9th MEETING OF THE IHO INTER-REGIONAL COORDINATING COMMITTEE
IHO-IRCC9
Paramaribo, Suriname, 12-14 June 2017

Report of the Marine Spatial Data Infrastructures Working Group (MSDIWG)

Submitted by:	Chairman, MSDIWG
Related Documents:	IHO Publication C-17
Related Projects:	None

Chair:	Jens Peter Hartmann, Denmark
Vice-Chair:	Sebastian Carisio, USA
Secretary:	John Pepper, OceanWise
Member States:	Argentina, Australia, Brazil, Canada, Cuba, Denmark, Estonia, Finland, France, Germany, Indonesia, Japan, Malaysia, Nigeria, Netherlands, Norway, Philippines, Portugal, Republic of Korea, Romania, Slovenia, Spain, Singapore, Thailand, Ukraine, UK, USA
Expert Contributors:	CARIS, Envitia, Esri, Geosciences Australia, GSDI Association, IIC Technologies Inc., OceanWise, and OGC. See Annex A for details of Membership.

1. Meetings Held During Reporting Period

The MSDIWG8 meeting of IHO Marine Spatial Data Infrastructures Working Group (MSDIWG) took place in Vancouver, Canada from 31 January to 2 February 2017. The outcome of the meeting is available from the IRCC section of the IHO Website under the MSDIWG. The MSDIWG meeting was preceded firstly on 30 January by an OGC Marine Domain WG meeting.

The aim of the MSDIWG8 meeting was to focus on MSDI and to propose ways to progress MSDI implementation within the Organisation and its Member States.

Next Planned Meeting:
The IHO/MSDIWG will hold a day-long Open Forum and the ninth MSDIWG meeting on 29 January - 1 February 2018, hosted by the Brazilian Hydrographic Service. Logistics and meeting details are available at:
https://www.iho.int/mtg_docs/com_wg/MSDIWG/MSDIWG9/MSDIWG9.html

We will retain the option to facilitate an Open Forum which would allow non-MSDIWG stakeholders (e.g. regional RHC MS, government, academia, industry, funding bodies and NGO's) to attend to see what the MSDIWG and the commercial partners can offer. Attendees at the Open Forum would then be encouraged to stay on for the MSDIWG9 meeting. This approach is being developed in consultation with the hosts.

The Open Forum meeting will be followed by a three day-long MSDIWG9 meeting at the same venue and the meeting will include WG Work Plan task group break-out sessions. The MSDIWG9 meeting will also be arranged as a back to back meeting with the OGC Marine Domain WG meeting on 2 February 2018.

The key interest for the IHO is enabling MS to ensure MSDI provides a framework for the provision of hydrographic information beyond the traditional field of surface navigation.

Terms of Reference of MSDIWG:
The MSDIWG Terms of Reference remain unchanged from 2015 and can be found on the IRCC section of the IHO Website under the MSDIWG.

2. Work Programme

2017-2020 Work Programme was redeveloped at MSDIWG8 based on resent changes and change in focus on MSDI from a regional and national perspective. In order to deliver this Work Programme there are established 8 MSDI Tasks:

A. Communication and dissemination
B. Operational - Data sharing and management
C. Policies and governances – RHC. (Ensure that MSDI is a standing agenda item for RHCs' meetings
   (IHO Res 2/1997, as amended, refers))
D. Standards (OGC and HSSC)
E. Innovation – Future perspectives (2021 - 2023)
F. Training and education
G. Maintain and extend the publication IHO MSDI C-17 (IHO Task 3.9.2.1 refers)
H. Conduct annual meetings of MSDIWG, arranged back to back with 1-day MSDI Open Forum
   (IHO Task 3.9.1 refers)

See Annex B for full details of the work programme.

MSDIWG-8 Action List**:**
The existing action list was updated and renewed as consequence of the new work plan. See Annex C for full details of the action list.

3. Progress on IRCC8 and HSSC8 Action Items

IRCC8/15 Finalize the ongoing revision of the IHO Publication C-17 and submit to IHB to seek comments from MSs (7e).
This action item was completed by October 2016 (CL 59/2016). Comments were received and reviewed during MSDIWG8 and revised draft New Edition 2.0.0 of C-17 is being submitted to IRCC9 (doc. IRCC9-07E2 refers).

IRCC8/18 Finalize the white paper to be presented at the next Conference/Assembly and to submit to IRCC for intersessional endorsement (7e).
The white paper was produced by the MSDIWG and submitted to the IRCC Chair as part of the MSDIWG report to the Assembly (see paragraph 6c).

IRCC8/20 Follow up the developments at the OGC Maritime Domain Working Group and report back to IRCC (7e) MSDIWG IRCC9.
The MSDIWG chair will make a presentation about the OGC Marine Domain WG at IRCC9

HSSC8/31 MSDIWG invited to consider the concept of Ecological Marine Units promoted by ESRI. HSSC report to IRCC-9.
At the MSDIWG8 meeting the concept of Ecological Marine Units was presented by ESRI and the MSDIWG discussed the concept. The MSDIWG will follow the development of concept for Ecological Marine Units.

HSSC8/64 HSSC and MSDIWG invited to pass wider geospatial research topics to the OGC Marine Domain WG (MDWG) for inclusion in its work programme.
The OGC MDWG meeting was arranged as a back to back meeting with the MSDIWG8 meeting and relevant geospatial research topics were passed to the OGC MDWG.

HSSC8/65 HSSC to invite MSDIWG to liaise with OGC MDWG. HSSC report to IRCC-9.
The MSDIWG has established close cooperation with the OGC MDWG, several MS are now members of both WG's

4. Problems Encountered

a. Reporting of MSDI activities by MS to Regional Hydrographic Commissions (RHC).
The level of reporting of MSDI activities by Member State to RHCs remains inconsistent. Some RHCs receive comprehensive inputs from Member State while others have yet to give MSDI sufficient visibility as a standing agenda item. The MSDIWG has limited visibility about how Member States engage with government, commerce, academia and the third sector to enable and deliver access to, sharing and re-use of hydrographic data to a wider user community. Hydrographic Offices (HOs) are in a great position to supply core reference datasets to national and regional SDI initiatives as HO data is critical to activities such as marine planning, coastal zone management, disaster mitigation and response and conservation.

b. Engagement on MSDI related activities.

Demands continue to be placed on a very few members of MSDIWG to attend IHO sponsored events such as RHCs and MSDI meetings, organizing MSDIWG meetings, providing MSDI Awareness short courses, attending meetings with other regional bodies and speaking at industry seminars.

c. Education and Learning

The way Capacity Building plans are defined at present means that the focus on data and information management resides at Phases 2 and 3. MSDIWG suggests it should take place earlier in the cycle of basic hydrographic understanding and involve elementary "data management best practice" training sessions. Emergent HOs are proving better equipped and more adept in understanding the value of data management and MSDI. The MSDIWG therefore suggest that CBSC should consider this in the light of the experience MSDIWG members and expert contributors have witnessed when delivering Capacity Building Training in MSDI.

5. Any Other Items of Note
a. Data Centric Operations and Workflows

Data are the second most important asset in an organization after the people it employs and is now often referred to as the "new oil" or the "new electricity"! Data therefore needs to be treated as an enterprise wide, national and even global asset with tremendous intrinsic value not only to the organization that captures and / or manages it but to other potential users as well. In the maritime sector, we have been promoting the term "collect once, use many times" for many years in respect of the wider value and utility of, for example, bathymetry data. But there are other important data held by the HO that also have additional or residual value once used to support the business of charting. The term "data centric" means managing your operations and workflows as close to "source" as possible rather than as products. Enabling efficient data sharing exchange and re-use across government, academia and commerce thereby stimulating economic and socio-economic benefits not only the nation but potentially across borders with neighbouring HOs.

b. OGC Candidate Standard to replace Coordinate Reference Systems (CRS)

This initiative specifies the core of an OGC Discrete Global Grid System (DGGS) encoding standard. This OGC standard defines the DGGS core data model and the core set of requirements to which every OGC DGGS encoding must adhere. Extensions to the DGGS core standard add further functionality to the core requirements. In particular, DGGS extensions to the core will be required to support additional functional capabilities and interoperability using OGC Web Service (OWS) architectures, such as OGC Web Coverage Service (WCS) and Web Coverage Processing Service (WCPS) interfaces. This standard defines:

    i.   A concise definition of the term Discrete Global Grid System as a spatial reference system;

    ii.   The essential characteristics of a conformant DGGS; and,

    iii.   The core functional algorithms required to support the operation of a conformant DGGS.

c. Appointment of RHC Ambassadors for MSDI

RHCs still need to identify and appoint "ambassadors" who would be willing and able to take the MSDI message to Member States to energize them in taking the actions necessary to bring about governance reviews and more efficient work practices (e.g. data centric workflows). A vital element of this work would be to collect and collate responses from Member State on MSDI prior to each RHC meeting. It is becoming more important to consider taking MSDI as a RHC agenda item therefore we hope to see a National MSDI report prepared by each Member State for submission to every RHC incorporating the status of MSDI, plans for involvement in MSDI and challenges facing the HO.

6. Conclusions and Recommended Actions

a. Revision of C-17

MSDIWG has prepared a draft Edition 2.0.0 of the IHO Publication C-17 Spatial Data Infrastructures: "The Marine Dimension" - Guidance for Hydrographic Offices that is being submitted to IRCC9 in doc. IRCC9-07E2.

b. Education and Learning

The RHCs that promoted training in MSDI now have students achieving promotions in the workplace as decision makers and, in some cases driving the MSDI evolution in their HOs providing testament on the return of investment in training. The IHO Capacity Building Programme for 2013-2017 supported Member States to improve their corporate governance in respect of data management, database design and MSDI through a variety of training courses and briefing sessions, ranging from half-day workshops and briefings to more comprehensive 5-day residential courses aimed at all levels of staff from practitioners through to directors.

c. Preparation of a new MSDI White Paper

The existing "promotional" MSDI White Paper "The Hydrographic and Oceanographic Dimension to Marine Spatial Data Infrastructure Development: 'Developing the capability'" was authored and published by Caris and OceanWise in May 2010 and later adopted by the MSDIWG. As knowledge and understanding of SDI and MSDI has developed in the past 5 years, the MSDIWG worked on a revised document named "Realizing the benefits of Spatial Data Infrastructures in the Hydrographic Community" (that is available from the IHO website at:
    https://www.iho.int/mtg_docs/com_wg/MSDIWG/MSDIWG_Misc/MSDIWG-BOK.html

d. Best Practices and List of Standards related to SDI/MSDI

MSDIWG produced a compilation of best practices and a list of standards related to SDI/MSDI. These documents are available at: www.iho.int / Committees & WG / MSDIWG / Body of Knowledge

e. GIS layer on existing SDI/MSDI around the world

The IHO Secretariat established a GIS layer representing existing SDI/MSDI around the world. This layer can be accessed at: www.iho.int / Committees & WG / MSDIWG / SDI/MSDI portals around the world

f. Creation of an OGC Ad-hoc Maritime Group

MSDIWG has been cooperating with the OGC, the world-wide body responsible for developing de-facto standards for the geospatial industry and has contributed to the development of an OGC compliant Conceptual Model for Oil Spill Response. OGC has recently facilitated a Maritime Ad-Hoc meeting in Washington on 10 March 2016 at which the MSDIWG was represented. As a result a Marine Domain WG was created within OGC with an aim of developing an OGC compliant MSDI Conceptual Model. Its first meeting took place in November 2016.

7. Concept Development Initiative - Defining the Future of Marine Spatial Data Infrastructure.

At the MSDIWG meeting in Vancouver 2017, the MS discussed the possibility to create an OGC study that could establish the framework for future development of MSDI. After the MSDIWG meeting OGC has developed a proposal for a concept development study for MSDI, with the ultimate intent after completion to propose to IHO a full pilot timed for 2018 to be funded by the IHO. See attached structured proposal for a concept development study for MSDI at Annex D.

The proposal presents the Open Geospatial Consortium's (OGC) approach for evaluating the current state and defining the potential future of Marine Spatial Data Infrastructures (MSDIs). The initiative will emphasize on the rapid evolution of technologies and methodologies for generating non-navigational location-based information of value to a broad range of users.

The goal of this proposal is to evaluate the current state and define the potential future of Marine Spatial Data Infrastructures (MSDIs). It has the following objectives:
- Document the current state of MSDIs
- Document the needs for a MSDI based on current emerging technologies
- Document strategies to interoperate with other Spatial Data Infrastructures
- Develop a common interoperability reference architecture
- Engage with experts from across the user community as well as from the community of technology / information and services providers, including hydrographic offices, industry, government, research, and other SDOs.

8. Action required of IRCC

The IRCC9 is invited to:

a. note the report;

b. acknowledge the work done on the draft Edition 2.0.0 of the IHO Publication C-17;

c. consider the new MSDIWG White Paper produced by the MSDIWG and agree on the way forward (paragraph 6c);

d. note the creation of the OGC Maritime Domain WG;

e. endorse the structured proposal for a concept development study for MSDI by OGC and request the IHO Council to approve IHO funds the study (paragraph 7);

f. Invite RHCs to nominate RHC MSDI ambassadors to promote MSDI in the regions and to support the RHC Chair to prepare the MSDI component of the national report to IRCC; and

g. Take any other action as appropriate.

Annexes:

A – Details of Membership

B – MSDIWG Work Programme 2017-2020

C – List of Actions from MSDIWG8

D – Concept Development Initiative - Defining the Future of MSDI

Marine Spatial Data Infrastructures Working Group (MSDIWG)

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(8 February 2017)

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IHO Marine Spatial Data Infrastructures Working Group (MSDIWG)
WORK PLAN 2017–2020

V1.0
Adopted by MSDIWG-8 and MSDIWG Members (Pending approval by IRCC9)

MSDI Tasks

A	Communication and dissemination
B	Operational - Data sharing and management
C	Policies and governances – RHC. (Ensure that MSDI is a standing agenda item for RHCs' meetings (IHO Res 2/1997, as amended, refers))
D	Standards (OGC and HSSC)
E	Innovation – Future perspectives (2021 - 2023)
F	Training and education
G	Maintain and extend the publication IHO MSDI C-17 (IHO Task 3.9.2.1 refers)
H	Conduct annual meetings of MSDIWG, arranged back to back with 1-day MSDI Open Forum (IHO Task 3.9.1 refers)

No	Work item	Priority H-high M-med L-low	Milestones	Start Date	End Date	Status P-planned O-ongoing C-completed	Responsible / contact person(s)	Related Pubs / Standard	Remarks
A.1	Implement MSDI Maturity Assessment to enable consistent reporting from MS through RHC to IRCC.	H	1. Design template 2. Assessment template in place 3. Assessment template in use	Jun 17	Jan 18	Planned	Denmark, OceanWise		
A.2	Identify definitions, appropriate and relevant standards and components of (M)SDI. Ref: D1 and D2	H	1. Provide a consolidated list of definitions, components, standards 2. Maturity continuum in place for outreach purposes	Jun 17	Jan 18	Planned	GSDI Malaysia		
A.3	Develop and provide guidelines on MSDI implementation.	M	1. Guidelines in place based on outputs from tasks B1-3: C2	2017	2018	Planned	IIC OceanWise Canada		
A.4	Develop MS or RHC relevant Case Studies. Ref: C2	M	1. Arctic Region 2. Baltic Region 3. Brazil 4. East Asia Region	2017 2017 2018 Mar 17	2018 2019 2020 Jan 18	Planned	USA Denmark Brazil Korea		

A.5	Create video recording of MSDI for HO and wider marine community .	M	1. Develop content:
			   a. Messages from C-17
			   b. Key points of MSDI
			   c. Role of MSDIWG
			2. Edit
			3. Record
			4. Edit
			5. Approve
				Mar 17	Jan 18	Planned	Korea		Korean and English versions.

B.1	Create an implementation "roadmap" template for MSDI (at national and/or regional level)	H	1. Gather information 2. Compile information 3. Publish template for implementation	Mar 17	Dec 17	Planned	IIC Esri USA		
B.2	Identify core data for input to MSDI to support multiple applications [Ref: B1]	M	1. Marine Cadastre 2. Emergency Response 3. Coastal Zone Management	Mar 17	2018	Planned	IIC Germany Canada OceanWise		
B.3	Identify wider user requirements for bathymetry data	H	1. Develop primary use case for Arctic Bathymetry SDI 2. Update concept development study ($) 3. Propose test-bed 4. Build test-bed ($$$)	2017	2018	Planned	IIC Esri OGC Caris Canada Portugal		$ = funding required
C.1	Draft data policy statements for MSDI (Ref:A3)	M	1. Define relevant statements 2. Compile compendium of Data Policy statements	2017	2018	Planned	USA GSDI OceanWise		
C.2	Develop a conceptual architecture for MSDI	M	1. Develop architecture(s) 2. Compile compendium of MSDI architectures	2018	2018	Planned	IIC Norway Malaysia		
C.3	Develop a governance model for MSDI	M	1. Regional bathymetry governance model in place (Ref: B3)	2018	2018	Planned	Denmark USA		
D.1	Identify relevant standards to support MSDI implementation and operation.	H	1. Provide annual reports to IRCC and HSSC 2. DGGS (Ref: B3)	Jun 17	Jan 20	Ongoing	OGC Marine DWG		

D.2	Assess the suitability and shortcomings of standards in supporting data interoperability.	M	1. Identify standards relevant to bathymetry (Ref: B3) 2. Marine Cadastre 3. Oceanography	2018	2019	Planned	OGC Marine DWG (inc: Portugal)		
E.1	Identify and report on the future trends affecting MSDI e.g. autonomous platforms, standards, big data, cloud, internet of things and artificial intelligence.	M	1. Information gathering (Horizon Scanning) 2. Publish White Paper (inc: PPP)	2018	2019	Planned	Esri OceanWise USA Portugal		
E.2	Establish an IHO MSDI vision for 2030.	L	1. Prepare draft Position Paper ("think piece") to include technologies, methodologies, sustainability 2. Align with other Visions	2019	2019	Planned	OceanWise UK		
F.1	Develop and maintain training syllabi	M	1. Review and update in line with relevant developments, methods and content	2018	2020	Ongoing	Denmark OceanWise		
F.2	Support development and delivery of e-learning platforms	L	1. Coordinate activities with East Asia TDRC 2. Compile list of existing e-learning modules relevant to MSDI	2018	2020	Ongoing	Esri OceanWise GSDI		
F.3	Develop a MSDI communications plan	M	1. Identify the need, audience and focus 2. Report findings 3. Deliver Plan	2018	2020	Planned	IHO Sec. GSDI		
G.1	Maintain IHO publication C-17 to reflect developments in ICT, Content, Standards and Governance of MSDI	H	1. Manage content 2. Create a Wiki 3. Request IRCC remove document from IHO Res: 2/2007	2017	2020	Ongoing	OceanWise USA Denmark Germany Portugal		V2.0 publish - June 2017
H.1	Conduct 2018 -20 meetings of MSDIWG, arranged back to back with 1-day MSDI Open Forum and OGC Marine DWG	H	1. Date and venue defined 2. Logistics in place 3. Open Forum programme defined 4. Develop content for DWG workshops	2017	2020	Ongoing	MSDIWG Management Group (Chair/Vice Chair, Sec, IHO Sec)		2018 – Brazil 2019-Korea 2020-tbc

Summary of Actions from MSDIWG8

Subject	ACTION No.	ACTIONS	OWNER(S)	Date	Status
Standards	01/2017	Ref: Action Plan B3- Prepare a White Paper advising of the advantages of adopting standards when developing the MSDI framework	OGC Marine DWG	June 2017	Not started
Training and Development	02/2017	Contact IRCC Chair requesting IRCC-9 receives prompt feedback from RHC's on MSDI Training Course outcomes	Chair/Secretary	End Feb 2017	Not started
IHO Publication C-17	03/2017	Request that IRCC consider making C-17 v2.0 dynamic in nature enabling new information to be made available in a timely manner.	Chair	April 2017	Not started
Global Referencing Systems (Ref: 15/2016)	04/2017	Submit a paper to HSSC-10 outlining options for the development of DGGS	OGC Marine DWG	Sept 2018	Not started
StandardsS-102 (Ref: 18/20 16)	05/2017	Provide report to MSDIWG-9 on S-102 Scientific implementation plans	Germany	Jan 2018	Not started
IHO Website	06/2017	Request ideas from IHB Secretariat on how the IHO website can enable "one click" download of information	Chair/Secretary	May 2017	Not started
WG Action Plan	07/2017	Revise Action Plan for submission to IRCC-9 to reflect new IHO 3 year Planning Cycle	Chair/Secretary	April 2017	Ongoing
MSDI Body of Knowledge	08/2017	WG Members to put forward case study material for onward publication in the IHO "Body of Knowledge" web pages	USA, Brazil, Korea, Canada, Malaysia, OceanWise	Dec 2017	Not started
Support for MS (Ref: B3)	09/2017	Prepare a primary use case for Arctic bathymetry SDI	OGC Marine DWG	June 2017	Not started
Ecological Marine Unit Explorer	10/2017	Develop EMU as a MSDI Case Study	Esri Chair	September 2017	Not started
Ecological Marine Unit Explorer	11/2017	Include EMU in WG Report IRCC-9 for onward submission to HSSC-8	Chair	April 2017	No started
Future meetings (Ref: 24/2016)	12/2017	WG members to indicate their willingness to host MSDIWG and Open Fora in 2018, 2019 and 2020.	All	Ongoing Brazil – 2018, Korea – 2019 (tbc)	
OGC DWG	13/2017	Develop and deliver a structured outline Project Plan for identified topic areas with timelines and with identified funding options	GSDI - Roger Longhorn/Chair DWG	March 2017	Not started
OGC DWG	14/2017	As part of the MSDIWG annual report to IRCC; recommend that MS, through RHC's are encouraged to join the OGC Marine DWG.	Chair, OGC MDWG	April 2017	Not started

Subject	ACTION No.	ACTIONS	OWNER(S)	Date	Status
Regional Hydrographic Commissions	15/2017	Draft letter to all RHC Chair's through IRCC providing a list of MSDI reporting requirements (e.g. Maturity Assessment template)	Chair	Feb 2017	Not started
Webinars-Remote meetings	16/2017	To investigate the use of "Go to Meeting" for future MSDIWG meetings	Chair/Secretary	June 2017	Not started
Crowd Sourced Bathymetry	17/2017	Provide WG comments on CSB Paper to CSBWG Chair	Chair	Feb 2017	Not started

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**Concept Development Study Proposal
Defining the Future for the
Marine Spatial Data Infrastructure (MSDI)**

Submitted 6 March 2017

Contents

Concept Development Initiative: Defining the Future of Marine Spatial Data Infrastructure

1. Purpose:

This proposal presents the Open Geospatial Consortium's (OGC) approach for evaluating the current state and defining the potential future of Marine Spatial Data Infrastructures (MSDIs). The initiative will emphasize on the rapid evolution of technologies and methodologies for generating non-navigational location-based information of value to a broad range of users.

2. Background:

Today's Hydrographic Offices have advanced a global coverage of navigational charts and associated electronic data to support safety of navigation. At the same time, our global society is experiencing rapid advancement of technologies to support littoral, coastal and deep water bathymetric collection as well as a broadening base of authoritative, corporate and citizen sources of hydrographic location information of value to ocean science, energy exploration, sustainable development and many other topics. Examples of emerging capabilities and integrative opportunities include, but are not limited to:

- Crowd-sourced bathymetric data collection
- Autonomous surface and submerged vehicle data collection
- Real time buoy observations
- Satellite / airborne imaging for shallow water bathymetric collection
- Shipboard active bathymetric data collection and navigation
- Explosion of Internet of Things (IoT) devices and their potential application
- Automatic Data Identification (AIS) traffic monitoring and Analytic services
- Big data analytics

Further, the MSDI must be defined such that it is compatible with other SDIs to allow support for integration of other data holdings, including the ability to address topics such as the land / water interface. There is a wealth of marine information not currently managed by Hydrographic Offices, however this information has relevance to a wide variety of non-navigation marine uses, and may also enrich navigational information. What shall be the extent of coverage of the MSDI, and what information assets shall it maintain and reference?

Supporting interoperability of emerging technologies, new information sources and with other SDIs is the underpinning role of open standards and the OGC. Open standards make possible agile sharing and exchange of hydrographic information, along with the ability to rapidly and efficiently extend IT systems to ingest and process new data especially from new technology sources. The International Hydrographic Organization (IHO), the Open Geospatial Consortium (OGC), and ISO/TC 211 are a few of the major Standards Development Organizations (SDO) that are providing core open standards to enable the MSDI.

While a core framework of standards to support MSDI are in place, solutions to major and emerging challenges are required from standards community. One such challenge focuses on identifying and implementing a more efficient and effective mechanisms to organize, retrieve and apply the exploding volume of data being collected by a myriad of devices over the globe.   A Discrete Global Grid System (DGGS) effort is underway in the OGC to support the massive and growing body of location-based information being collected and processed by individuals, governments, businesses, researchers and citizens alike. Other challenges include the need for automated methods for determining the uncertainty associated with and integration of potential sources of data such as crowd-sourced or volunteered geospatial information.

The MSDI is also important to addressing the goals of the United Nations 2030 Agenda on sustainable development and its 17 Sustainable Development Goals (SDG), many of which have a direct need for spatial information and supporting decision support technologies to address these goals. SDG 14 regarding Oceans, Seas and Marine Resources will benefit greatly from a globally consistent MSDI with a level of standards based interoperability that allows rapid mobilization of new and emerging data sources and technologies to address marine topics at local, regional and global level.   OGC is directly contributing to the goals of the 2030 Agenda through its participation in the United Nations Global Geospatial Information Management (UN-GGIM) program, and through its role as a Participating Organization in the Group on Earth Observations.

Further, ongoing and recent OGC interoperability initiatives have bearing on the definition of an MSDI. In addition to engaging the marine community, the OGC will leverage outcomes of prior testbeds and pilots to assist in shaping a MSDI interoperability reference architecture. Such projects include the recently completed Arctic Spatial Data Pilot (Arctic SDP), the International Oil and Gas Producers (IOGP) / IPIECA Oil Spill Response Common Operational Picture Study, and SDI and related Cross Community Information Sharing requirements addressed in OGC's previous interoperability Testbeds.

3. Proposal Objectives:

The goal of this proposal is to evaluate the current state and define the potential future of Marine Spatial Data Infrastructures (MSDIs). It has the following objectives:

- Document the current state of MSDIs
- Document the needs for a MSDI based on current emerging technologies
- Document strategies to interoperate with other Spatial Data Infrastructures
- Develop a common interoperability reference architecture
- Engage with experts from across the user community as well as from the community of technology / information and services providers, including hydrographic offices, industry, government, research, and other SDOs.

4. About the Open Geospatial Consortium:

The Open Geospatial Consortium, Inc. (OGC) is an international voluntary Standards Development Organization (SDO) that provides a broad interface with over 500 industry, government, academia and

research organizations engaged in advancing standards to improve geospatial interoperability. OGC's standards are implemented in hundreds of products in the global technology marketplace, and are implemented in user community solutions to improve the discovery, sharing, access, fusion and application of geospatial / location based information; and to rapidly mobilize new technologies and information sources.

OGC is comprised of a range of industry, government, NGO, academic and research organizations representing a variety of markets and domains of use – working collectively to advance interoperable best practices and standards to enable rapid mobilization of geospatial technology services, technologies and information. Organizations representing domains such as meteorology and oceans, emergency management, response and recovery; defense and intelligence; urban planning and management are active in OGC. These organizations benefit from coordinating with others in their market or domain of interest. More importantly, members benefit greatly from their ability to advance solutions to address the complex challenge of cross-domain information sharing and processing to address increasingly complex issues such as climate change, and alternative energy planning.

In addition to its proven consensus process for advancing and adopting open standards for implementation and use worldwide, OGC emphasizes an [Innovation Program](#) of fast paced Concept Development Initiatives, Testbeds, Pilot initiatives and Interoperability Experiments. These initiatives allow OGC members to rapidly conceptualize and develop candidate standards and best practice interoperability recommendations in an environment where these standards can be actively and rapidly developed, tested, validated and demonstrated in the context of real world business scenarios.

Since its inception, OGC has been a major enabler of Spatial Data Infrastructure (SDI) programs worldwide to advance a common set of standards to enable the publishing, discovery, access, fusion and application of geospatial / location information for improved decision making.

Furthermore, the OGC has a solid track record of partnering with the broader standards community such as with ISO Technical Committee 211 (Geographic Information / Geomatics) and the International Hydrographic Organization, OASIS, OMG, IETF, ITU and the W3C to support cooperative standards and best practice development. One example of this cooperative support includes the successful collaboration between ISO/TC 211, IHO and OGC to develop a set of guides to articulate the value of open geospatial standards and to provide guidance on the implementation and adoption of geospatial standards by the user community. These documents can be downloaded for review at: http://ggim.un.org/ggim_committee.html.

5. Tasks:

The OGC will leverage the proven processes of its successful Innovation Program to organize a Concept Development Study (CDS) Initiative to engage the marine community in assessing current MSDI capabilities and architecture. The CDS will also identify potential MSDI future states based on a range of factors including the rapid evolution of technologies and the broadening base of potential contributors of

useful hydrographic information. The CDS will engage the hydrographic community, SDO membership and other experts from industry, government, academia and research in the cooperative definition of a current and future state MSDI. Major tasks will include:

1. Conduct **initial assessment of MSDI** by researching available documentation and by interviewing experts. The study will present the current state of MSDI, future needs based on the emerging technologies, and an Interoperability Reference Architecture describing the standards framework for the MSDI.

2. Release of an **Invitation to Participate** in a MSDI Current / Future State Workshop to review and refine the draft MSDI Current / Future State report.

3. Convene a one day MSDI Current / Future State workshop in a location agreed upon with the Sponsors, with remote connectivity for invited participants who are unable to attend in person.

4. From the results of the initial Workshop, develop and issue a global **Request For Information** to contribute to the definition of the current MSDI and a future state MSDI that takes into account the implications emerging technologies, new methods of collection and processing, recommendations on extent and content of the MSDI, and the interoperability / standards framework needed to enable MSDI agility to change and growth.

5. Review and consolidate responses to the RFI along with input from the initial workshop and initial assessment into a draft **MSDI Current / Future State Report**

Figure 1 MSDI Tasks / Deliverables

6. Convene a follow-on one day workshop to discuss and **finalize the MSDI Current / Future State Report**.
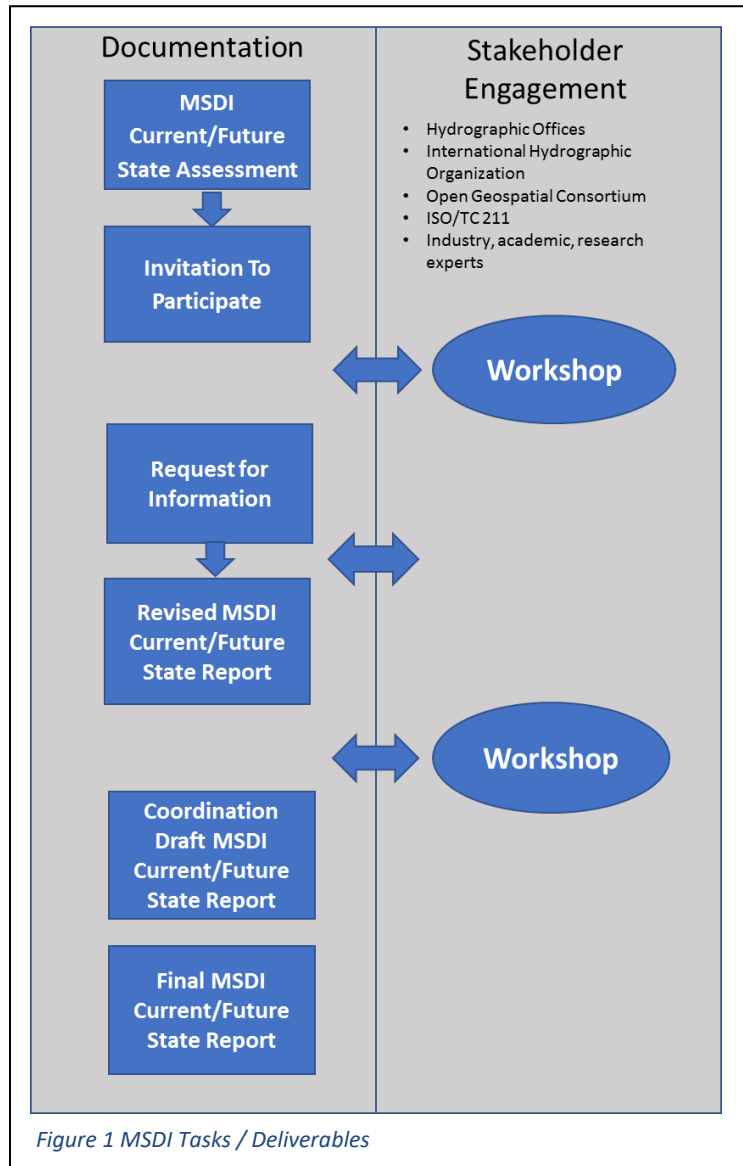
7. Prepare *formal coordination draft of the MSDI Current / Future State report*, to include a presentation summarizing the report and its findings, and issue to participants for final review and approval.

8. Perform a final revision based on coordination feedback and *release the final MSDI Current / Future State Report* to sponsors and public.

9. Propose a potential follow on OGC *innovation pilot project or testbed,* with a focus on key use cases identified in the final report, such as but not limited to cross community bathymetric information sharing for the Arctic.

6. Deliverables and Schedule

Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Initial MSDI Assessment and Report		▓	▓	▓	▓	▓																					
Invitation to Participate in MSDI Workshop					▓	▓	▓	▓																			
MSDI Current / Future State Workshop											▓																
Request for Information											▓	▓	▓	▓	▓	▓	▓										
Revised MSDI Current / Future State Report																▓	▓	▓									
Workshop to review and finalize MSDI Current / Future State Report																				▓							
Coordination Draft of MSDI Current / Future State Report																					▓	▓	▓				
Release Final approved version of MSDI Current / Future State Report																										▓	
Proposed follow on Innovation Pilot or Testbed Recommendation																										▓	

7. Cost

The following is a breakdown of OGC's cost proposal submitted as a firm fixed price project:

OGC Cost Proposal Summary		Project
Reference		MSDI CDS
Duration (Weeks)		30
Type of Proposal		Firm Fixed Price
OGC Staff Extended DL Burdened w/Fee		Dollars
1. Management	$	6,812.48
2. Initial MSDI Assessment Current / Future State Report	$	14,404.96
3. Invitation to Participate in Workshops	$	985.53
4. Workshops	$	10,845.48
5. Request for Information	$	2,061.94
6. Initial Draft MSDI Current/Future State Report	$	16,019.60
7 Coordination Draft MSDI Report	$	16,019.60
8. Final MSDI Report	$	4,066.48
9. Pilot Initiative Recommendation	$	5,360.56
Total Direct Labor	$	76,576.63
Other Direct Costs exc. G&A + Fee		Dollars
Travel	$	3,600.00
Total Other Direct Costs	$	3,600.00
Total Price before Adjustment	$	80,176.63
Adjustment	$	(176.63)
Total Price after Adjustment	$	80,000.00

8. Other Considerations.

8.1 Workshop Facilities:

OGC assumes that facilities for the workshops discussed in this proposal will be arranged and provided by Sponsoring organizations at no cost to the OGC. OGC will provide net meeting services as required to support remote participation by participants unable to travel. If desired, OGC will assist sponsors in identifying potential meeting locations by working with its member representatives, who may have facilities and interest in hosting workshop events.

Persons invited to attend workshops in person are expected to cover their own travel costs.

9. Key Personnel

Dr. Luis Bermudez

Dr. Luis Bermudez is the Executive Director of the OGC Innovation program. He has a Ph.D. and M.S. in Environmental Informatics from Drexel University. Dr. Bermudez has more than 20 years of experience in the information and technology industry including geospatial, sensor web, semantic web and legal information. On the last 5 years while working for OGC, he has led numerous initiatives of OGC's Innovation Program and has played the role of system architect on OGC Testbeds.

Prior to joining the OGC in 2010, he was the Technical Manager for the SURA Coastal Ocean Observing and Prediction Program and Technical Lead of the Marine Metadata Interoperability project at the Monterey Bay Aquarium Research Institute (MBARI). In both positions, he advanced solutions implanted world-wide to support management and sharing of coastal data, including numerical models and ocean observing systems. In Colombia (1996-1999), he developed CRM and legal information systems, and provided consulting on strategic planning and technology implementation for Latin America companies.

Mr. Bermudez is an adjunct faculty member in the Master of Professional Studies in Geographic Information Systems program at the University of Maryland, where he teaches topics on GIS, databases, NoSQL, cloud computing and cartographic modeling.

Mr. Lew Leinenweber

Mr. Lew Leinenweber brings significant experience as a Project Manager and Software Engineer, which has been focused on developing systems and capabilities incorporating geospatial technologies. As Director of Innovation Programs, Mr. Leinenweber is responsible for planning, managing and developing architectures for interoperability initiatives such as testbeds, pilots, interoperability experiments.

Since 2005, Mr. Leinenweber has served as Initiative Architect or Initiative Manager for Innovation Program testbeds including OGC Web Services Phase 3 (OWS-3) through OWS-6, and served as Initiative Manager for the OWS-4 testbed. As an OGC member company representative, he served as Chairman of the Emergency & Disaster Management (EDM) Domain Working Group (DWG). During this period, he also served as a member of the Emergency Management Technical Committee in OASIS supporting the development of Emergency Data Exchange Language (EDXL) message standards. Previously, he led software development projects including database migrations and software process improvement initiatives in accordance with the Software Engineering Institute's Capability Maturity Models (CMM and CMMI).

Mr. Leinenweber holds a BS in Physics from University of North Carolina at Chapel Hill and an MS in Computer Science from The Johns Hopkins University in Baltimore, Maryland.

Mr Trevor Taylor

Mr. Trevor Taylor has over twenty-five years of experience in the international Earth Observation community. With a background in Geography (Carleton University, Canada), Mr. Taylor has worked with the Canada Centre for Remote Sensing, Dipix Technologies, Interra (now InterMap) Technologies and PCI Geomatics. Currently, Mr. Taylor is Director, Member Services, Asia and the Americas with OGC.

Mr. Taylor has significant global experience in a wide variety of technical, client services, project, business and strategic planning activities. Example completed project work relevant to standards and the marine domain include Coastal Mapping (near shore, Western Africa), FP-5 GETIS, Participant lead (sample scenario: Marine Vessel Safety, European Union), Cyclone Monitoring (India, Thailand, Vietnam), SAR and Detection of Land/Water boundaries (Canada, Malaysia), Known Depth Analysis, Port and Port approaches charting (Middle East), plus numerous other projects containing a geospatial standards element.

Mr. Taylor has been involved in OGC for fifteen years both as member representative at the technical, principal, principal plus and strategic levels, with a focus on South America, India, China and Western Europe and as OGC staff.