A Comparative study of the development of Marine Spatial Data Infrastructure (MSDI) by IHO Member Nations

Marine Spatial Data Infrastructure Working Group (MSDIWG)

January 2016

Dr. Kian Fadaie

Canadian Hydrographic Service

Introduction

- This presentation reviews the way a select set of IHO member nations have developed a Marine Spatial Data Infrastructure (MSDI) to support the distribution of maritime information.

- The report is based on information gathered based on a MSDI survey developed by Canada and distributed to IHO member nations in IHO circular letter 56/2015.

Marine Spatial Data Infrastructure (MSDI)

- Spatial Data Infrastructure (SDI) is used to denote; the relevant base collection of data technologies, standards, policies and institutional arrangements that facilitate the sharing and access to geospatial data.

- MSDI is the "Marine" component of the spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general.

   "Spatial Data Infrastructure Cookbook v2.0 January 2004"

MSDI Requirement

- Shipping is very competitive and services to the marine industry need to be very cost effective both for the marine industry consumers of the information and to the government suppliers.

- Delivering Web services through a Marine Spatial Data Infrastructure provides the best way of using modern technology to lower costs for the government suppliers of marine information and to increase the efficiency of marine transport by increasing the knowledge of the marine environment.

- Many nations are well advanced in the development and deployment of MSDI systems and services. Conditions vary in different countries.

Survey

- This presentation documents a study on the current status of the development of MSDI internationally in IHO member nations.

- It is based on responses to a survey issued by the IHO through a circular letter.

- There were 24 responses to the survey. In addition some support data was collected from other sources.

The four pillars for a Spatial Data Infrastructure

The questions asked of the nations corresponded to the four pillars for a Spatial Data Infrastructure, including resources. The general questions were:

- **People** (including who the audience is and who is offering the Marine Spatial Data Infrastructure (MSDI));
- **Policies** (the policies and management structures established to manage the MSDI);
- **Technology** (the services implemented and the data offered by the MSDI);
- **Standards** (the standards used to establish the MSDI); and
- **Resources** (the costs and time frame for the establishment of the MSDI).

The intent of the study is to determine the relative level of advancement for various MSDI's.

Level of Effort

- Only general budgetary information was requested in the survey; however, the scale of the effort to build a MSDI is significant.

- For example US NOAA stated that the cost was "multiple millions of dollars spread over many different budget items".

- However many nations do not seem to break-out MSDI costs as a separate budget items. Therefore the direct costs are not available.

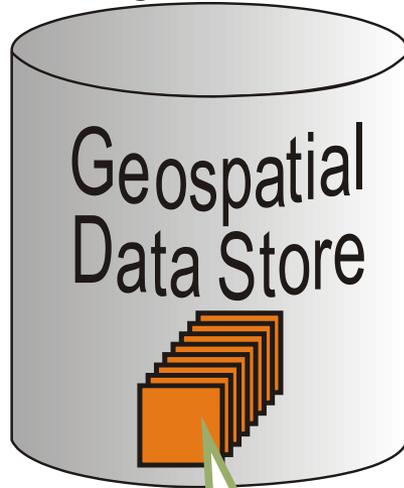# What is a Marine Spatial Data Infrastructure

An MSDI includes all aspects related to spatial information including the structure of the data and all of the interfaces to the systems that disseminate or present the information. Components of a MSDI are:

- Data structure/schema (Application Schema);
- Data description/semantics (Feature Catalogue);
- Metadata;
- Data and metadata capture operations;
- Data (the data elements);
- Data management;
- Discovery;
- Access;
- Transformation.

Elements of a Spatial Data Infrastructure

Storage of the Data

Geospatial Data Store

Exchange
Data Formats,
XML, GML

Services based on
- Metadata
- Schems and
- Encoding
  standards.

Metadata Register

Feature Concept Dictionary

Spatial Referencing System Register

ISO 19135, ISO 19126

Metadata

ISO 19115, 19115-1, 19115-2,
19130-1,-2, 19159-1,-1, 19113,
19114, 19157, CAN/CGSB:171.100 NAP

ISO 19109

Application Schema
(Integration of all data

ISO 19110

Feature Catalogue
(description of real world elements)

ISO 19107, 19108, 19123

Geometry
(Points, Lines, Curves, Surfaces,Coverage))

ISO 19111

Spatial Referencing
(datums, coordinate references)

Structure of the Data

Data Discovery
Web Mapping Service
Web Feature Service
Web Coverage Service
Web Processing Service

Access to the Data

Standards

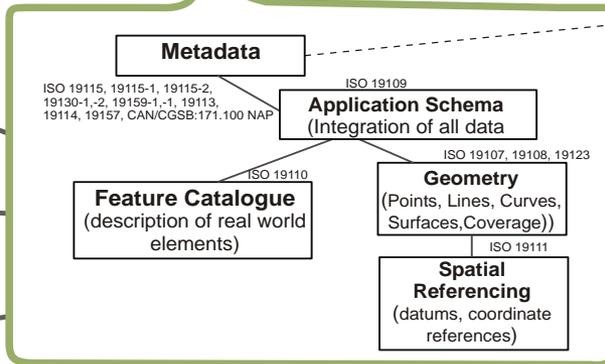IHO – Data product Standards.

ISO – General geospatial data standards (form the basis for IHO standards)

OGC - Industry standards group that primarily develops service standards that support Web Services.

Standards of particular interest to the MSDI:

– **Catalogue Service for the Web**

– **Web Mapping Service**

– **Web Feature Service**

– **Web Coverage Service**

– **Web Processing Service**

National MSDI Initiatives (Questionnaire Statistics)

- IHO C-17 report from 2011 identified a number of countries as having SDIs that had relevance to a Marine Spatial Data Infrastructure.

- A number of other nations have begun developments at this time.

- In the current questionnaire 24 nations responded. The following is a brief overview of the results.

Sponsorship, Mandate and Target Users

- All nations that have committed to the development of an MSDI are sponsored by government at some level. Government agencies or government run national committees are responsible for the development of MSDIs.

- The way the mandates are described vary considerably but the mandate identified by all nations are a variation on "improve access to data" and "management of data". Some nations add other purposes such as disaster management.

- Of the 17 nations that have indicated an access policy, 13 will make at least some of their data publicly available.
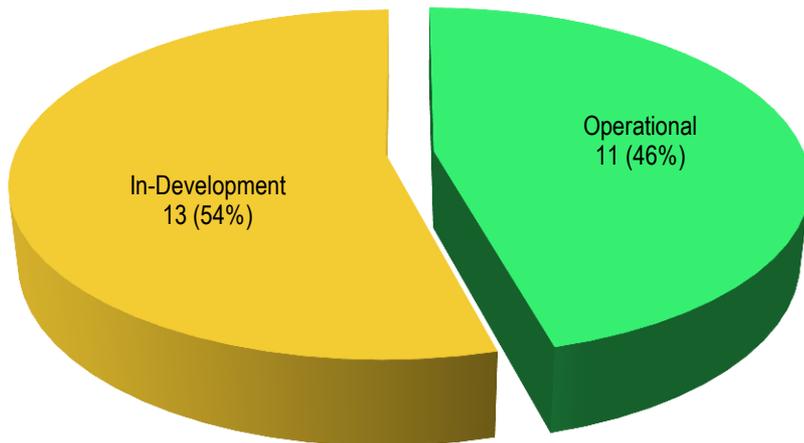
K. Fadaie

Policy

- Some nations have very sophisticated MSDI implementations. 11 of the 24 respondents indicated that their MSDIs were at some level of operation even though in some cases there is little or no marine data at this time.

Operational vs. In-Development MSDIs

In-Development
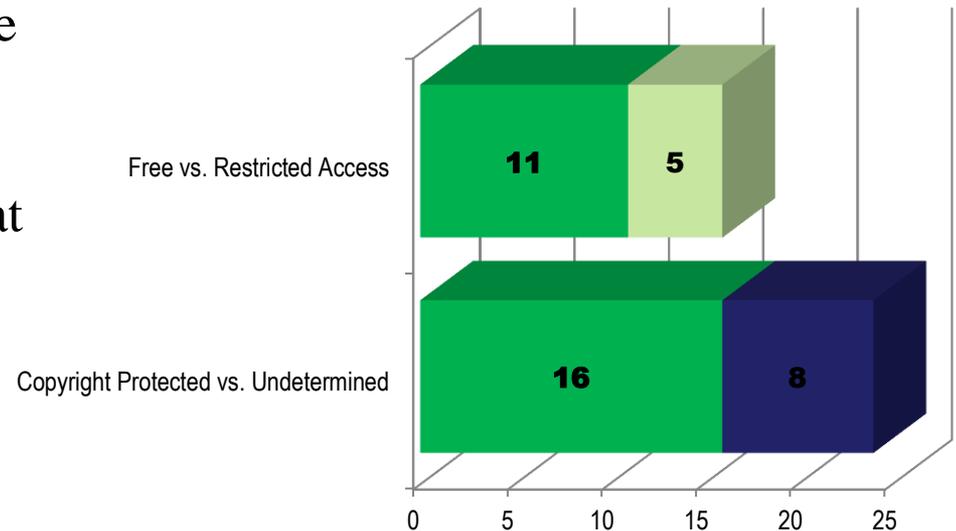13 (54%)

Operational
11 (46%)

- Many nations have developed national SDIs that support many types of data and are in the process of adding marine data.

Copyright

- All nations maintain some level of copyright over their data however the terms by which data is provided vary. Many nations make their data freely available and restrict only classified or private data. Some nations only allow access to data by other government agencies.

- The graph shows the number of respondents that indicate that there is some level of copyright protection and indicates the breakdown of those 16 nations that identified copyright protection status whether data is freely available under the copyright or usage restricted.

Access to Data and Copyrights

Free vs. Restricted Access — 11, 5

Copyright Protected vs. Undetermined — 16, 8

0 5 10 15 20 25

Data Costs

- It is difficult to assess the costing of data since different nations seem to identify different types of data as being for free access.

- Nations will indicate that data is free to access through a given service, but that service only addresses some of the data.

- Fundamentally, there appears to be a consensus that most data should be freely accessible to the general public; however, most nations indicate that they plan to sell or restrict some types of data.

- The level of availability varies from full open access to US (non-military) marine data to restricting all data to use by government agencies.
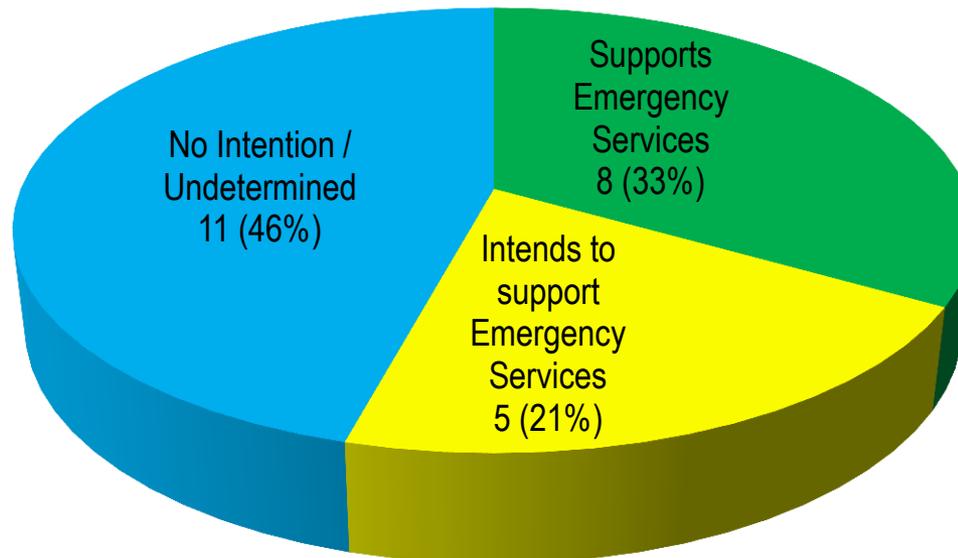
Management and Applications

- The management policies also vary significantly from nation to nation. In several countries there appear to be national SDIs that address many types of data and are managed by multi department management boards.

- There does not appear to be a common main application identified for the various MSDIs. Some nations indicate that the purpose is to disseminate data to the public, whereas others consider the MSDI as a sales tool for data.

- Many nations link the MSDI to "Open Government" and others to economic development.

Support Emergency or Safety Services

- The support for emergency services such as oil spill management was identified by several nations. A clear majority of respondents indicate that they plan to or currently support emergency services

Support of Emergency Services

No Intention / Undetermined 11 (46%)

Supports Emergency Services 8 (33%)

Intends to support Emergency Services 5 (21%)

Single Source for Information

- It is clear that most nation's intent is to maintain alternatives to their MSDIs for data distribution.

- Only 2 nations indicated that their MSDI would be the only source for certain information and two nations indicated that it is yet to be formalized.

Technical Oriented Questions: Levels of Service Implemented

- The use of technology was determined by examining each of the base technical elements of a Spatial Data Infrastructure. The categories were:

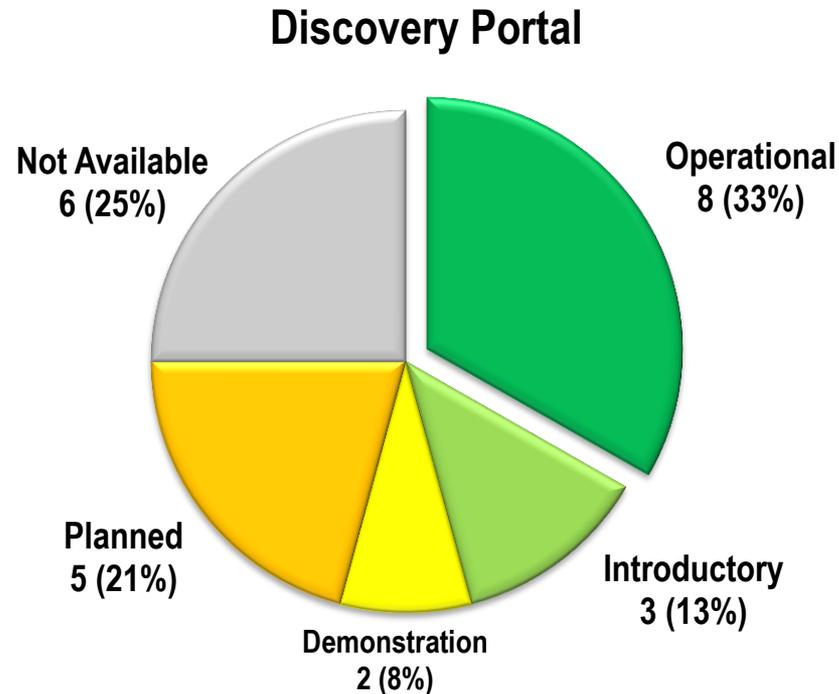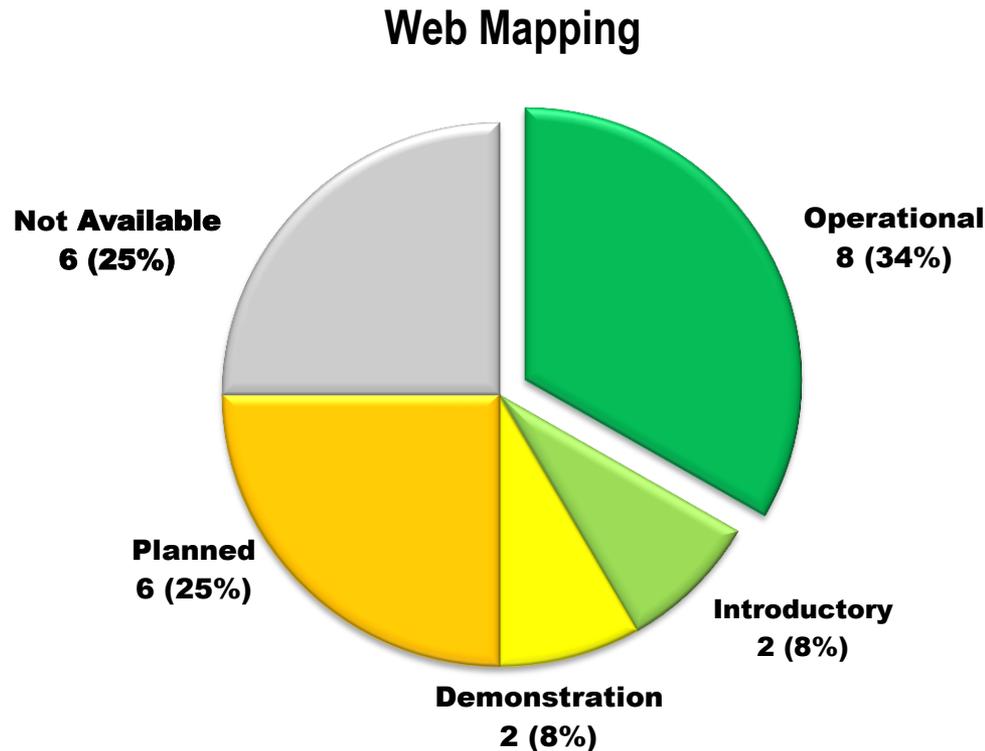|	
Operational	**An operational service is fully available to its target audience (not necessarily to the public).**
Introductory	An introductory service has limited availability or limited data
Demonstration	A demonstration service is technically functional, but not intended for operational use.
Planned	A planned service is in the planning or software development stage
Not Available	A service that is not available

Data Discovery

- Responses ranged from no data discovery portal, or a future planned portal to a fully functional portal compliant with the OGC/ISO standards for a Catalogue Service for the Web.

Discovery Portal

Operational
8 (33%)

Not Available
6 (25%)

Planned
5 (21%)

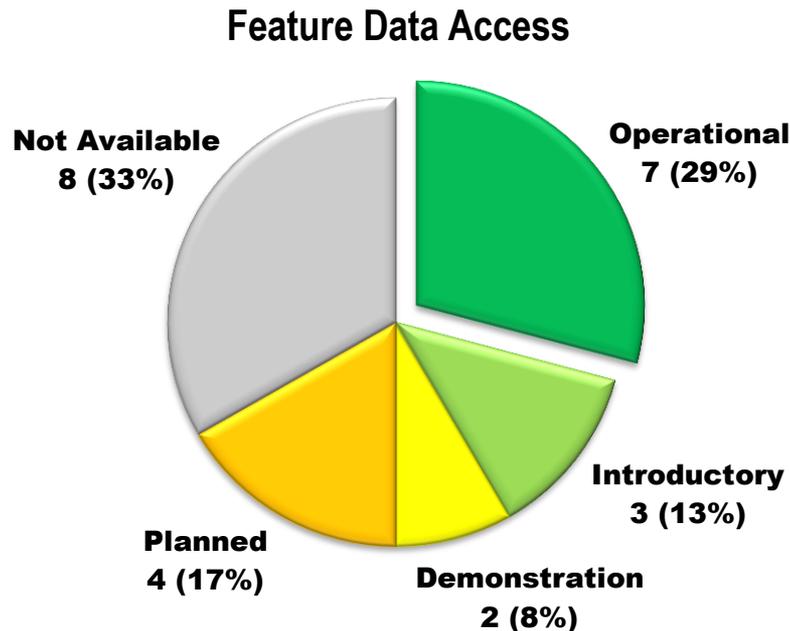Demonstration
2 (8%)

Introductory
3 (13%)

Web Mapping

- This service is planned or offered by most nations.
- Of the 18 respondents implemented or planned systems all indicated that they were OGC / ISO standards compliant.

Web Mapping

Not Available 6 (25%)

Operational 8 (34%)

Introductory 2 (8%)

Demonstration 2 (8%)

Planned 6 (25%)
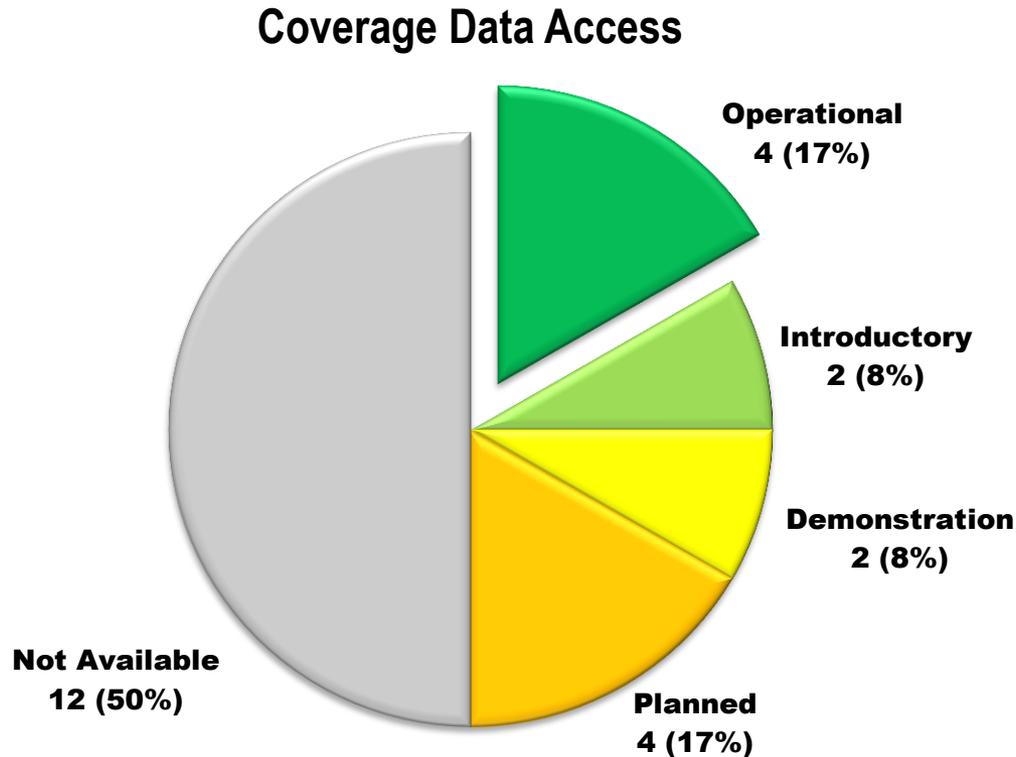
Access to Feature data

- The ability to access feature level data (such as IHO S-57 or future IHO S-10X ENC data) through a web service or through a file service offered through the MSDI.

Feature Data Access

Not Available
8 (33%)

Operational
7 (29%)

Introductory
3 (13%)

Demonstration
2 (8%)

Planned
4 (17%)

Coverage Data

- Coverage data is provided by less than half the respondents. Of those providing or planning to provide coverage data only one indicated that they would use other than the ISO / OGC standards. One case is the use of ESRI ArcGIS for coverage data.

Coverage Data Access

- Operational 4 (17%)
- Introductory 2 (8%)
- Demonstration 2 (8%)
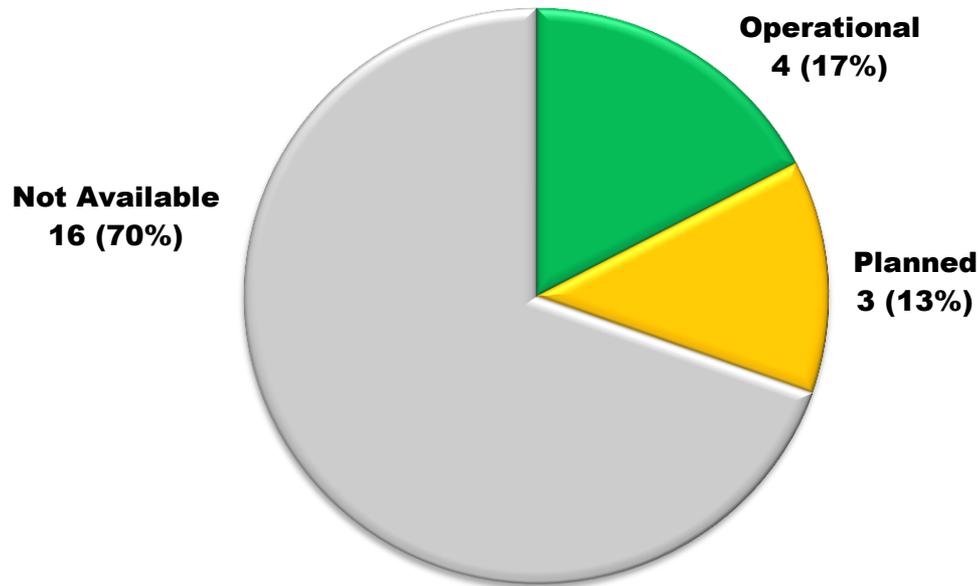- Planned 4 (17%)
- Not Available 12 (50%)

Online Data Processing

- Online data processing is a speciality service provided by only 4 nations and planned by 3. One nation uses online processing to provide tidal predictions, One other nation simply used the ESRI ArcGIS data processing tools...
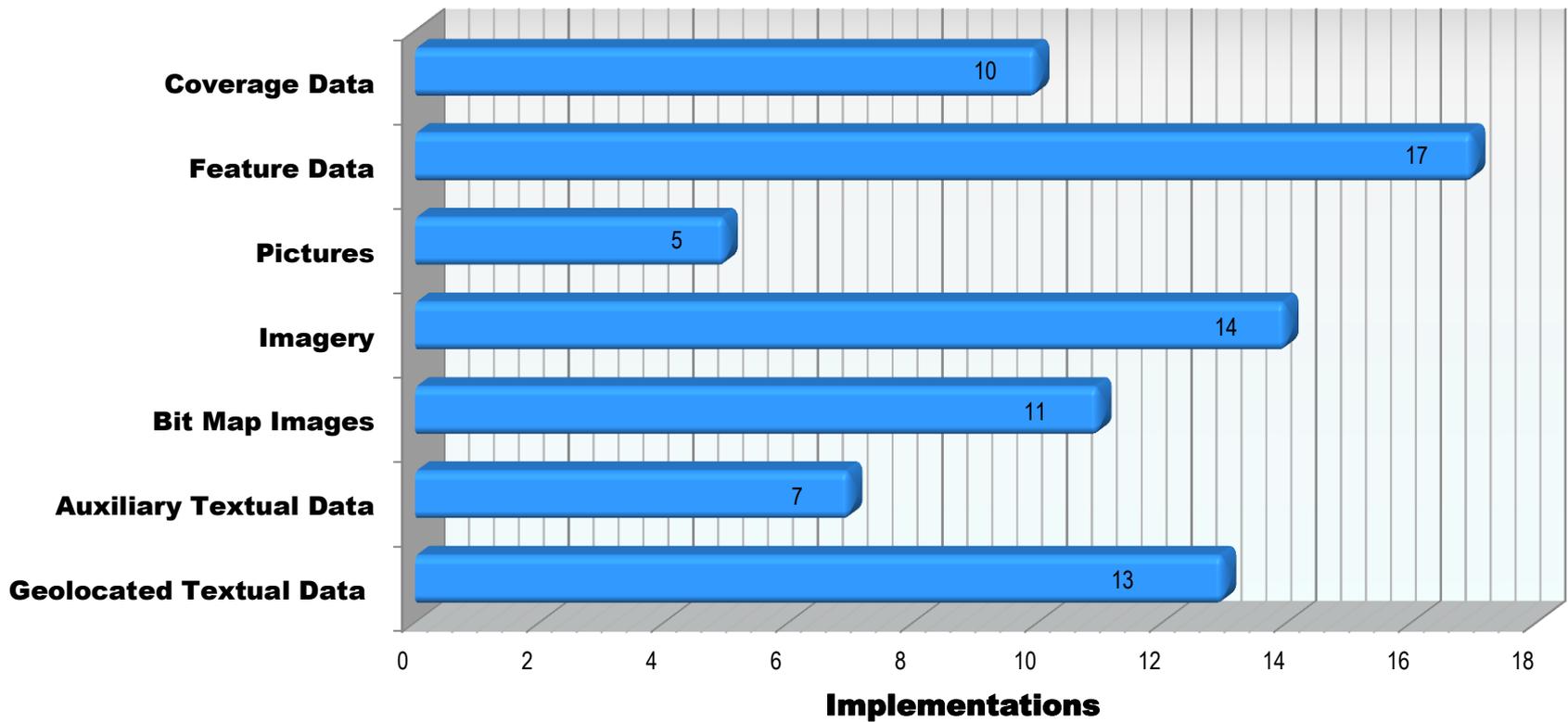
Online Data Processing

Operational
4 (17%)

Planned
3 (13%)

Not Available
16 (70%)

24

Data Types

Supported Data Types

Implementations by data type:
- Coverage Data: 10
- Feature Data: 17
- Pictures: 5
- Imagery: 14
- Bit Map Images: 11
- Auxiliary Textual Data: 7
- Geolocated Textual Data: 13

Implementations

Data Topics

Covered Topic Areas

Topic Area	Implementations
Other	4
Military	5
Marine	16
Transportation & Logistics	7
Imagery	6
Topographic Data	8

Implementations

Standards

- Which IHO Standards are supported?

- The responses ranged from no IHO data standards supported to IHO S-57, IHO S-100 and IHO S-44. Most nations indicated support for S-57 but some only indicated that they supported chart images.

- There is a wide variation in the level of standardization of data.

Resources

- **Most nations did provide some resource information and at least one said explicitly that such information is "Not Provided".**

- **The following can be noted:**

  - The 18 countries that have active MSDI projects stated that their MSDIs either already exist or will be operational in 2016.

  - Most indicated that their MSDI projects would become permanent operational systems.

  - The MSDI projects are either funded through the hydrographic office or are funded through a cooperative arrangement between multiple government departments.

  - The future plans identified vary per nation; however, there generally seems to be a consensus on working to improve metadata and cataloguing, improve standards compliance, expand existing services and to move to operational status.

Summary

- A Marine Spatial Data Infrastructure (MSDI) has the potential to provide significant economic gains to the nations that implement such a service.

- All of the technology needed to establish an MSDI is currently available from many companies.

- Most of the data needed to be served through an MSDI also already exists. As the standards develop some additional input is required to maintain standards compliance and to support new data product standards that are emerging.

- What is required for an MSDI is the development of governance policies and the investment to establish a system in many countries.

Recommendations/Next Steps

- There is cohesion and agreement amongst member states to use common standards:

  - These standards are to cover mostly catalogue service for web
  - Web mapping service should be the baseline for all MSDIs.
  - Metadata is pivotal to support data discovery

- Establish the common international theme structure that will drive and encapsulate the diverse datasets into a discoverable structure.

  - Navigation Category : Chart, Navigational routes, Sea-lanes…
  - Administration Category : Maritime Limits and Boundaries, Fisheries Management, Marine Cadaster…
  - Science Category : Operational Oceanography, Bathymetry, Currents, Water temperature, …

Recommendations/Next Steps

- MSDI must be made into a cascading Discovery Portal:
    - An International Discovery Portal needs to be created and maintained.
    - (States) Develop, maintain a Federated Discovery Portal that can be used by the International Discovery Portal.
- IHO is to develop product specification for all themes.

Questions

Thank you !

Kian Fadaie
Kian.Fadaie@dfo-mpo.gc.ca

32

Supplementary Information

33

Catalogue Service for the Web

The **Catalogue Service for the Web** is based on metadata. It allows a user to discovery data through a digital catalogue of metadata for geospatial data, services, and related resources. Metadata describes the available resources that can be queried and discovered.

Storage of the Data

Data Discovery Based on Metadata

Geospatial Data Store

OGC Catalogue Service for the Web
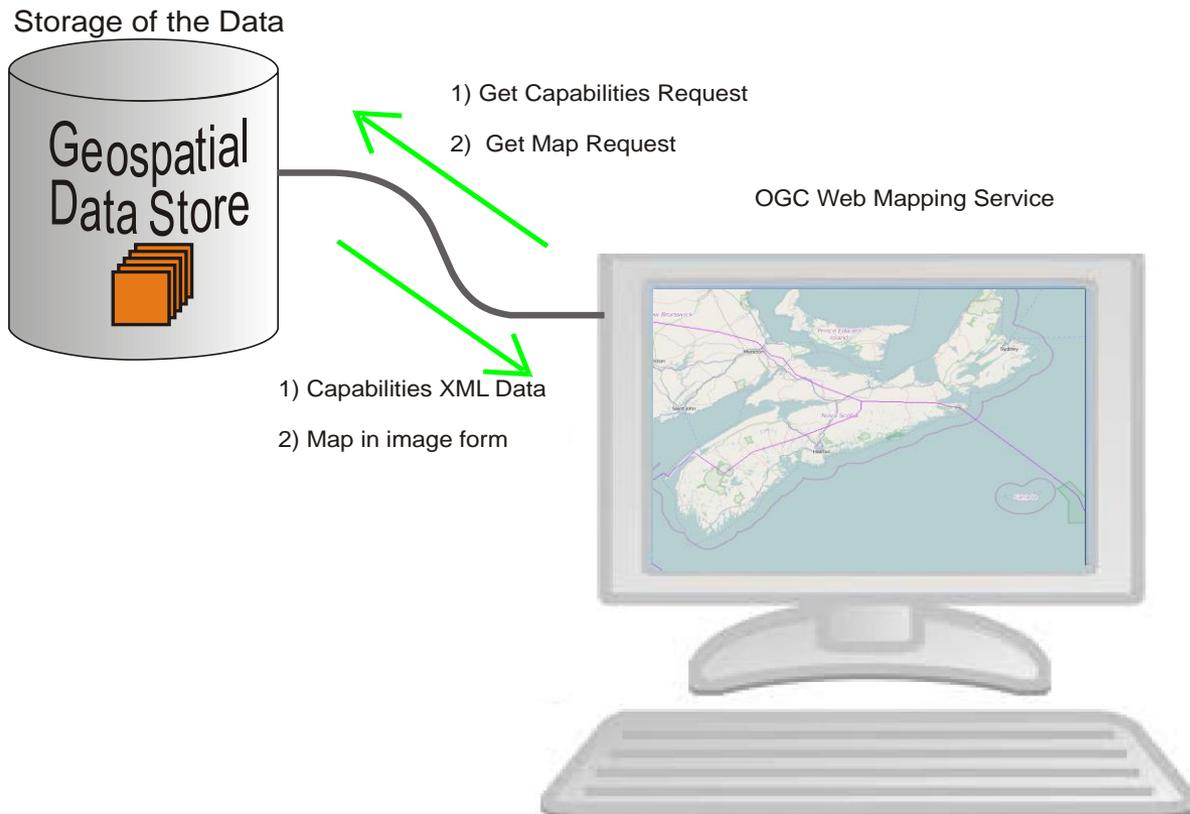
Find

Data Discovery

Metadata

Data Discovery is driven by Metadata
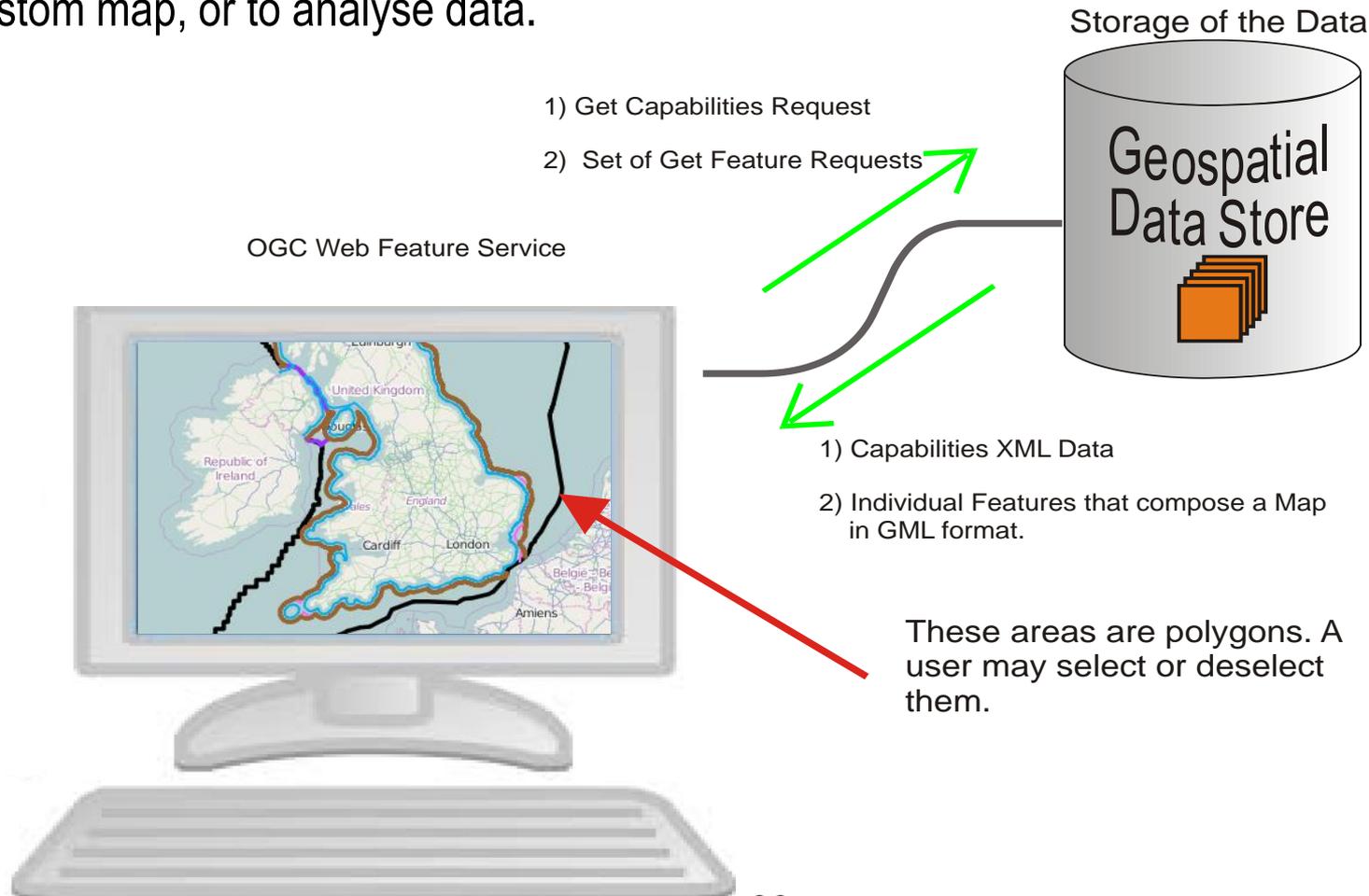
Web Mapping Service

The **Web Mapping Service** allows a user to request and display an image of a map. Multiple layers of geo-registered images may be overlaid to produce a composite map corresponding to a query.
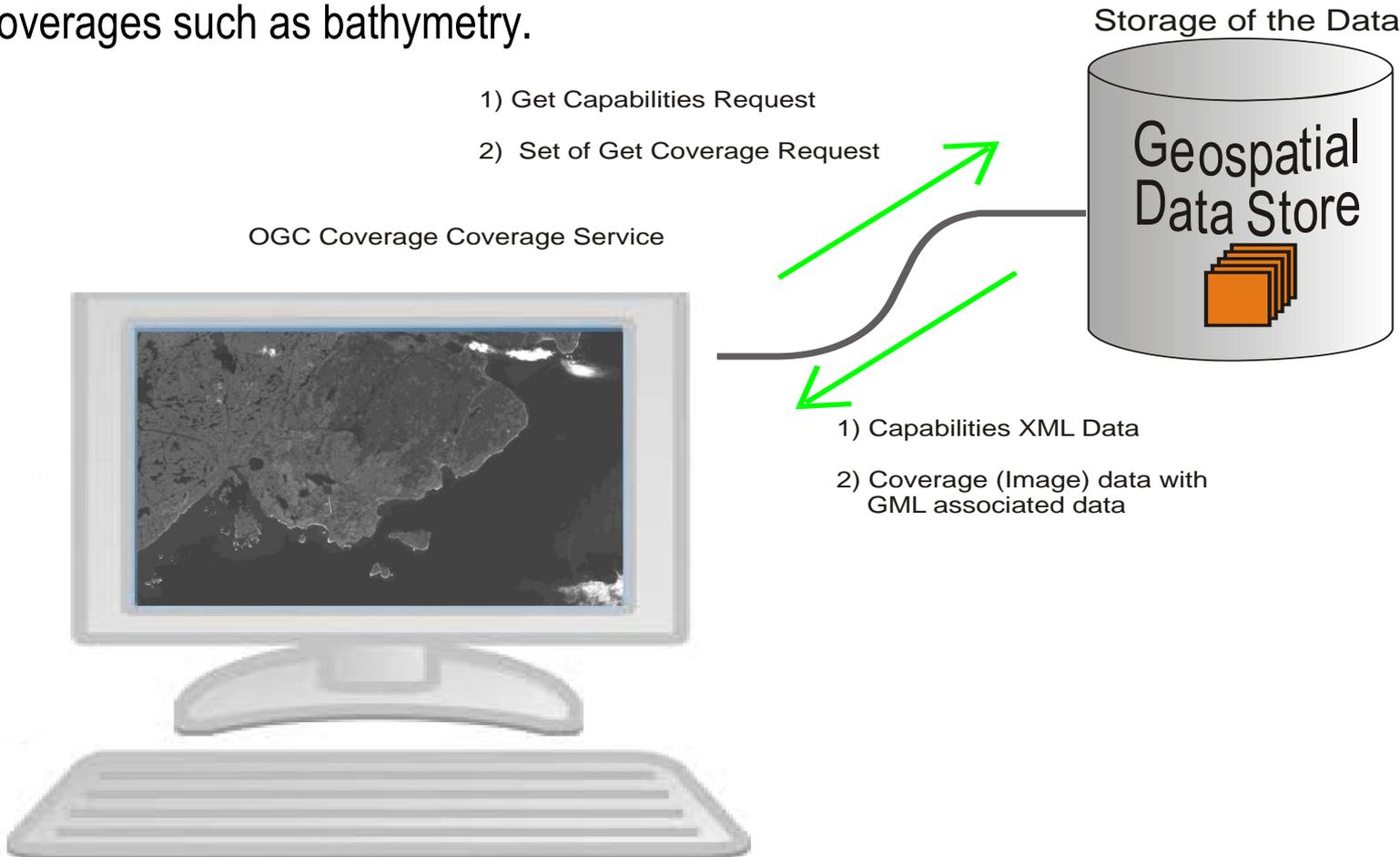
Storage of the Data

Geospatial Data Store

1) Get Capabilities Request

2) Get Map Request

OGC Web Mapping Service

1) Capabilities XML Data

2) Map in image form

Web Feature Service

The **Web Feature Service** allows a user to request individual features and construct a custom map, or to analyse data.

Storage of the Data

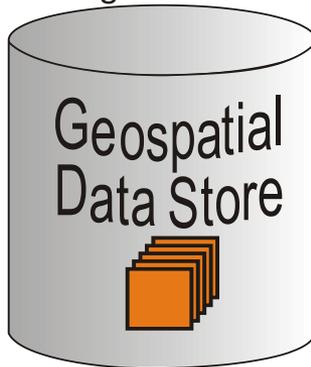1) Get Capabilities Request

2) Set of Get Feature Requests

OGC Web Feature Service

Geospatial Data Store

1) Capabilities XML Data

2) Individual Features that compose a Map in GML format.

These areas are polygons. A user may select or deselect them.

Web Coverage Service

The **Web Coverage Service** allows a user to selectively request imagery or other coverages such as bathymetry.

Storage of the Data

1) Get Capabilities Request

2) Set of Get Coverage Request

OGC Coverage Coverage Service

Geospatial Data Store

1) Capabilities XML Data

2) Coverage (Image) data with GML associated data

Web Processing Service

The **Web Processing Service** allows a user to request calculations to be performed on data..
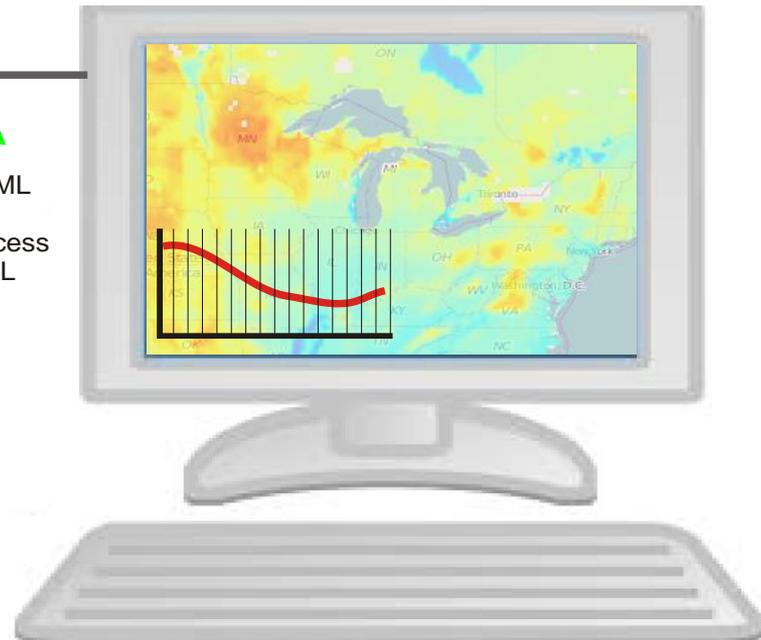
Storage of the Data

Geospatial Data Store

1) Request map using WFS
2) Get Capabilities for WPS
3) Describe Process
4) Execute

OGC Web Processing Service

1) Load map using WFS
2) Capabilities document in XML
3) Process description in XML
4) Output of results of the process
   for example generate a GML
   overlay map or a graph etc.

Applicable Standards

Data Standards	
IHO – S-100 **Universal Hydrographic Data Model**	References all of the ISO data standards and supporting standards such as metadata, and registers and is a base for the IHO Product Specifications.
IHO – S-101 ENC	Using a GML encoding
IHO – S-102 **Bathymetry**	Using a supported coverage encoding such s GMLJP2
IHO – S-57 **Transfer Standard for Digital Hydrographic Data (Older ENC standard)**	Supported only as files, or converted to GML feature data by the MSDI service.
IHO – S-61 **Product Specification for Raster Navigational Charts (RNC)**	Can be supported as files or in a WMS with some limitations on clipping and scaling.

Applicable Standards

Service Standards	
OGC Catalogue Service for the Web (CSW)	Discovery Service - supports the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects. Relies on several supporting service standards and especially metadata.
OGC Web Map Service	WMS- provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. Make use of many supporting standards including a Styled Layer Descriptor portrayal standard.
OGC Web Feature Service	WFS – provides direct fine-grained access to geographic information at the feature and feature property level. A transactional capability is optionally available to allow user input. There are many supporting standards in particular OGC OWS Common.
OGC Web Coverage Service	WCS – provides a capability to access coverage data and to clip and adjust the data. There are many supporting standards including many coverage encodings including GeoTIFF, netCDF, JPEG2000, GMLJP2.
OGC Web Processing Service	WPS – provides the capability to make processing services for geospatial data available. These can include calculations on the data provided by a WFS or WCS. There are many supporting standards and sub services such as a Web Coverage Processing Service.
OGC Web Map Tile Service	WMTS – provides pre rendered map tiles improving the performance of a WMS.

Applicable Standards

Encoding GML, KML, GeoTIFF, netCDF, JPEG2000, GMLJP2	A number of encodings are defined in OGC that are needed to support data on the services.
	GML – Geographic Markup Language (XML encoded vector data)
	KML – Keyhole Markup Language (Annotation on background images (as used by Google and others))
	GeoTIFF – simple coverage encoding with minimal metadata
	netCDF - (Network Common Data Form) encoding for array oriented scientific coverage data.
	JPEG2000 – Lossless JPEG image data with associated XML metadata
	GMLJP2 – imbedded GML (for metadata) in JPEG data