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MGDI: INFORMATION INFRASTRUCTURE FOR THE MARITIME COMMUNITY

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ABSTRACT

The marine environment is our last frontier. The need for better data and information is paramount to ensure proper management and sustainable development of this remote, often inhospitable and multi-dimensional environment. New technological advances in our ability to collect and process ocean data have resulted in very rapid growth in the volume of data and information about this environment. Efforts are now underway in many jurisdictions to implement the technical and policy framework required to facilitate access to this geospatial data and information. In Canada, government and industry are collaborating to develop a Canadian Geospatial Data Infrastructure (CGDI) through a national program called GeoConnections. As partners in this initiative, the Canadian Centre for Marine Communications (CCMC) and the Department of Fisheries and Oceans (DFO) are leading the development and implementation of a Marine Geospatial Data Infrastructure (MGDI) that will facilitate access to inshore, coastal and marine environmental, transportation and resource data and information by a broad range of users. This paper outlines the building blocks required to implement MGDI and references pertinent Canadian technologies and initiatives that make this possible.

BACKGROUND

Since the beginning of time, populations have tended to migrate towards coastal areas and over half the world's population now lives within 60 kilometres of the coast. In these areas, the increased demand on aquatic and terrestrial resources and the conflicts among the many users has increased global awareness of the need to preserve and protect marine and fresh water environments. Concomitantly, populations have continued to harvest the renewable and non-renewable resources in these regions often to the point of depletion or extinction. The resources of these marine and fresh water regions are immense not only in economic terms but, also in societal terms and in terms of protecting and sustaining our aquatic habitat.

In a recent article in the Hydrographic Journal dealing with Global Ocean Markets¹, the authors state, “It is only in recent years that nations have begun to recognise the size, diversity and complexity of the ocean industries and their importance to all. To many people, marine equals shipping which is indeed an important industry as the world fleet carries over 95% of the world trade by tonnage and shipbuilding is a business worth over \$32 billion per annum. Offshore oil and gas is the worlds biggest marine industry, where oil production alone can have a value of more than \$300 billion per annum. Submarine cables are now a huge business that provides the ‘world-wide’ part of the world wide web and enables the very existence of the internet.”

In Canada, Ocean based activities now generate nearly \$20 billion in annual economic activity, which is important to the national income and even more to the approximately seven million Canadians living in coastal communities. Where once, Canada’s oceans were the exclusive domain of commercial fishing and marine transportation industries, there is now a wide array of new ocean activities including offshore oil and gas, aquaculture, ecotourism, recreational fishing, cruise shipping and recreational boating².

In the context of this paper, and for the Marine Geospatial Data Infrastructure (MGDI) initiative, the maritime or marine regions of Canada encompass all of Canada’s landmass that is covered by water as well as the water column, the non-renewable resources, the seafloor and the underlying sediments. This includes the marine regions from the shoreline to the deep ocean and all of the fresh water lakes, rivers and watersheds of importance in terms of commerce, societal needs and sustaining habitat. Furthermore, the marine community includes all of the individuals, groups and institutions, with a stake in these regions. This includes fishermen, marine scientists, mariners, hydrographers, habitat managers, offshore developers and persons in similar disciplines in the private, the public and the academic sectors. MGDI is therefore a programme that embraces geospatial data, databases and geospatial information infrastructure over an area that includes three-quarters of Canada’s landmass and all individuals with an interest in the marine regions as we have defined them. As we will explain in more detail later, the task of MGDI, or the MGDI participants, is to coordinate the infrastructure that will allow the sharing of marine geospatial data in a cost effective manner to the mutual benefit of all stakeholders.

The concept of collecting, managing and storing geospatial data in digital form is not at all new. Steps in what was then called automated hydrography in the Canadian Hydrographic Service (CHS) started in the 1960s and were well underway by the mid 1970s. In the early 1980s, the first discussions were held on the Electronic Chart with the first major Canadian workshop being held at the University of New Brunswick in 1982.

In 1983, a second workshop was held in Baltimore, another in Rockville in early 1985 and on 19 April 1985, a workshop was held at Dartmouth Nova Scotia with 140 participants. This workshop was co-chaired by two of the early visionaries in the Electronic Chart field, Neil Anderson, then a member of CHS and Capt. John Hammer III, then with Defence Mapping Agency, a precursor to the National Imaging and

Mapping Agency of USA. An interesting comment made by Neil at this workshop is that “The key to the electronic chart is access to databases. There are a large number of individual databases today in the hydrographic offices of the world’s nations. To assure convenient external access, these will need to be restructured into a common format for the Electronic Chart to allow it to be used worldwide³.” Notwithstanding these early thoughts on common formats, It is interesting to note that S57 Edition 3 was not in place until 1996 for the interchange of cartographic data and it was not until December 1997 that the performance standards for Electronic Chart Display and Information Systems (ECDIS) were approved by IMOⁱ.

There have been many changes since the 1985 workshop on the Electronic Chart and an impressive effort put forth by many nations and agencies to see that the digitally based products, be they vector based or raster charts, digital Sailing Directions or Notices to Mariners are available for the mariner to purchase. Indeed the focus today is as much on the Marine Electronic Highway as it is on the provision of the charts and classical hydrographic products. In other marine scientific disciplines, the move to acquire, manage and store data in digital form is equally strong.

At a national level, when the opportunity came to participate in a program that would look at geospatial data for many applications, the scientific community was quick to grasp the opportunity. The “acquire once and use many times” concept was becoming well established in the community. This was abetted by the strategic Plan⁴ of the International Hydrographic Organization wherein under benefits, it is stated “Additionally, Governments benefit from the work of the IHO in developing the application of hydrographic data to other tasks. There is a growing demand for hydrographic data for purposes other than navigation, especially for fishing, offshore industry, coastal protection, harbour construction, and marine scientific research.”

GENESIS OF MGDI

The Marine Geospatial Data Infrastructure (MGDI) initiative had its beginning in 1999. In that year the Canadian Geospatial Data Initiative (CGDI) was approved as a federally funded five-year \$60 million initiative under the leadership of Natural Resources Canada. This federally funded partnership program known as GeoConnections is designed to:

- co-ordinate Canada’s numerous databases of geographic information and make them accessible through a common window on the internet; and
- enable partnerships between provincial and federal governments, the private sector and the academic community.

The Program Advisory Network for GeoConnections consists of twelve committees or nodes and one of these nodes is a Marine Advisory Network node. The Marine Advisory Network node is co-chaired by the Department of Fisheries and Oceans (DFO) and the Canadian Centre for Marine Communications (CCMC).

ⁱ Refer to the Recommendations on performance standards for electronic chart display and information systems (ECDIS) (resolution A.817(!), as amended and resolution MSC.84 (70).

The Marine Advisory Network node has a Marine Advisory Committee with membership representing the various stakeholders in the sector. The task or mission of the Marine Geospatial Data Infrastructure (MGDI) initiative is to ensure that the geospatial data requirements of stakeholders in all marine regions of Canada are satisfied in a manner similar to that which the Canadian Geospatial Data Infrastructure (CGDI) responds to the terrestrial requirements for geospatial data under the GeoConnections Program. It is envisaged that this information infrastructure will provide connectivity and interoperability to marine stakeholders who need access to distributed geospatial data and information and who wish to supply data to the infrastructure

Under the Marine Advisory Committee, all work related to the implementation of MGDI is coordinated through a Geospatial Projects Integration Office administered by DFO. The main objective of this office is to ensure that a common integrated infrastructure serving all identified stakeholders in the Marine Sector is developed and integrated.

The MGDI Concept

The MGDI concept is not new. Neil Anderson in 1989 pointed out that environmentally sustainable marine resource development, whether for sustainable fisheries, integrated coastal zone management, or non-renewable resource development, is an interdisciplinary process that depends on access to data from multiple sources⁵. MGDI represents a spatial and temporal data infrastructure comprising a system of data and enabling policies and technologies that are critical to sustainable development, management and control of national marine, coastal and freshwater areas. An integrated view of MGDI is shown as Figure 1. Some of the key characteristics of a solid information infrastructure are as follows:

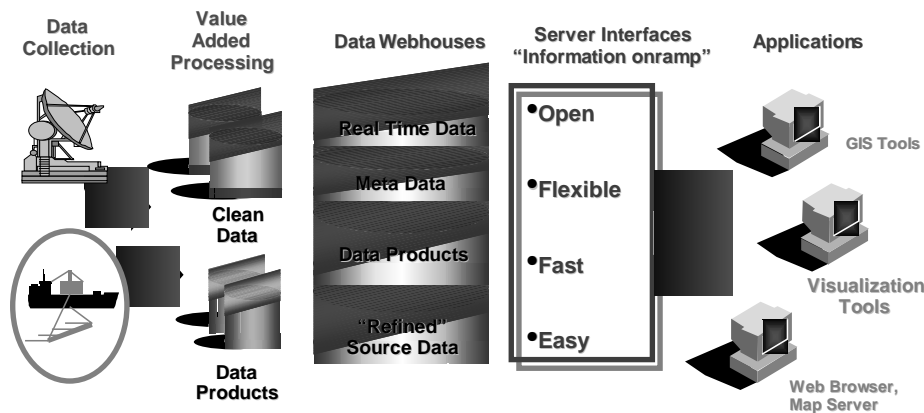


Figure 1 Integrated View of the Marine Geospatial Data Infrastructure (Adapted from Kucera and Keighan, 1998)

- Good infrastructure is based on common standards. Common standards ensure that component technologies work together. In other words, the technologies are interoperable.
- Wide area networking ensures that the infrastructure reaches a broad audience. Telecommunications and information technology for networking distributed databases is highly evolved (in large part due to recent growth of the Internet and World Wide Web) and is relatively well developed for offshore areas in Canada and other parts of the world.
- Good infrastructure is invisible to the users. If we consider the telecommunications industry as an example, users of telephones do not see, nor do they need to concern themselves with how the infrastructure works. It just does.
- Good infrastructure enables simple, third party access. Users require simple access if infrastructure of any kind is to be useful and used.
- Good infrastructure is affordable. By serving a broad base of users, infrastructure becomes affordable for each. As such, one of the primary objectives of MGD I will be to break down the present barriers among the various data and information silos. This means that a considerable amount of development work will need to be done in advance of the time when the infrastructure is fully functional and self-sustaining.

Some of the **Information Elements** that have been considered in the design of MGD I are as follows:

- For each sector of the marine community, there is a distinct user group often with particular needs that must be considered.
- There are certain databases that can be considered as foundation or framework databases that are needed to support virtually all spatial information needs and applications in the marine sector.
- Processes must be cost effective.
- Because of the large size and complexity of the datasets, advanced data management technologies are required.
- Access to the data, databases and information must be two-way and simple.
- Governance needs to be considered in developing policies, standards and ensuring interoperability.
- User training will be an ongoing function.
- Implementation needs to be done in a spirit of cooperation and partnership.

USER GROUPS

The following are the main user groups for marine geospatial data, databases and information:

Marine transportation

The marine transportation industry will employ marine geospatial data to improve decision-making on navigating vessels safely and efficiently. Crews, passengers, cargo, and the environment all stand to benefit.

Marine habitat management

Making sound decisions on conserving, protecting, and sustaining marine environments requires the kind of reliable and credible scientific information that MGD I will offer.

Integrated coastal zone management

MGDI can help those who plan coastal zone developments to answer questions on the impact global warming will have on sea level, storms, and flooding.

Renewable resources

The collapse of Canada's coastal fishing industries underscores the importance of better fisheries management. MGD I will enable a better balance between the needs of fishermen and resource managers.

Non-renewable resources

High-resolution seabed mapping and improved climate forecasting can provide oil and gas companies with the best information for siting and building offshore production facilities.

Disaster management and emergency response

Geomatics technologies can provide forecast information that will allow stakeholders to take the necessary action to lessen the impact of icing, storms, hurricanes, and flooding - events that can result in injury or death and significantly damage coastal property.

Sovereignty and defence

Canada can use geomatics tools to help protect its extensive coastal regions. Mapping and monitoring offshore areas using satellites and sensors on ships and aircraft allows us to demonstrate our sovereignty and protect marine resources for future generations.

Ocean research

Understanding disruptions of the ocean-atmosphere coupled system (such as El Nino) will assist Canada to lessen negative social and economic impacts of climate change.

Recreation and tourism

Geospatial information can be used to boost tourism by making coastal areas safer and easier to access while protecting marine habitat. Information that will allow the transit of passenger vessels into many of the small and scenic harbours will be most important to local economies.

Freshwater resource management

Community policy makers and water resource managers can use geospatial information to balance resource management with social and economic needs.

Marine engineering works and services

Geospatial information can give marine engineering companies a competitive edge, no matter what their business: shipbuilding, port development, buoy manufacturing, marine materials, marine towing and salvage, diving equipment, or coastal and offshore structures.

SUMMARY OF USER NEEDS

Eight workshops were held throughout Canada to obtain user requirements. Some of the common themes that emerged from the workshops are as follows:

- Users for the most part want information not data.
- There is a need for One Stop Shopping or single portal availability to satisfy data needs in each marine sector.
- Many marine users want a two-way infrastructure whereby they can contribute valuable data and need the infrastructure to aggregate data from various sources and feed information back to them.
- In all sectors, strategic as well as operational information is required.
- Data requirements are global. Users felt that if the MGD I initiative deals only with data in the Canadian context, it will not likely be sustained in the longer term.
- Users at virtually all the workshops listed access to water depth information as a basic foundation database requirement.
- Users stressed the need to be able to access collected data and information. There was a general feeling that a considerable amount of data has been collected in various formats and these data reside in government laboratories and are not accessible to potential users.
- Data ownership, licensing, policy and cost recovery issues were recognized as issues that need to be resolved. These issues, not technology, are the more difficult barriers to the success of MGD I.
- Standardized formats in terms of databases, data transfer and data query are needed. Interoperability is critical and users should be able to use their own hardware and software to access and use the infrastructure.
- All datasets should carry date stamps, as users indicated that times of collection are an important factor.
- Users need to know if there are data quality issues in the information being accessed. If there are, then the infrastructure should deal with these issues.
- In virtually all the workshops, the need was identified for a seamless land and water digital elevation model for all of Canada's lands.
- The real value of the MGD I initiative will be in providing access to useful information for making decisions.

CURRENT STATUS

The past year was a relatively active one for MGD I with a number of initiatives completed, a number underway, and a number planned for completion over the coming

year. The following statements provide a status for MGDI in the main areas of progress:

- The MGDI initiative is firmly in place as the marine node of GeoConnections. This has been achieved through the financial support of CGDI, CCMC and DFO in providing funding for the development of the original MGDI architecture, for workshops and continuing support for the Geospatial Projects Integration Office.
- The Geospatial Projects Integration Office is active in coordinating all work related to the implementation of MGDI.
- MGDI is well represented on the CGDI web site.
- An MGDI Stakeholders Steering Committee is now under development to represent all stakeholder groups in the marine sector with each committee being chaired by a member of the Marine Advisory Committee.
- The ADM Science, DFO, is a member of the Management Board of Geoconnections to ensure that marine interests are represented at all levels.
- Work is well underway on the DFO GeoPortal.

THE FUTURE

To overcome the barriers to sharing geographic information, data producers, users, and technology providers in Canada, the U.S., Europe, and other parts of the world have

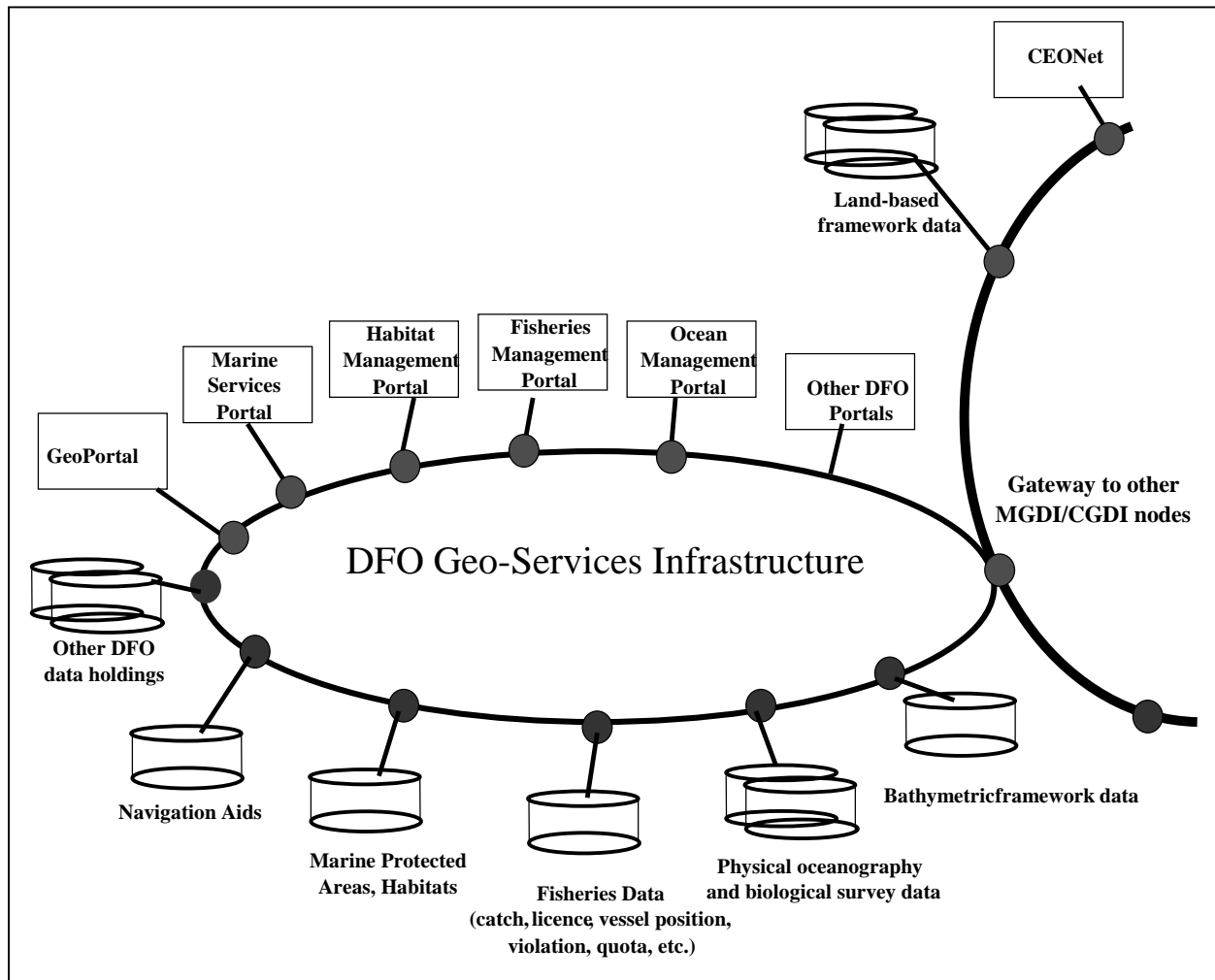


Figure 2: DFO GeoPortal Conceptual View

united in new, successful, efforts to produce practical standards for Web-based technology. This is driving software vendors to produce the components needed for “open” systems, eliminating the technical barriers to the sharing and integration of geographical data. In DFO, the GeoPortal Project was established to build upon the new technology and to provide some of the major building blocks of MGD. The GeoPortal comprises two major components: a geospatial infrastructure for data discovery, data access and data integration, and a user interface to enable access to all of the services provided via the infrastructure.

Through this sharing of information, there will be a substantial reduction of effort by reducing duplication in having to re-acquire and re-convert the same data for different technology platforms. The GeoPortal aims to position DFO so that it can make strategic and tactical use of geospatial information to better achieve its mandate.

The DFO GeoPortal is also aiming to be an enabling agent to facilitate the inclusion of geospatial contents and geospatial services in community portals. A community portal can be defined as a portal addressing the information requirements of a specific target community (habitat management, oceans data, marine services, etc.). The DFO GeoPortal will be used by the community portal developers to target specific geospatial contents and services to be included in their own portal as illustrated in Figure 2.

The DFO GeoPortal is based on open Web-based service architectureⁱⁱ, which means that users can access a variety of data-related services through the Portal. These services will be distributed, in that they can run on different machines and be able to discover and access data from different data sources. The architecture is based on international specifications, which allow for interoperability of data formats and data processes through standard interfaces.

Another building block is the underlying framework data. These framework data are the set of continuous and fully integrated geospatial data that will provide context and reference information for the Marine Geospatial Data Infrastructure.

SUMMARY

The major outcomes from the MGD initiative are as follows:

- It provides an integrated geospatial infrastructure that is two-way and user-friendly for a broad marine community.
- It provides cost benefits through the sharing of data, databases and information.
- It provides connectivity, interoperability and access for many users including access to information, not previously accessible.

ⁱⁱ *CGDI Technical Vision and Implementation Plan, GeoConnections, Ottawa, March 2001*

The major outcomes from the DFO GeoPortal project are as follows:

- It represents the development of the knowledge worker through an open capability that enables the integration of the various DFO information holdings through their georeference.
- The GeoPortal does not need one centralized data warehouse, but can integrate information at the source, provide a capability to store value-added information and to publish resulting products through the Internet. Data services (e.g. Chart data as backdrop) are provided by the infrastructure for use by the other communities, eliminating the need to replicate or maintain this data.
- It is an *enabling agent* to facilitate the inclusion of geographical data content and services for the various DFO community information systems. This capability can be demonstrated by several applications (POD Chart Dealers, Habitat, Vessel Tracking, Science SCIDAT, others).

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