The Integrated Management System of Ocean Color Remote Sensing Data

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ABSTRACT

The integrated management system of ocean remote sensing data (IMSORS) has recently become more and more important as the data volume growing exponential, the data diversity increasing, and the developing of the marine research, and so on. IMSORS evolves into a service-oriented architecture (SOA) that provides the flexibility, multi-scale, and generality necessary to manage the vast amount of data and applications. Google Earth and web-based GIS are growing rapidly and used to visualize and share three-dimension (3D) marine environmental data in IMSORS. Google earth can provide 3D visual and virtual globe for us. IMSORS display the ocean color information in the globe. Web-based GIS is being used in marine environment visualization, spatial analysis and prediction etc in the IMSORS.

Keywords: ArcSDE, service-oriented architecture, Web-based GIS, Google earth, 3D visualization, Ocean color, Web Map Service (WMS), Web Feature Service (WFS)

1. INTRODUCTION

Now on the one hand the infrastructure is heterogeneous across operating systems, applications, system software in oceanographic research field. On the other hand, useful information and knowledge need to be mined from mass oceanic information acquired by different methods. State Key Laboratory of Satellite Ocean Environment Dynamics (SOED) has already established IMSORS system which can receive and deal with datum from many ocean color and temperature satellites to get information of ocean color and environment. These data include sea surface temperature, seawater transparency, sea weather visibility, aerosol concentration etc.. For management and application the marine information fully, the IMSORS has been established by SOED. The IMSORS faces the key challenges: massive increases in data volumes, the extraordinary diversity of ocean color data, evolving user requirement, and ever-developing science and technology. IMSORS must address all of these problems and quickly respond to these changes, balanced the existing infrastructure and the infrastructure to address new requirements.

1.1 EOSDIS and CLASS

NASA's Earth Observing System (EOS) Data and Information System (EOSDIS) have provided the data and information systems and services to the EOS program and the National Oceanic and Atmospheric Administration (NOAA) have the Comprehensive Large Array-data Stewardship System (CLASS) to management their information and data.

EOSDIS has been under development since the early 90's. It is a distributed system that is deployed and operated at eight Distributed Active Archive Centers (DAACs) across the U.S. It supports the full range of data and information systems and services for EOS and other NASA Earth science programs including data production, active archive, search and order, data distribution and direct data access. The data product generation occurs both at the DAAC facilities and at remote facilities developed and managed by the EOS scientists. EOSDIS also includes a distributed framework that supports the interconnection and interoperability of these components.

The Comprehensive Large Array-data Stewardship System (CLASS) is NOAA's planned mechanism for securely archiving large-volume data and data products, and for making this data available to researchers, commercial users, and the public. The volumes of data collected by future satellite-based instruments and observation systems will overwhelm

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the existing archive and distribution systems without a dramatic expansion in capacity: CLASS is the vehicle for the necessary expansion [1].

1.2 SOA introduction

The Service Oriented Architecture (SOA) has been gaining lots of interest in the way of seamless integration of information systems spreading across several organizations. As shown in Fig. 1, taken from [2], service provider exposes some software functionality as a service to its clients. SOA allow clients to access the service that the provider also has to publish the service. As soon as the service requester finds a suitable service description for its requirements at the agency, it can start interacting with the provider and using the service. SOA is an evolution of distributed computing based on the request/reply design paradigm for synchronous and asynchronous applications with its loosely coupled nature [3], i.e., the service interface is independent of the implementation, allows plugging in new services or upgrading existing services to address the new requirements so IMSORS is evolving toward a service-oriented architecture (SOA) that provides the flexibility, scalability, and generality necessary to accommodate the vast amount of change in its environment and at the same time provide interoperability with other system of the ocean environmental.

Fig. 1. Basic Methodology of Service Oriented Architecture (SOA)

1.3 GIS and Google Earth Plugin

GIS applies to the marine and coastal environment which traces back to that America national ocean surveying and mapping bureau automated the production of nautical charts in the early 1960s. After 1990s marine satellite remote sensing technique, computer technique, and GIS technique develop rapidly. Extensive amounts of accumulated and diverse marine satellite remote sensing datasets need to be commonly organized, accessed and queried by marine scientists. Thus, there is a need for a powerful, yet simple to use, GIS-based tool that stores marine datasets, performs analytical GIS functions and visualizes the results in 3D animations [4]. Web-based GIS depend on the community standards to enable interoperability at various levels. The Open Geospatial Consortium (OGC) plays that role for Web-based GIS. It is looking at Web services to provide the foundation for interoperability.

Oceanographic scientists are beginning routinely to use 3D modeling and visualization techniques in their work. 3D modeling and visualization technique is exactly needed even to the general user. Google Earth and World Wind are the representation as web 3D modeling and visualization techniques. While the appeal of these techniques is evident, with unprecedented opportunities the public access to data and collaborative engagement over the web [5]. The Google Earth Plugin and its JavaScript API let user embed the full power of Google Earth and its 3D rendering capabilities into their web pages. Just like in the Google Maps API, you can draw markers and lines in 3D [6]. We integrate Google earth in the IMSORS by using the Google Earth Plugin.

IMSORS focuses on web services for Ocean and Marine applications integrated with Google Earth, web-base GIS. The integrated system provides the users a standard interface for querying ocean resources information. The implementation of IMSORS based query mechanism is in compliant with the Web Map Service (WMS) and Web Feature Service (WFS) [7].

2. DATA INTRODUCTION

Over the years the state key laboratory of satellite ocean environment dynamics have acquired great progress in ocean color remote sensing mechanism, simulation, inversion algorithm study and the ocean color remote sensing data application for ocean fishery, water quality monitoring, hydrometeor forecast etc.. These researches have got along with international advanced level in the efforts of researchers under support of National 863 Projects and National Natural Science Foundation.

2.1 Data source

Now IMSORS need manage many sources data: almost 10 satellites data, including TERRA/MODIS, AQUA/MODIS, SeaStar/SeaWiFS, NOAA-12/AVHRR, NOAA-15/AVHRR, NOAA-16/AVHRR, NOAA-17/AVHRR, NOAA-18/AVHRR, FY-1C/MVISR, FY-1D/MVISR etc. and other in-suit data. These data have massive increases of data volume and data diversity. IMSDORS has established a multiple site distributed system to preservation these data. Because ocean color data are immensely heterogeneous, being available in various formats and stored in diverse media. The added flexibility of adding and removing data sources to the integrated system makes IMSORS appropriate solution for the users who needs to access data from repositories.

2.2 Remote sensing data levels

Satellite data are the subject of very complex and lengthy processing step from the raw data stream to the attractive, global maps of selected parameters. The stages in the conversion process are known as product levels. IMSORS use the following product levels as shown table 1.

Level-0 (L0) is universally defined as the initial, unprocessed data from the sensor.

Level-1A (L1A) products contain the data from all bands as well as spacecraft and instrument telemetry after removal redundant information. Calibration and navigation data, and instrument and selected spacecraft telemetry are also included. Level-1A data are used as input for geo-location, calibration, and processing.

Level-1B (L1B) data set contains calibrated and geo-located and removed redundant information generated from level-1A sensor counts. Additional data are provided, including quality flags, error estimates, and calibration data.

Level-2 (L2 or L2A) product is generated from a corresponding level-1B product. The main data contents of the product are the geophysical values for each pixel, derived from the level-1B raw radiance counts by applying the sensor calibration, atmospheric corrections, and bio-optical algorithms. Each level-2 product corresponds exactly in geographical coverage to that of its parent level-1B product and is stored in one physical.

Level-3A (L3A) single track data products consist of the accumulated data for all level-2 data corresponding to period of one day, 10 days, a calendar month, or a calendar year.

Level-3B (L3B) products are image representations of binned data products. The data in L3B product represents an image of the parameter specified by the global attribute parameter. L3B theme products are fusion of fixed periodic multi-track L3A.

Level-3C (L4C) products are theme of no fixed period of time data fusion of multi-track L3A and clouds replacement.

Level-4A (L4A) products are the thematic contours of geophysical elements and thematic map of marine dynamic information based on L3C.

Table 1 the level of data.

Produc level	Defining and Description
L0	Raw data from the sensor
L1A	Data after removal redundant information, only SeaWiFS
L1B	Data after removal redundant information, geo-location, calibration
L2 or L2A	Data obtained by retrieval of geophysical information from L1B
L3A	Data obtained single track theme product by map projection and re-sampling from L2A
L3B	Theme product fusion of fixed periodic multi-track L3A
L3C	Theme products of no fixed period of time data fusion of multi-track L3A and clouds replacement
L4A	The thematic contour of geophysical elements and thematic map of marine dynamic information based on L3C

3. NORAS SYSTEM ARCHITECTURE DESIGN AND DEVELOPMENT

3.1 The system architecture of IMSORS

Fig 2 shows the schematic framework of the integrated management system of ocean remote sensing data (IMSORS). The main components of the integrated system are (1) Data Sources (distributed database), (2) Query Interface (mainly web site), (3) Query Processor, and (4) WFS/WMS module. The working principle of service-based discovery and retrieval mechanism has been incorporated in the integrated system. A service consumer makes request to a central server, which acts as the Discovery Agency (find-a-service). Once the services are discovered, service consumers make actual data request to the service provider the user request parameters and available information services. Once the request for data is posed to the central server, the Query Processor is used to understand the meaning of the users' request instead of simple parameter matching approach. The Query Processor module uses the resource descriptions in the system in order to translate a user query into some queries that refers directly to the schemas of the data resources and dispatches them to the appropriate WFS sub-module at the data producer end. A query is posed in terms of the features and is executed by the concerned WFS/WMS module on one or more of the local repositories. The WFS/WMS modules act as wrappers at the data repositories. The wrappers components actually retrieve data: it receives data access requests, executes them at the data repository, converts the data in standard GML form before transferring them back. The discovery and retrieval mechanism of a service-oriented architecture has been fully realized for marine geo-spatial data interoperability.

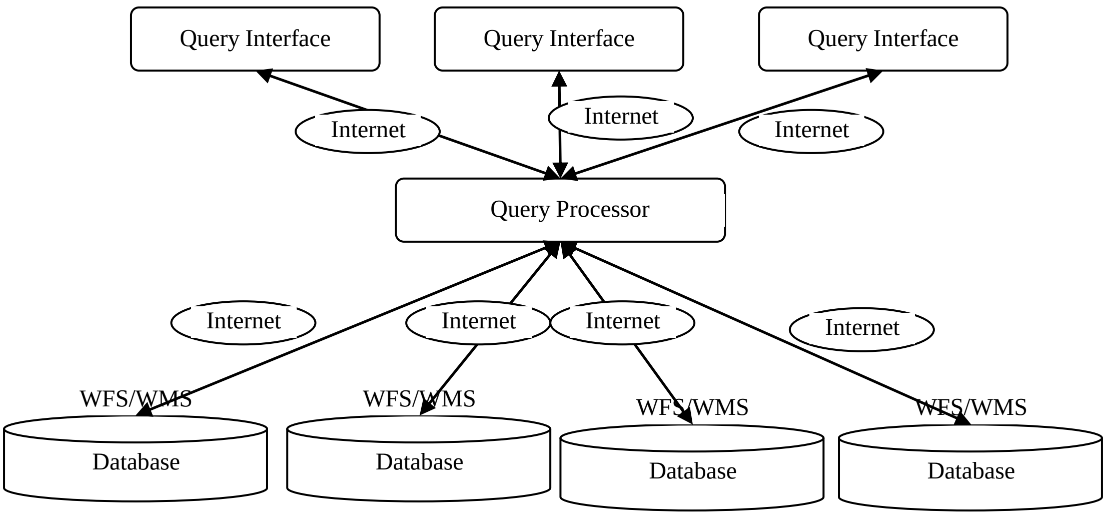

Fig.2. SOA Framework of IMSORS

3.2 The distributed database

Ocean color remote sensing systems have many data sets and database. Placing data on-line for access via the Internet is a high priority in accordance with the user's priority. Data storage and retrieval systems will continue to be upgraded to support effective and efficient access with special focus on internet interfaces. IMSORS has also been designated as the system that will support the long-term archive requirements for ocean color remote sensing data products. The IMSORS was developed as a framework to provide integrated data support while accomplishing the needed capacity expansion. We design each new database include three parts, as shown in fig 3: vector database, raster database, and other database. Vector database store and manage all kinds of isograms products and fundamental geographic information data. For example sea surface temperature, seawater transparency isograms products. Raster database store and manage images and some thematic maps. Otherwise some other data of marine information need be managed in the database.

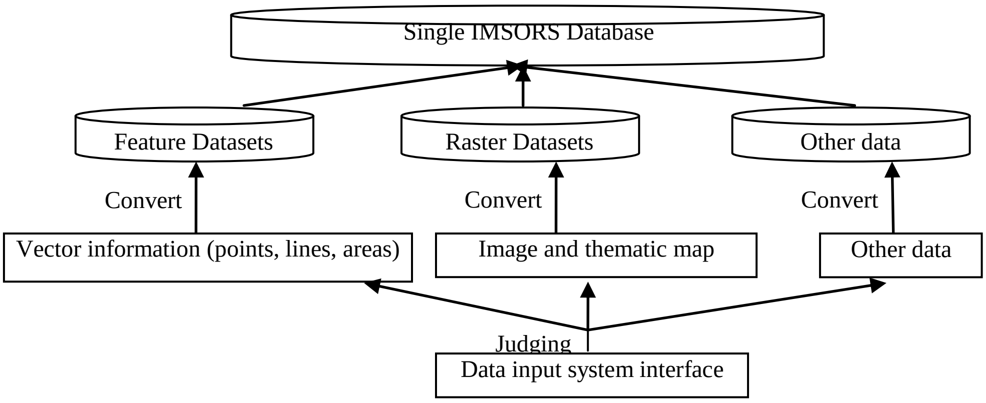

Fig. 3 The design of the new single IMSORS database

A great amount of data, especially satellite remote sensing image data and data derived from them, historical data, need large commerce database and GIS middleware—ArcSDE as platform of data management to design, study and develop marine satellite remote sensing data management.

4. THE APPLICATION INTERFACE OF IMSORS

The application interface of IMSORS is web site and user can query their need data, display the data, and query the attribute and location of the data. Fig 4 shows the interface page includes three parts: toolbar, file listing area, file displaying area. Data load can open a data query interface, user can select data service provider, service name, database name, data type, and data name or select located area data. Inputting database allow user save selected data input some database. In addition, the query data can display and list to make user judging, accepting and rejecting. The application interface of IMSORS also has simply spatial analysis.

IMSORS use GIS to gather, neaten, analyze, and compute a baseline survey on the geological, climatic, hydrological conditions and other environmental characteristics of the ocean. User query their data and information from web site and web site return and display the results to user by Web GIS and Google Earth.

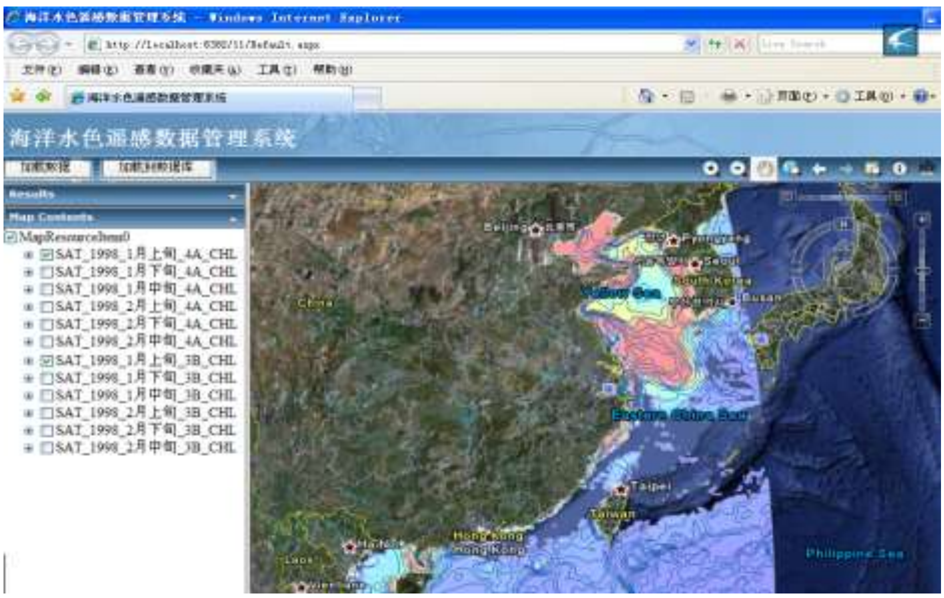

Fig. 4. the application interface of IMSORS includes three parts: toolbar, file listing area, file displaying area.

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