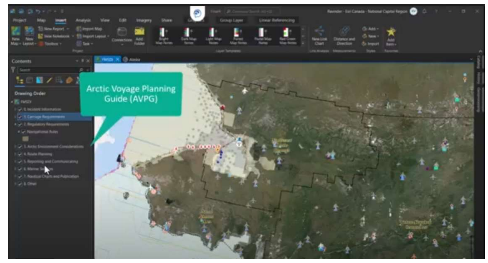
Compatibility of Datasets - Arctic Voyage Planning and search &rescue scenario

esri Canada

- Esri Canada (Client D100) used ArcGIS Pro (*latest version*) software:
  - To consume and test the performance and compatibility of the datasets provided by the servers (*server 1 and 2*)
  - **Developed an Arctic Voyage Planning Guide** to help the ship captain in search and rescue scenarios.
- **Easy to integrate the OGC compliant data** from other servers into ArcGIS Pro.
- **No issues in terms of data interoperability and interac**tions



Demonstration Video

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Oil Spill Effects During Recovery

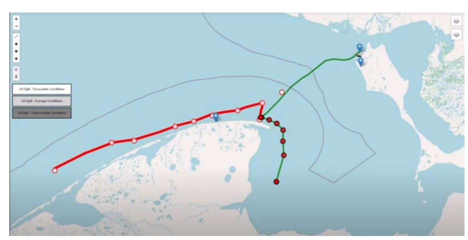
HELYX™

Overview

- Built web client using Leaflet (open JS library)
- End user without desktop GIS capability
- Connect to numerous data sources
- Perform analysis in the client

Key findings

- Can easily consume and visualise various types of geospatial data
- Via OGC APIs, WMS / WFS and local files
- Able to perform client-side processing
- Can struggle with large datasets or complex shapes
- Datasets from different sources do not always reconcile
- Most noticeable differences around coastlines



Demonstration Video

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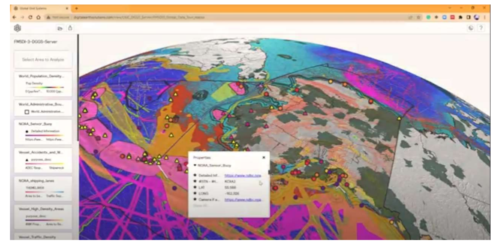
DGGS API and coastal erosion, rising sea levels and navigational hazards

SCHULICH School of Engineering Geomatics Department
UNIVERSITY OF CALGARY

- The University of Calgary team demonstrates interactivity between a Discrete Global Grid System Server and an end-user Client application using Open Geospatial Consortium API and Discrete Global Grid System Standards.
- Users Calculate, Explore and Search/Filter over 150 GB of geographical data integrated by the DGGS on-demand ready for their analysis ; Scientific - **Coastal Erosion, Navigational - Risk Assessment, and Environmental - Climate Change** within the study area in Alaska.



Demonstration Video

Key takeaways include:

- Prototyping a DGGS Tile Generator to interoperate and transmit DGGS data via OGC Tile Matrix standards.

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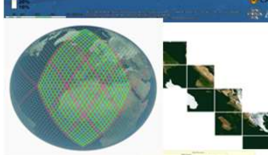
DGGS API (3D) - Analytics Related to Coastal Flooding and Erosion

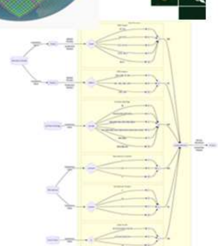
Ecere corporation
GNOSIS

Visualizing output of **on-demand coastal erosion** analysis from *University of Calgary* server (*OGC API - **DGGS***)

ISEA9**R** (**rhombic**) **Equal area *and* axis-aligned** DGGS, **2D TileMatrixSet** (*OGC API - **Tiles***)



Coastal erosion workflow expressed with *OGC API – Processes - Part **3**: **Workflows and Chaining***, Common Query Language (**CQL2**)



Demonstration Video

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Phase 3: Demo Result

Demonstrate a cross-cutting solution leveraging cloud infrastructure and real-time data.

tanzle

- Modular data integration platform
- May be configured to source and supply any describable data in raw and standard formats
  - including but not limited to IHO and OGC standards
- Organize data in a *when-where-what* order
- reactively manage meta data
- Provide a real-time data plane and efficient visualization of data over time

Demonstration Video

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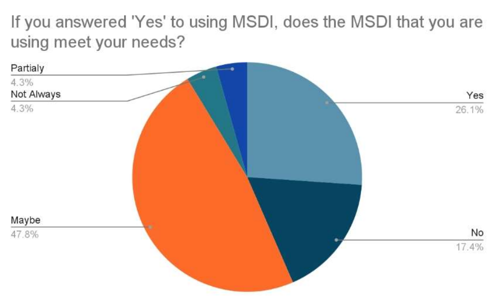
Survey

Released in October 2022 to gather and identify the requirements and use cases of a regional/international MSDI. to help shape the OGC's future FMSDI pilot activities and to serve the user community's needs better (n=35) – questions listed below.

- Is your organization aware of marine spatial data infrastructures (MSDIs)?
- Is your organization aware of the concept of a Federated MSDI?
- What is the overall role of your organization in a federated marine spatial data infrastructure
- Is your organization aware of marine spatial data infrastructures (MSDIs)?
- Is your organization aware of the concept of a Federated MSDI?
- What is the overall role of your organization in a federated marine spatial data infrastructure
- What activities is your organization involved in within the marine domain?
- Do you use any of these spatial/marine standards?
- Do you currently use an MSDI (Marine Spatial Data Infrastructure)?
- If you answered 'Yes' to the previous question (#6), does the MSDI that you are using meet your needs? Please rank each of the FAIR (Findable, Accessible, Interoperable and Reusable) Data Principles as it applies to data and services provided in the MSDI you contribute to or access (5-star rating system, with a 5-star being the best score).
- Please rank the UN-GGIM Integrated Geospatial Information Framework (IGIF) Strategic Pathways, on the basis of needed improvement to enable federation of the MSDIs you contribute to or access, from your perspective
- Please provide applicable high-level use case(s), from your point of view, that would best exercise a federated MSDI.

Full Results will be discussed as part of the Engineering Report review



Need to continue implementing interoperability between OGC and IHO to make more IHO S-100 datasets available to the public.

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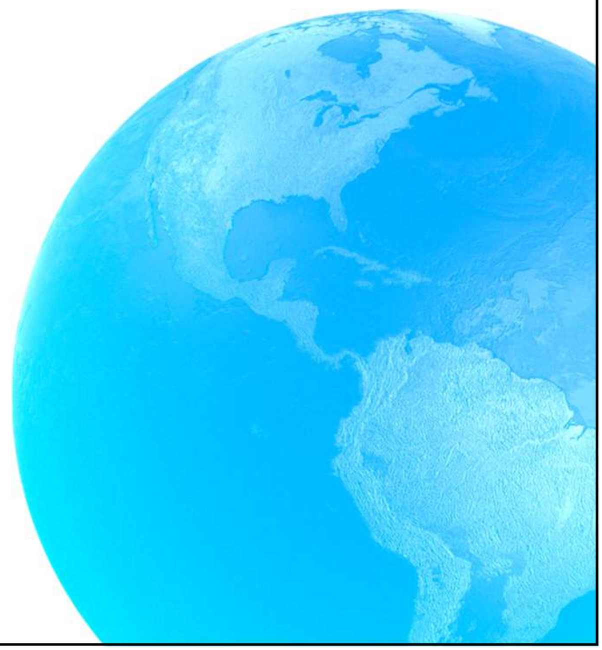
Testbed 18

Moving Features and Sensor Integration



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Developing Location Interoperability

Task Objectives:

Develop a framework for interoperable sensor data integration and to demonstrate its capabilities in the context of moving features from multiple sources into a common analytic environment

Deliverables:

D140/141: Moving Features Ingestion Service
D142: Sensor Hub
D143: Client
D020: Moving Features ER

Research Problems:

Harmonization of sensor integration approaches across the existing and emerging OGC and external standards

The maturation of the Moving Features architecture and its integration with the harmonized OGC sensor architecture

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Roadmap

Federated MSDI Initiative

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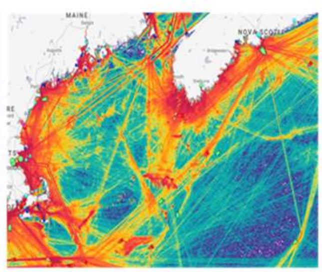
Scenarios

Application to the Marine Environment


Hurricane Tracking


Vessel Tracking


Environmental Monitoring

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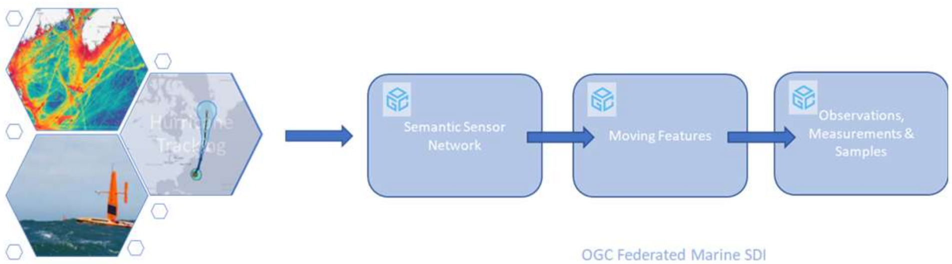
Approach



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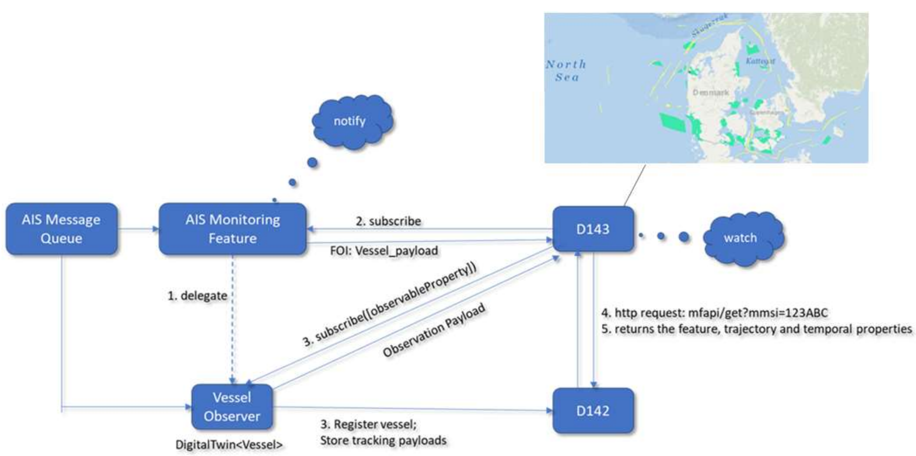
AIS Vessel Traffic



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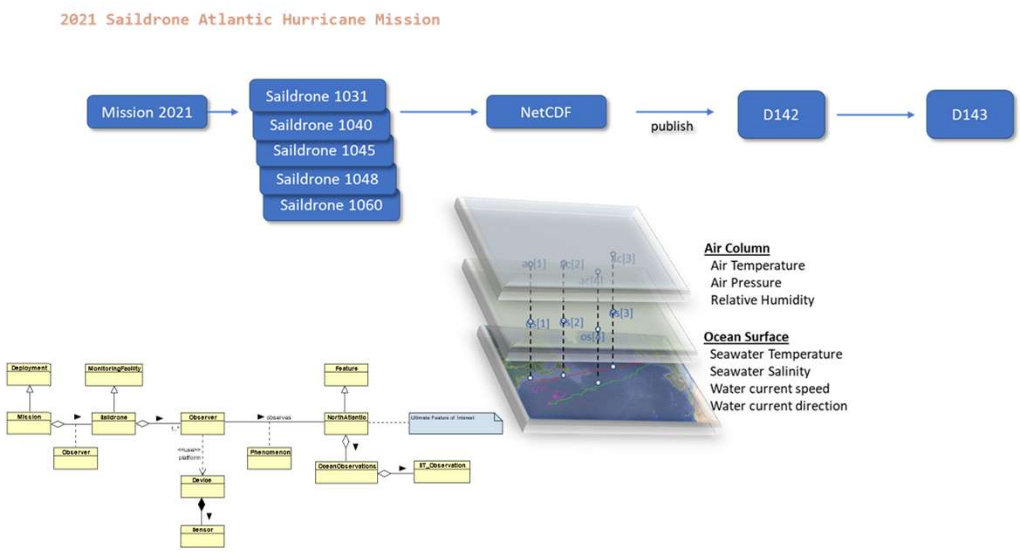
NOAA / PMEL Saildrone Program



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NOAA Hurricane Monitoring Program

Diverse sensor observation systems for heterogeneous data

- Hurricane track data
- Wind speed
- Pressure
- HDOB (High Density OBservation)

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Data Model Transformation

Feature of Interest (only static info)

uid: urn:osh:foi:vessel:316026695
name: CSL WELLAND
description: Vessel 316026695
mmsi: 316026695
imo: IMO9665279
callSign: CFK5151
vesselType: Cargo
length: 225.0
width: 23.0
draft: 9.0

+

Time Series

Observation (O&M / OMS)

phenomenonTime: 2020-01-01T00:10:54Z
featureOfInterest: urn:osh:foi:vessel:316026695
result:
location: POINT(-84.29747, 46.48246)
sog: 3.8
cog: 335.7
heading: 334.0
status: 0

Observation (O&M / OMS)

phenomenonTime: 2020-01-01T00:09:46Z
featureOfInterest: urn:osh:foi:vessel:316026695
result:
location: POINT(-84.29671, 46.48132)
sog: 4.1
cog: 334.5
heading: 334.0
status: 0

…

Feature at time T

uid: urn:osh:foi:vessel:316026695
name: CSL WELLAND
description: Vessel 316026695
mmsi: 316026695
imo: IMO9665279
callSign: CFK5151
vesselType: Cargo
length: 225.0
width: 23.0
draft: 9.0

geometry: POINT(-84.29747, 46.48246)
sog: 3.8
cog: 335.7
heading: 334.0
status: 0

Moving Feature

uid: urn:osh:foi:vessel:316026695
name: CSL WELLAND
description: Vessel 316026695
mmsi: 316026695
imo: IMO9665279
callSign: CFK5151
vesselType: Cargo
length: 225.0
width: 23.0
draft: 9.0

+

Temporal Geometry

phenomenonTime	location
2020-01-01T00:10:54Z	POINT(-84.29747, 46.48246)
2020-01-01T00:09:46Z	POINT(-84.29671, 46.48132)
2020-01-01T00:08:34Z	POINT(-84.29583, 46.48003)
…	…

Temporal Properties

phenomenonTime	sog	cog	heading	status
2020-01-01T00:10:54Z	3.8	335.7	334.0	0
2020-01-01T00:09:46Z	4.1	334.5	334.0	0
2020-01-01T00:08:34Z	4.4	335.1	334.0	0
…	…	…	…	…

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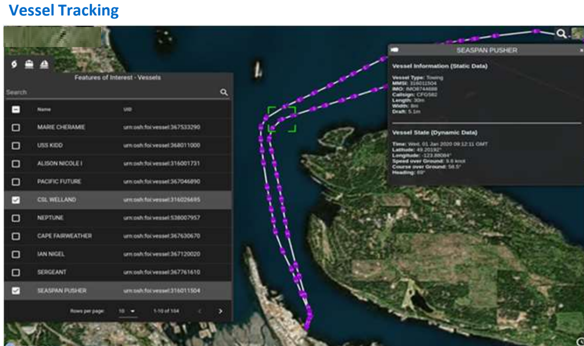
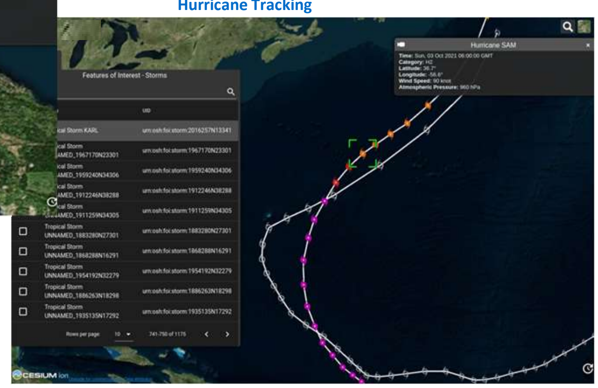
Application

Vessel Tracking



Hurricane Tracking



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Findings & Results

Existing OGC technologies can support dynamics and motion.

Extensible systems architecture supporting the movement of real-world features and observers in both space & time

Contextual observations of features, movement and historic trajectories relative to features of interest and coverages

OGC Connected Systems working group

Scalability of the observation domain to 3D+ for the marine environment

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Testbed 19 – Moving Features 3D+

Freeing OGC standards and technologies from Terrestrial constraints

Moving Observation Systems

Tighter alignment of standards for hosted observers of real-world features

Architecture and standards for Moving

Feature content to support 3D (six degrees of freedom) and 4D (spacetime) geometries.

Moving Features traversing open space

Can the nature of movement in 3D+ be applied to the oceans environment

non-Terrestrial CRS and spacetime CRS

Is there a consideration for an Oceans-specific CRS for movement under the sea?

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Federated MSDI

OGC Moving Features → **OGC Marine Reference Model**

- Mapping to the OGC Features API
- MF-JSON encoding @scale; alternative encoding formats
- Resolution of information model to existing OGC standards
- (Space) Time-series analysis
- Real time event modelling & inference

OGC Marine Reference Model

- Marine Regulated Areas (S-100)
- AIS Vessel Traffic
- Environmental Monitoring Features
- UN-GGIM IGIF-T

OGC Sensor Integration → **OGC Connected Systems**

- Resolution of sensor standard(s) to existing OGC standards and other industry standards (IHO, IMO, IALA, …)
- Complements and overlaps with OGC Observations, Measurements and Samples (OMS v3)
- Role of SSN towards a 'digital twin model' of the ocean
- The role of time – TM_Instant; TM_Period; Sampling Schedules
- The role of space – sampling points, curves, trajectories, corridors, coverages
- Observation Systems @Scale

OGC Connected Systems

- Modernization of the SensorML and related Sensor Web Enablement (SWE) Standards
- Alignment with OGC OMSv3
- Investigation of Coverage-based observations and OGC EDR

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OGC Marine Reference Model

Feature Domain Model

- IHO S-100 Standard
- IMO Vessel Traffic
- UN-GGIM IGIF-T
- Ocean Observation Systems

Application Service Model

- OGC Features API
- OGC EDR API
- OGC DGGS API
- OGC Coverages

Best Practices

- Marine Policy Management
- Vessel Traffic Management
- Climate Change
- Disaster Management
- …

Technology Agnostic

Aligned with core OGC Standards & Specifications

Referent feature domain model

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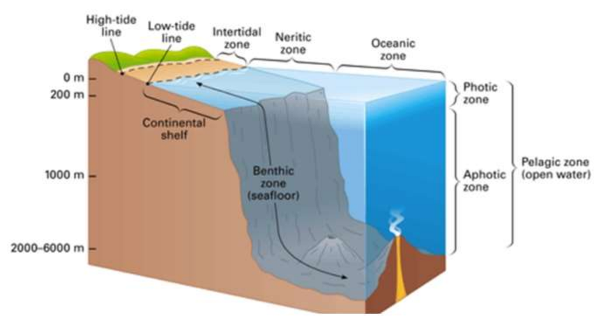
Digital Arctic

Government of Canada Gouvernement du Canada
Canada

Background:

Coastal erosion at the land – sea interface: Where the land meets the sea

- Demonstrating interoperability between land and marine data to understand coastal erosion (e.g. ocean currents, geology, permafrost characteristics, etc.) in the Arctic
  - Defining coastline (highest line) and transition zone.
  - Need to connect with national organisations working on the coastal transition zone.



(from https://bodell.mtchs.org/OnlineBio/BIOCD/text/chapter34/concept34.4.html)

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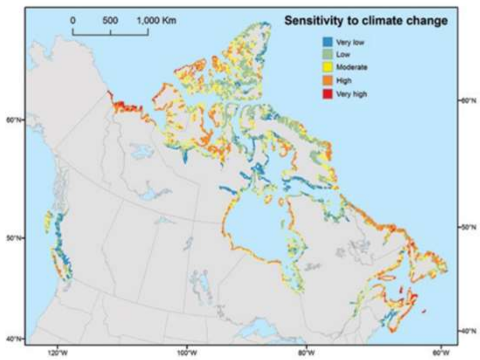
Digital Arctic

Government of Canada Gouvernement du Canada
Canada

Demonstrate the role of OGC Standards to:

- Support measurement of impacts of coastal erosion (e.g. infrastructure, food safety, traditional activities, wildlife migration, sea level rise, inundation etc.) in the context of a changing Arctic.
- Impact on wildlife migration corridors: land-sea ice-island (caribou) and sea (marine mammals)
- Mapping coastal sensitivity to climate change and the impacts on local communities
- Integrating Sensor Feed (e.g weather buoys), tabular and spatial data, improved data discovery, catalogues, web service to API transition, emerging Arctic requirements (e.g. vector tiles and style sheets across land - water interface (roads, coastline).



From Canada's Marine Coasts in a Changing Climate[2]

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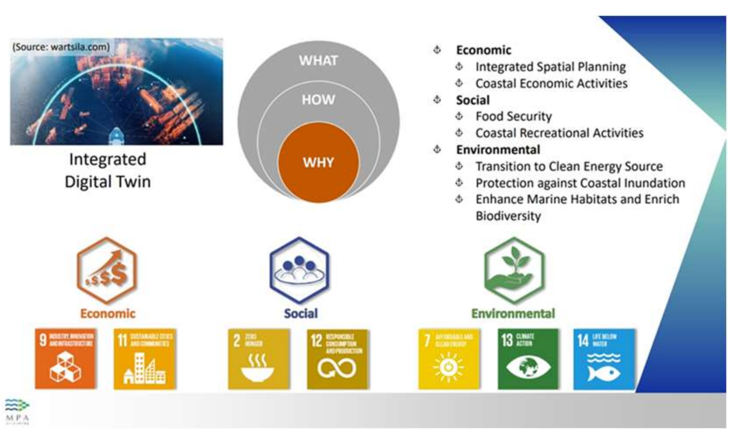
Digital Twin Challenge: Integration of Land and Marine data for Coastal Protection Planning, Critical Infrastructure Protection, and Resilience.



MPA SINGAPORE

SLA SINGAPORE LAND AUTHORITY

For More Details - attend tomorrow's joint Opening Session
Lecture Theatre (Level 2)
0830-1030am

Sources: Eric Foo, MPA - https://ggim.un.org/meetings/2022/4th-EG-LAM/documents/2.3_Eric_Foo.pdf , collected Sept 14, 2022
3D graphic courtesy of SLA : https://www.sla.gov.sg/articles/press-releases/2020/launch-of-onemap3d-beta-at-singapore-geospatial-week-2020

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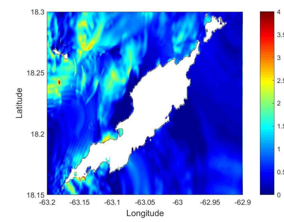
Use Case: Marine Data Interoperability in the Caribbean



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After Next ? Ideas ?

- **Additional Small Island States – Sea Rise Scenarios?**
- **Mediterranean – Cross Jurisdiction Federated MSDI /environment ?**
- **Middle East - Coastal Dynamics, sea rise , environmental sensitivity?**
- **Africa – Extreme Weather events (land and sea) ?**
- **South America - all the above ?**

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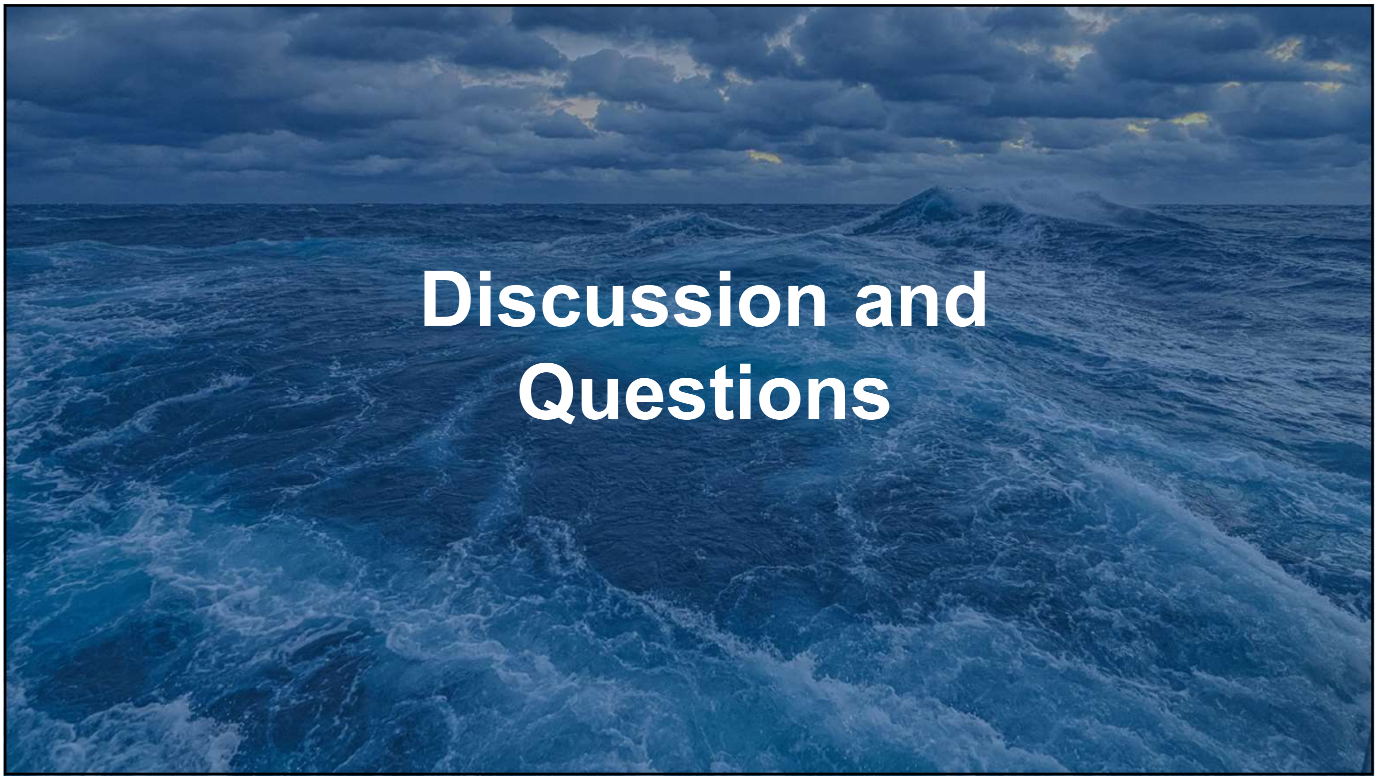

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Thank You

Community

500+ International Members
110+ Member Meetings
60+ Alliance and Liaison partners
50+ Standards Working Groups
45+ Domain Working Groups
25+ Years of Not for Profit Work
10+ Regional and Country Forums

Innovation

120+ Innovation Initiatives
380+ Technical reports
Quarterly Tech Trends monitoring

Standards

65+ Adopted Standards
300+ products with 1000+ certified implementations
1,700,000+ Operational Data Sets
Using OGC Standards

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