Development of Spatial Data Infrastructures (SDI) for Marine Data Management

OGC - IHO Marine SDI Concept Development Study (MSDI-CDS)

Sebastian Carisio

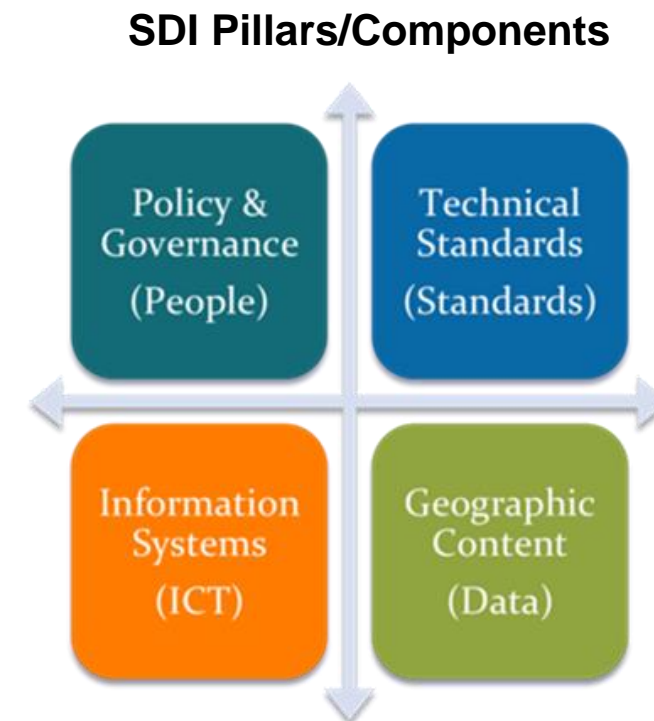*Lead Technical Cartographic Analyst, NGA Maritime Safety Office*

Vice-Chair, IHO MSDIWG

Co-Chair, OGC Marine DWG

Spatial Data Infrastructure (SDI)

- SDI
  - "The relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data."
    - The SDI Cookbook[1]

- Four Pillars/Components of SDI[2]
  - **Data and Metadata** - comprise the information to be made accessible
  - **Information System/Technology** - which encompasses the hardware, software and system component.
  - **Standards** - which emphasizes the "unlocking" of geospatial data.
  - **Policy and Governance** - which dictates the structural relationships of all those involved.
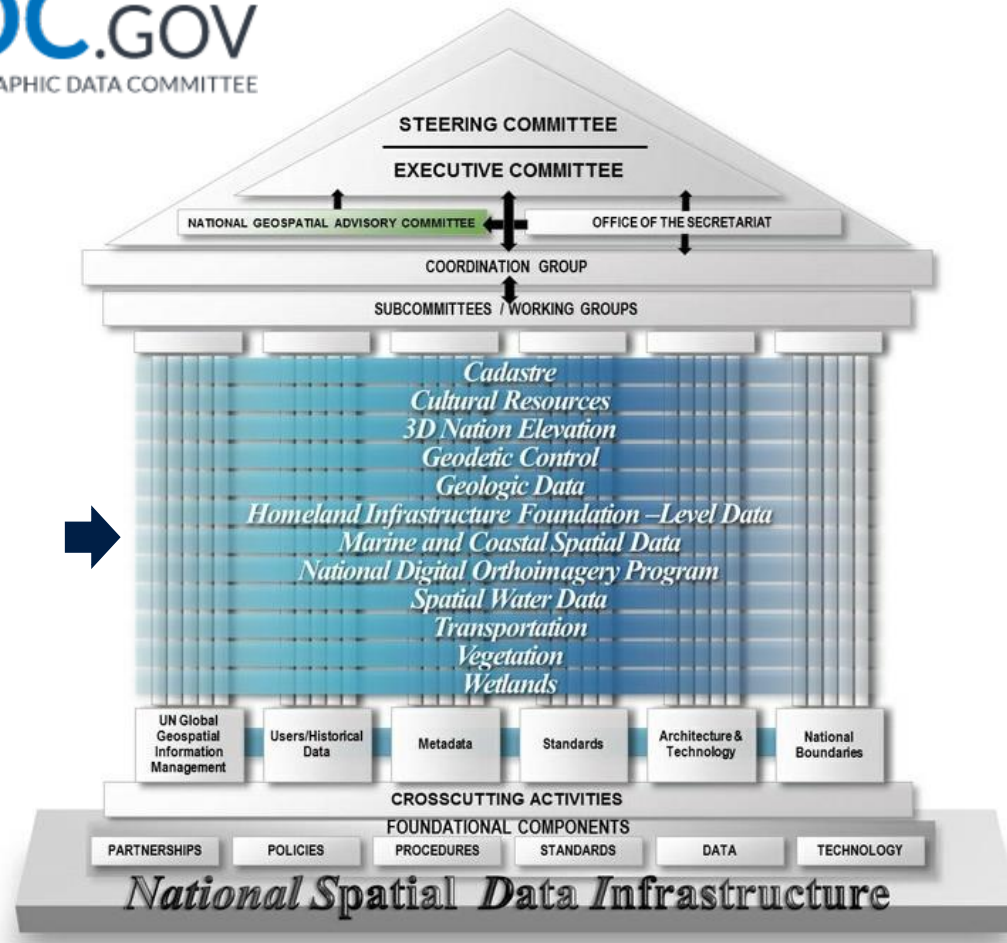
SDI Pillars/Components

Federal Geographic Data Committee (FGDC)

FGDC.GOV
FEDERAL GEOGRAPHIC DATA COMMITTEE

STEERING COMMITTEE
EXECUTIVE COMMITTEE
NATIONAL GEOSPATIAL ADVISORY COMMITTEE | OFFICE OF THE SECRETARIAT
COORDINATION GROUP
SUBCOMMITTEES / WORKING GROUPS

Cadastre
Cultural Resources
3D Nation Elevation
Geodetic Control
Geologic Data
Homeland Infrastructure Foundation –Level Data
Marine and Coastal Spatial Data
National Digital Orthoimagery Program
Spatial Water Data
Transportation
Vegetation
Wetlands

UN Global Geospatial Information Management | Users/Historical Data | Metadata | Standards | Architecture & Technology | National Boundaries

CROSSCUTTING ACTIVITIES
FOUNDATIONAL COMPONENTS
PARTNERSHIPS | POLICIES | PROCEDURES | STANDARDS | DATA | TECHNOLOGY

National Spatial Data Infrastructure

Geospatial Data Act of 2018

The GDA codifies the committees, processes, and tools used to develop, drive, and manage **the National Spatial Data Infrastructure (NSDI)** and recognizes responsibilities beyond the Federal government for its development. The GDA reflects growing recognition of the essential role of geospatial data and technology in understanding and managing our world and highlights the need to support their continuing development as critical investments for the Nation.
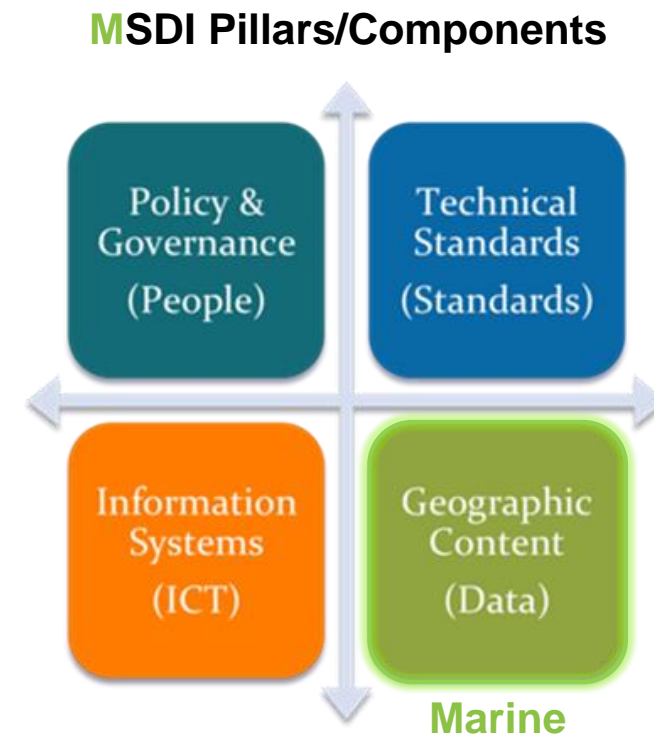
Directs the FGDC to lead the development and management of the NSDI Strategic Plan.

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IHO International Hydrographic Organization

# Marine Spatial Data Infrastructure (MSDI)

- MSDI
  - Element of SDI focused on the marine input.
  - A MSDI is not a collection of hydrographic products, but an infrastructure that promotes interoperability of data at all levels (e.g., national, regional, international).
    - Discoverability
    - Accessibility
    - Interoperability
    - Data-centricity
  - Supports wider, non-traditional user-base of marine data typically used for navigation.
  - MSDI Working Group (MSDIWG)
   - International Hydrographic Organization (IHO) working group to deliver IHO MSDI-related policy objectives.[1]

MSDI Pillars/Components

Policy & Governance (People) | Technical Standards (Standards)

Information Systems (ICT) | Geographic Content (Data)

Marine

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IHO
International Hydrographic Organization

"Marine" Spatial Data

- "Marine" used as the more generic and encompassing word to describe a variety of data types which might be combined for efficient analysis by a **wide range of disciplines and user groups**, for example:
    - **Hydrography**
    - **Oceanography**
    - **Marine Biology & Scientific Research**
    - **Ecology and Environmental**
    - **Maritime Governance**
    - **Transportation**
    - **Infrastructure (physical)**
    - **Industrial and Commercial**
    - **Tourism, Recreation, Cultural Use**

- "Marine" Data must be held in a generic way, rather than for a particular product for a limited user group or for a specific purpose. An MSDI is not a collection of hydrographic products, but an infrastructure that promote interoperability of data at all levels.

5

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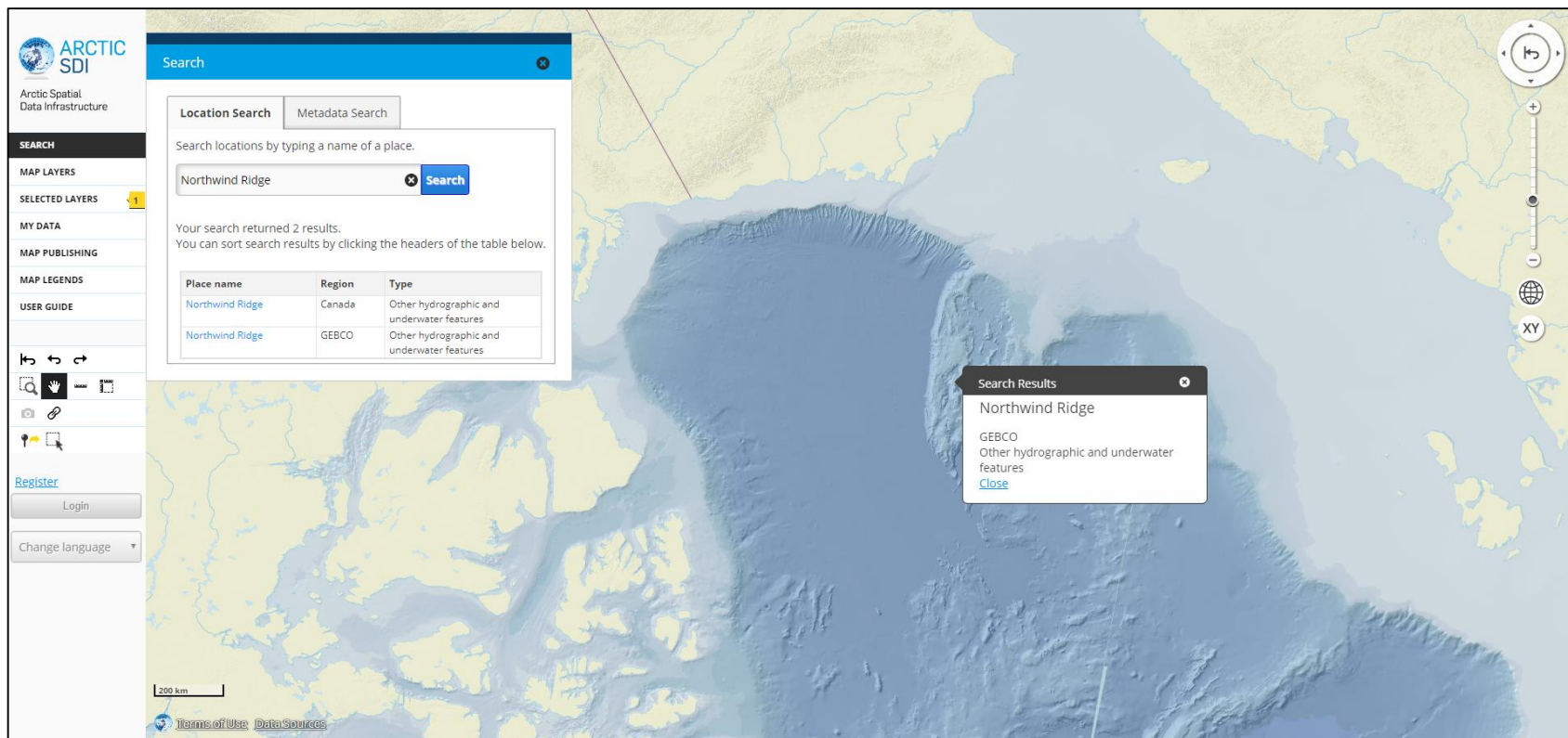IHO
International
Hydrographic
Organization
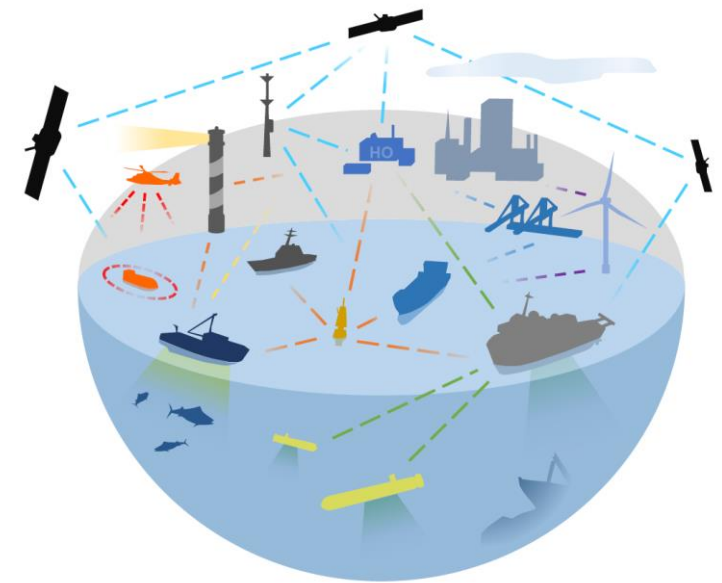
Example: Marine Spatial Data Reuse
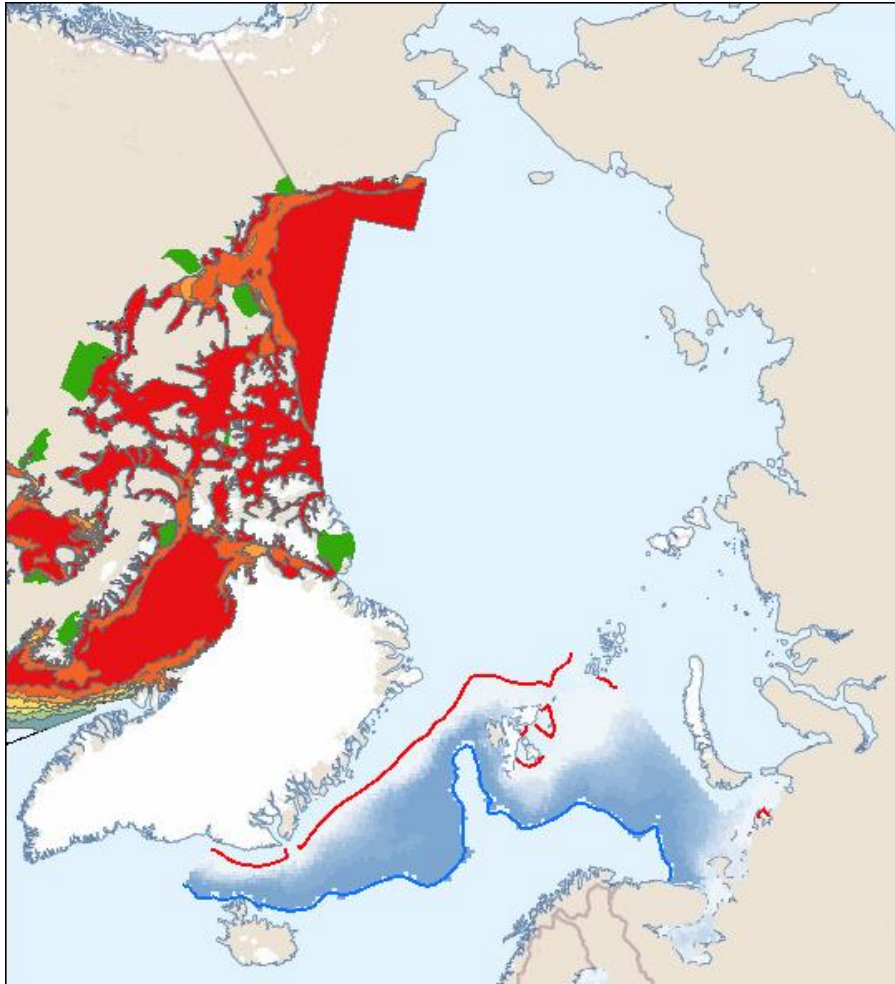
Canadian Arctic Voyage Planning Guide (AVPG) web service displaying in Norway Marine Spatial Management Tool made possible by OGC WMX standards.
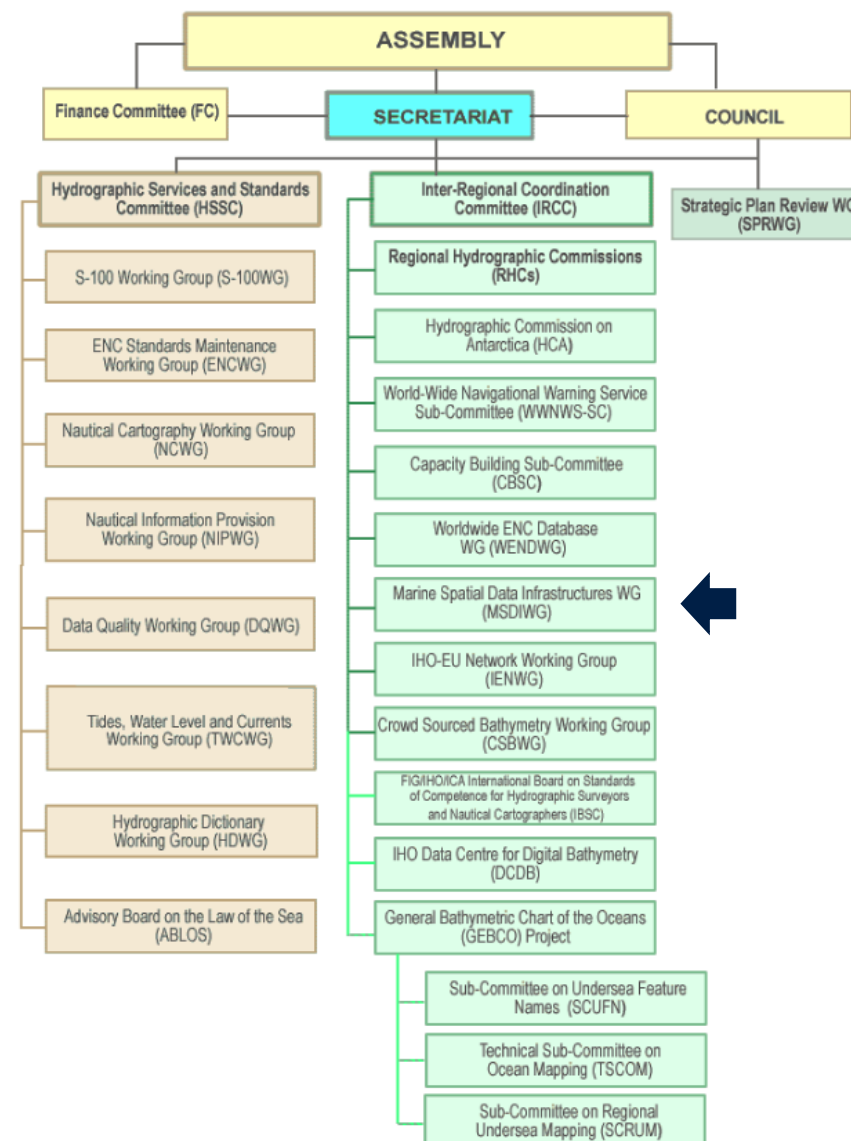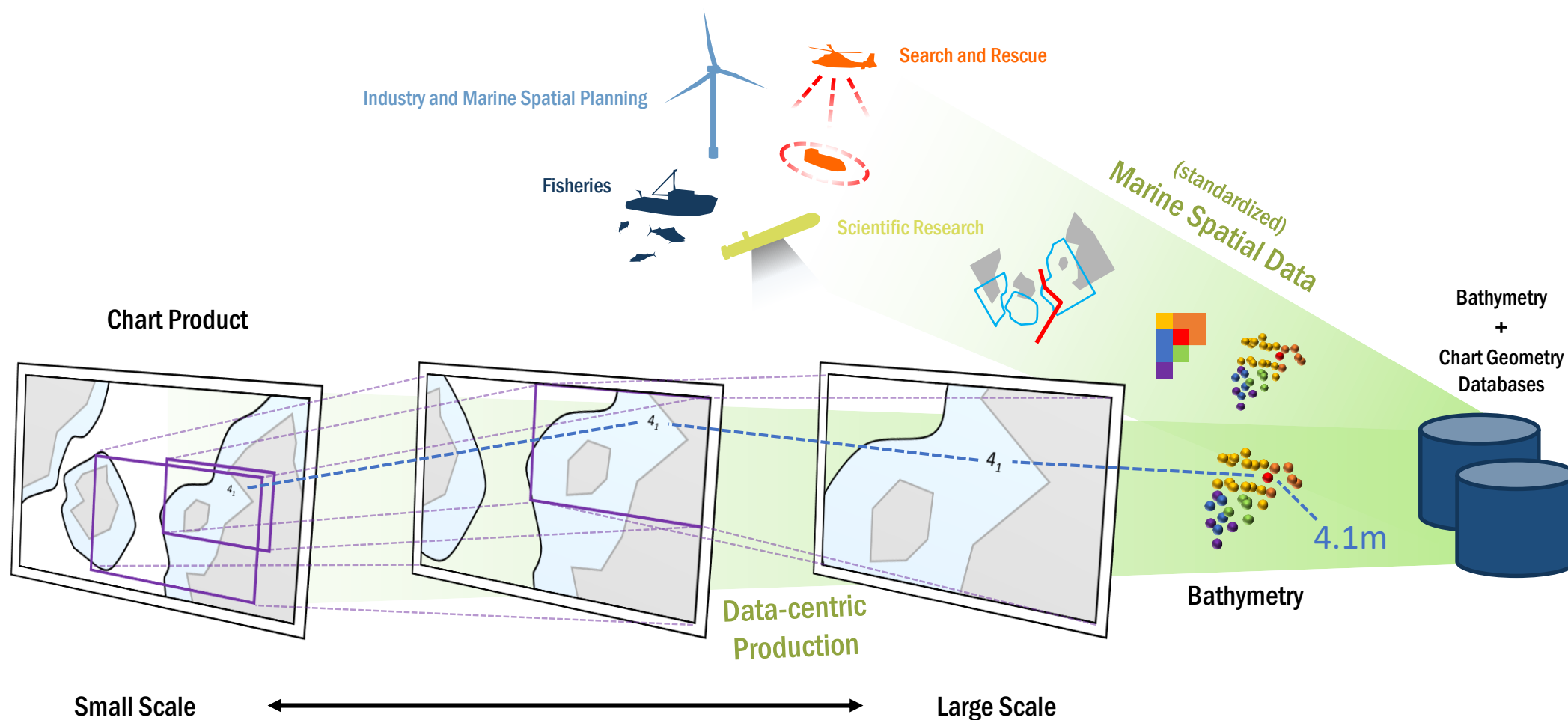
Example: Marine Spatial Data Reuse

Arctic SDI Geoportal displaying Arctic SDI Basemap, utilizing International Bathymetric Chart of the Arctic Ocean (IBCAO), and the GEBCO Sub-Committee on Undersea Feature Names (SCUFN) digital gazetteer service of the names, generic feature type and geographic position of features on the seafloor.

IHO MSDIWG

3.1 **Monitor national, regional and international SDI activities** and trends, and present information on those activities to IRCC members by correspondence and at the annual meeting.

3.2 Promote the use of **IHO standards** and member state **marine data** in SDI activities.

3.3 **Liaise**, as appropriate, with other relevant bodies to increase the visibility of marine spatial data.

3.5 Determine any actions that the IHO and individual Member State might take **to forge links with other bodies (e.g. OGC, ISO TC211, IOC)** to ensure Member States are best placed to meet the developing challenges associated with data management and governance.

3.6 Identify and **recommend possible solutions** to any significant technical issues **related to interoperability between maritime and land-based inputs to SDI**

3.7 Identify any **IHO capacity building** requirements related to MSDI.

3.8 Develop a **syllabus for MSDI familiarization**.

3.9 **Follow the development in MSP implementation worldwide.**

Data-Centric Production and MSDI

Industry and Marine Spatial Planning

Search and Rescue

Fisheries

Scientific Research

(standardized) Marine Spatial Data

Chart Product

Bathymetry + Chart Geometry Databases

4.1m

Bathymetry

Data-centric Production

Small Scale

Large Scale

OGC Marine DWG

- The DWG will also ensure that the evolving **IHO standards** (e.g. S-100) **are brought to the attention of the OGC members** and the evolving **OGC standards are brought to the attention of IHO members** in an effort to ensure best practices are being used and the latest technical approaches considered.

- The **DWG will work closely with the IHO MSDI Working Group** and potentially its adjacent groups/commissions/committees under the IHO Inter-regional Coordination Committee and the IHO Hydrographic Services and Standards Committee and other related organizations.

- **Membership will be open** to those with an interest in the marine geospatial data community. Active membership is defined by regular member contributions of material or participation in Marine DWG meetings and discussions.

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# IHO & OGC Memorandum Of Understanding

- WHEREAS, the IHO and the OGC wish to **harmonize their respective work programs**, **achieve mutual benefit** from sharing expertise of domain experts of the two organizations and welcome **cross-project participation** where appropriate.

- WHEREAS, the IHO and the OGC wish to recognize each other's unique capabilities and membership in order to cooperatively **promote new technology and content interoperability, achieve expanded membership growth and representation, and advance emerging interoperable capabilities.**
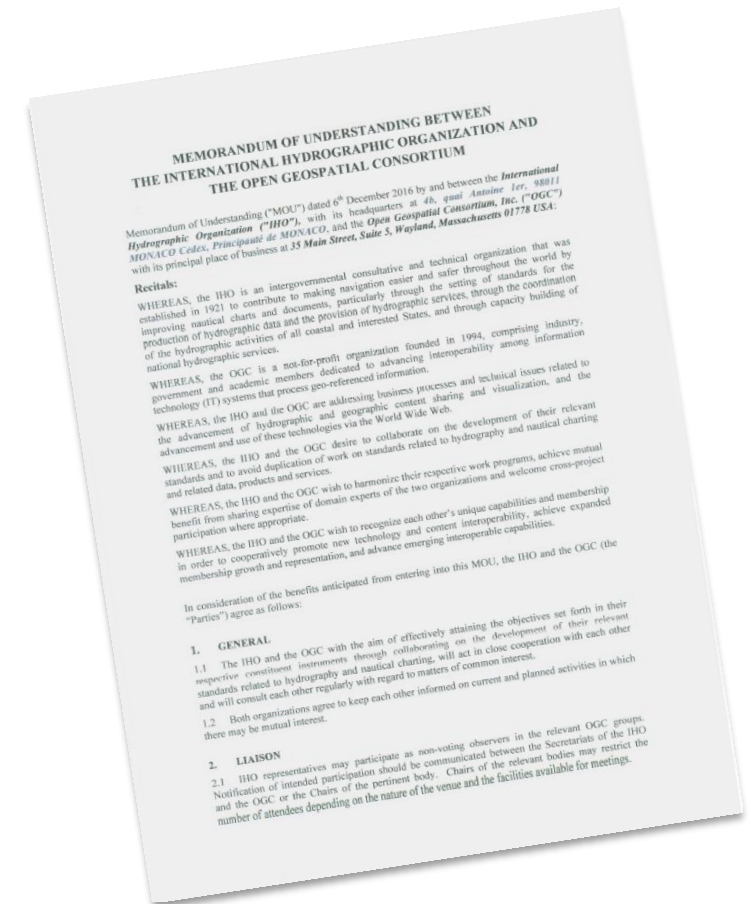
Marine CDS Background

- At the MSDIWG meeting in Vancouver 2017, the MS discussed the possibility to **create an IHO/OGC study that could establish the framework for future development of MSDI**.

  - Rapid advancement of technologies, diversity of data collectors, and increased data collection from non-traditional sources (e.g. corporate, citizens)

  - Expanding body of data collected for non-navigational applications (e.g. Ocean science, energy exploration, UN sustainable development goal 14)

  - Opportunities related to integration of diverse data sources & capabilities.

Shipboard
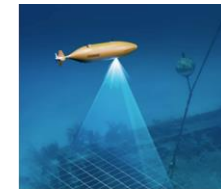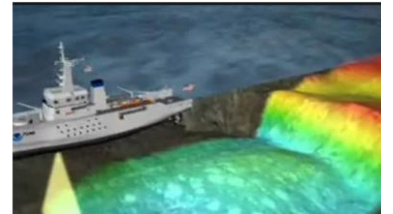
Autonomous Underwater Vehicle (AUV)

Crowdsource (IoT)

MSDI-CDS Objectives

- Engage different stakeholders across the Marine community (providers, developers, users) to understand the most important challenges.

- Document findings and provide recommendations on:
  - Scalable, interoperable MSDI reference architectures
  - Requirements that can be addressed in a follow-on Pilot initiative that focuses on MSDI best practices.

MSDI-CDS Progression

- Started MSDI-CDS (Summer 2018)
  - http://www.opengeospatial.org/projects/initiatives/msdi-cds-2018/

- MSDI-CDS Workshop (23 OCT 2018), US CMTS at the US Department of Transportation (USDOT).

- Request For Information (RFI) (07 FEB 2018)
  - RFI posted on OGC's website and distributed broadly throughout the international marine community.
  - Responses were gathered to help build the final technical report.
  - https://portal.opengeospatial.org/files/?artifact_id=81715

- MSDI-CDS Roundtable (27 MAR 2019)
  - Group of OGC members to review study findings and a draft of the final report.

- **Engineering Report published (05 AUG 2019).**
  - *19-025r1, Development of Spatial Data Infrastructures for Marine Data Management*
  - https://www.opengeospatial.org/docs/er

MSDI-CDS List of Contributors

- National Geospatial-Intelligence Agency (sponsor)
- Arctic Spatial Data Infrastructure (Arctic SDI)
- British Oceanographic Data Centre (BODC)
- Canadian Hydrographic Service (CHS)
- Cooperative Institute for Research in Environmental Sciences (CIRES)
- Danish Geodata Agency, Danish Hydrographic Office
- Directorate of Hydrography and Navigation (BRAZIL)
- Esri
- Geographic Information System Service (GISS)
- Geoscience Australia - Marine Geoscience Group
- The HDF Group
- Helyx Secure Information Systems Ltd
- Hexagon Geospatial
- International Hydrographic Organization (IHO)

- IIC Technologies
- Italian Hydrographic Institute (IIM)
- Land Information New Zealand (LINZ)
- Marine Environmental Data and Information Network (MEDIN)
- National Geospatial-Intelligence Agency (NGA), Maritime Safety Office (MSO)
- National Oceanic & Atmospheric Administration (NOAA), Office of Coast Survey (OCS)
- National Technical University of Athens (NTUA)
- Natural Resources Canada: GeoConnections and Fisheries and Oceans Canada (DFO)
- Naval Research Laboratory (NRL)
- Navy Hydrographic Center
- Netherlands Hydrographic Service
- Norwegian Mapping Authority (Kartverket)
- OceanWise Limited
- OGC Marine Domain Working Group (OGC Marine DWG)
- Portuguese Hydrographic Institute

- Sounding Science LLC & Geopoint Solutions
- Teledyne CARIS
- United Kingdom Hydrographic Office (UKHO)
- U.S. Army Engineer Research and Development Center
- U.S. Coast Guard Navigation Center
- U.S. Committee on the Marine Transportation System (CMTS)
- U.S. Department of Transportation (DOT)
- U.S. Energy Information Administration (EIA)
- University Of Colorado Boulder
- University of Southern Mississippi (USM)
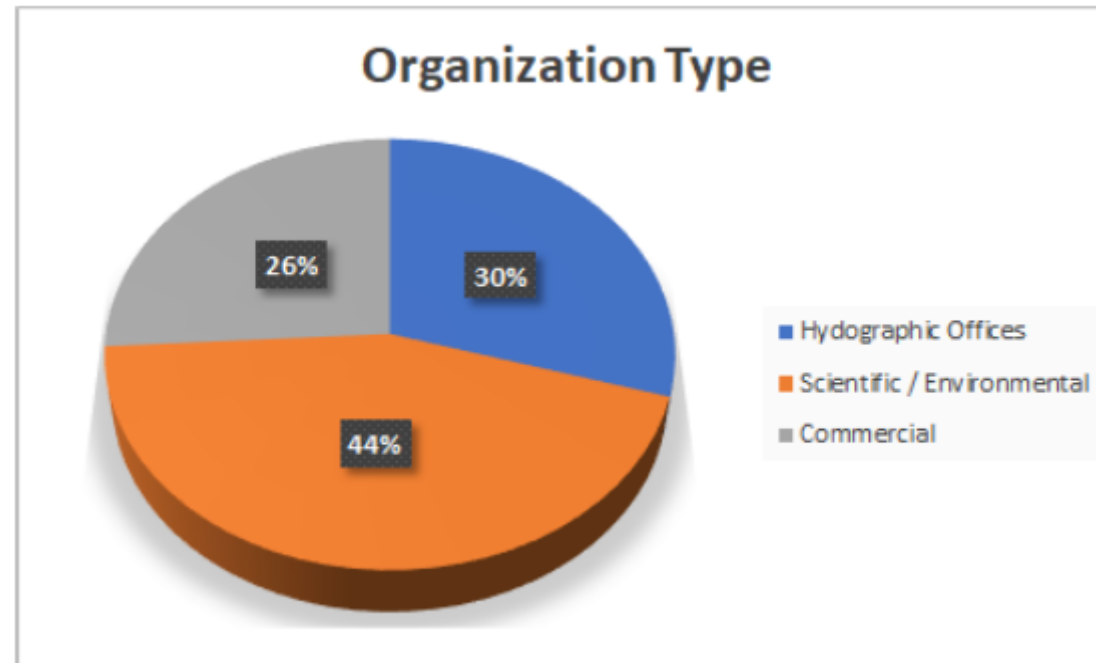- White House Office of Science and Technology Policy

RFI Respondents

Figure 1.3: Organization Type of RFI Respondents (Source: OGC)

Engineering Report (ER)

- Introduction
- MSDI Definition and Stakeholders
- Currently Used and Emerging Standards
- Marine Data Themes in a MSDI
- Data and Governance
- MSDI Interoperability Reference Architecture
- Portals, Applications and Scenarios
- Other Factors and Conclusion
- Appendix A: Data Identified
- Appendix B: Marine Data Portals

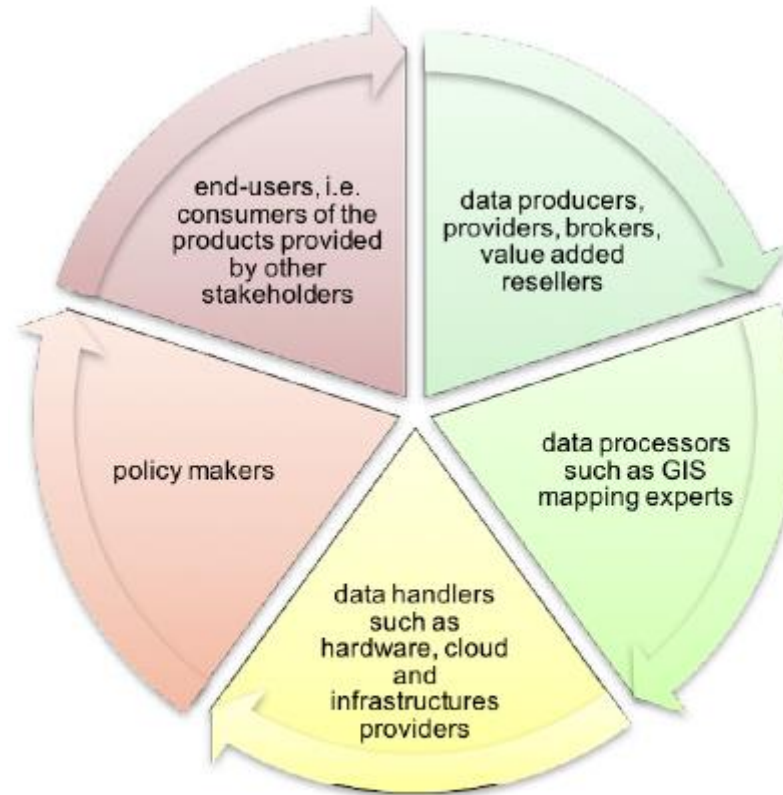# Chapter 2: Marine SDI Stakeholders

Figure 2.2: Classes of Stakeholders

Chapter 3: Currently Used and Emerging Standards

- **Content Standards** - For understanding the contents of different data themes by providing a data model of spatial features, attributes, relationships, and a data dictionary.

- **Management Standards** - For handling spatial data involving actions such as discovery of data through metadata, spatial referencing of data, collection of data from the field, submission of data by contractors to stakeholders, and tiling of image-based maps.

- **Portrayal Standards** - For structured visual portrayal of spatial data.

Chapter 4: Marine Data Themes

Example Themes:

- Hydrography
- Oceanography
- Marine Biology & Scientific Research
- Ecology and Environmental
- Maritime Governance
- Transportation
- Infrastructure (physical)
- Industrial and Commercial
- Tourism, Recreation, Cultural Use

Ontologies

- A major goal of a MSDI is to develop a multi-domain and multilingual ontology of marine data and services to provide semantic interoperability within the system.

Chapter 5: Data and Governance

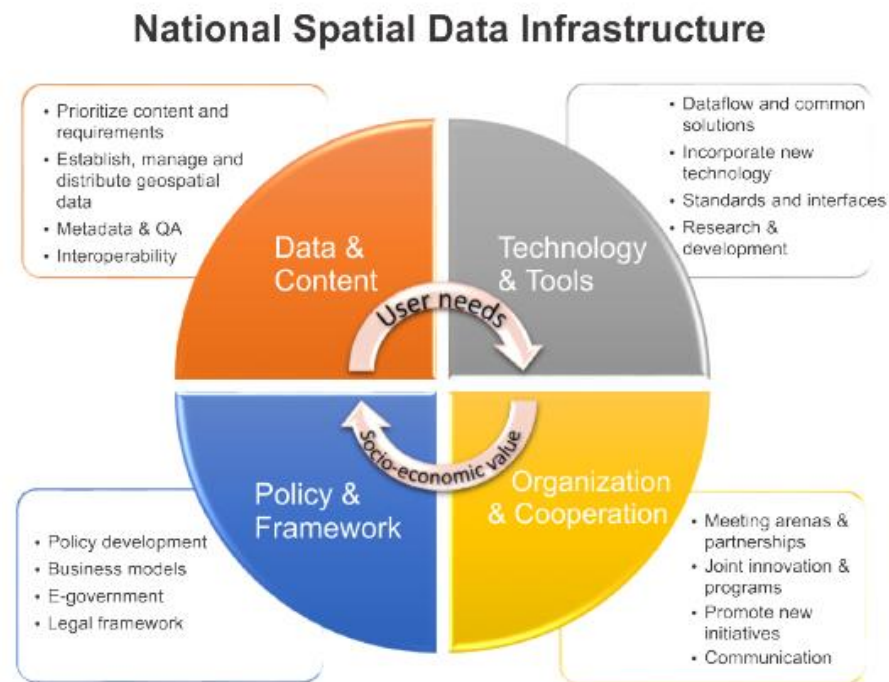Figure 5.2: High Level Governance Goals

Figure 5.3: National Spatial Data Infrastructure Model, source: Norwegian Mapping Authority (modified)

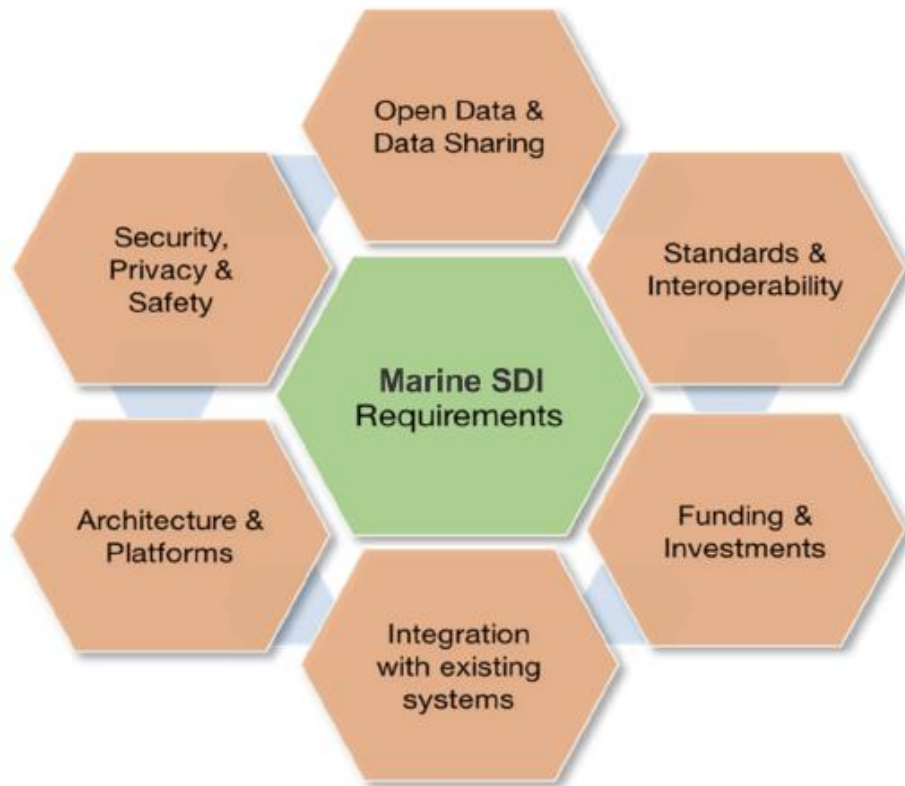# Chapter 6: Marine SDI Requirement Categories

Figure 6.3: High level requirement categories
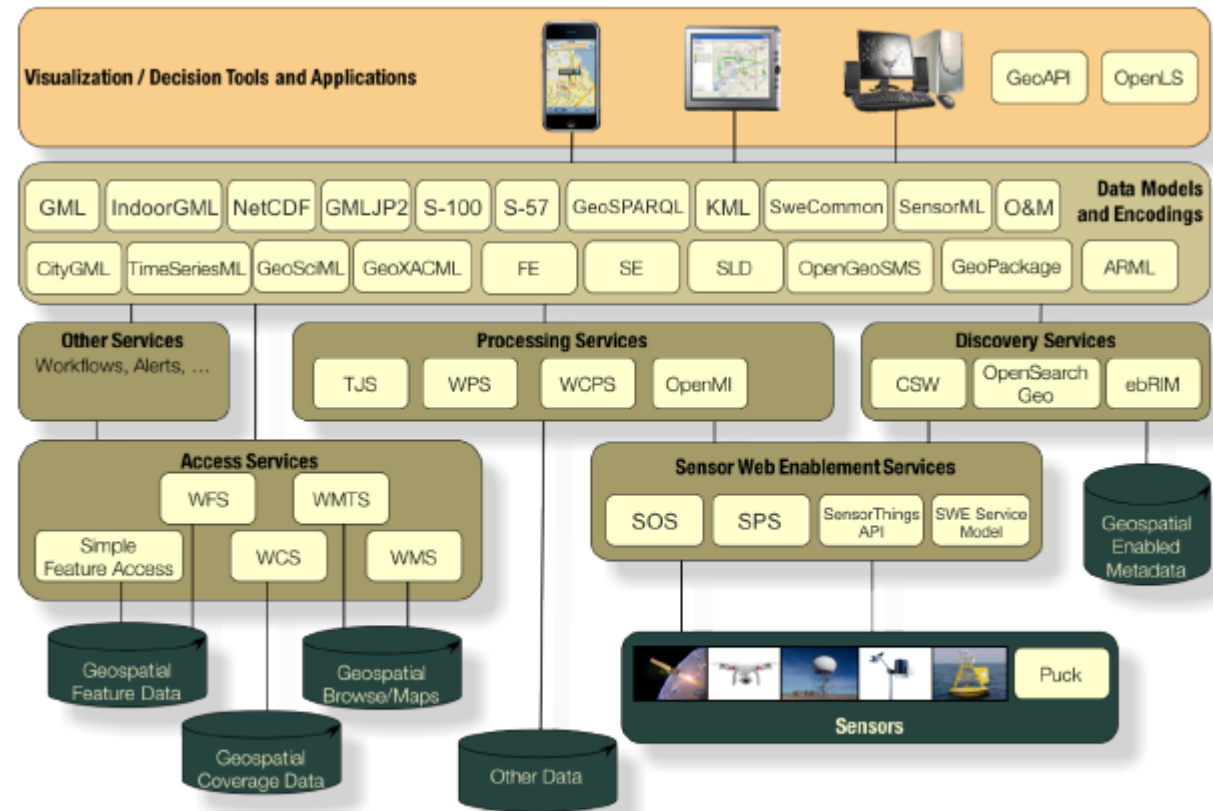

Figure 6.5: Federated Approach, source: OGC

Chapter 7: Portals, Applications and Scenarios

- Portals and Software Applications
    - List of reported data portals provided in Appendix B
- Potential MSDI Scenarios (described)
    - Offshore Wind Power Site Selection
    - Land / Sea boundary

Chapter 8: Other Factors and Conclusion

- Coordination of SDI related activities and collaboration among the various organizations involved is a critical success factor for a Marine SDI.

- It was found that a MSDI Reference Architecture must find the right balance between being prescriptive while remaining agile to allow for easy integration of upcoming technologies.

- The majority of respondents considered that an MSDI should be community-driven.

- Building on the CDS results and the suggestions for future MSDI development, e.g., pilot actions, the OGC will produce a strategy to achieve this goal.

Chapter 8: Other Factors and Conclusion

Four overarching requirements of any Marine SDI (from contributors):

1. Provide stakeholders with appropriate access to the spatial data they need.

2. Allow different stakeholders, at different locations, to access the SDI.

3. Allow for data exchange, especially the dynamic data, in an appropriate, efficient and secure way.

4. To achieve one, two and three above, will require the continued and increasing use of OGC and other open standards.

Chapter 8: Other Factors and Conclusion

- In the future, integration of near real-time observations from both satellites and in-situ sensors will be of increasing importance in the marine environment.

- To help in remediating issues due to limited bandwidth in much of the marine environment, a significant portion of the base or core data can be prepared in advance and pre-loaded on mobile devices for field use (GeoPackage).

- All data should be accompanied by metadata. Exploration into minimizing the need for manually generated metadata should be continued.

Conclusions are not to be regarded as a definitive list, but could provide a focus for a future Pilot initiative.

Link to Engineering Report

- The ER is posted to OGC's website here:

https://www.opengeospatial.org/docs/er

- Direct link to download PDF here:

https://portal.opengeospatial.org/files/?artifact_id=88037