BIOME: A Browser-Aware Search And Order System*

CONF-9605163--1

Jon W. Grubb, Sarah V. Jennings, Teresa G. Yow, Ph.D., Patricia F. Daugherty

Abstract

The Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC), which is associated with NASA's Earth Observing System Data and Information System (EOSDIS), provides access to a large number of tabular and imagery datasets used in ecological and environmental research. Because of its large and diverse data holdings, the challenge for the ORNL DAAC is to help users find data of interest from the hundreds of thousands of files available at the DAAC without overwhelming them. Therefore, the ORNL DAAC developed the Biogeochemical Information Ordering Management Environment (BIOME), a search and order system for the World Wide Web (WWW). The WWW provides a new vehicle that allows a wide range of users access to the data. This paper describes the specialized attributes incorporated into BIOME that allow researchers easy access to an otherwise bewildering array of data products.

Keywords

Retrieval and Resource Discovery, User and Application Interfaces, Design Techniques for Web Applications, Data Retrieval, Data Analysis, Metadata, Database, Scientific Data Server, Client/Server, User Interface Design

1. Introduction

1.1 The ORNL DAAC

The Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) is one of nine data archive and distribution centers belonging to NASA's Earth Observing System Data and Information System (EOSDIS). Both the Earth Observing System (EOS) and EOSDIS are components of NASA's contribution to the U.S. Global Change Research Program through their Mission to Planet Earth. The nine DAACs, located throughout the U.S., provide data support for various NASA research projects and make data available to the global change research community, policy makers, educators and the general public.

The ORNL DAAC specializes in data and data products relating to the Earth's biogeochemical dynamics. These data often come from NASA's ground-based research programs, and include tabular data and satellite imagery, as well as non-NASA biogeochemical data and value-added products relevant to global change research. Holdings include data on biogeochemical cycling, global change, global warming, terrestrial ecology, ground truth, biomes, ecosystems, atmospheric trace gases, etc.

Data may be obtained through the EOSDIS X-Windows systems, or by email, telephone, or mail from the ORNL DAAC User Services office. The User Services group spends much of their time answering questions on a person-to person basis. To reach the widest possible group of users, the ORNL DAAC also makes the information available on the World Wide Web (WWW).

1.2 The ORNL DAAC on the WWW

The original plan for data distribution by the DAACs was to make data and descriptions of data holdings available via a centralized *telnet* area used by all nine DAACs. This Information Management System (IMS) has been

successfully implemented and is mirrored at telnet sites maintained by each of the nine DAACs (ORNL's is telnet eosims.ornl.gov 12345). However, one drawback to the IMS is that users must have a workstation or X-emulation software to access the system.

To address this problem, in 1994 the ORNL DAAC created a WWW site using a National Center for Supercomputing Applications (NCSA) httpd 1.4 server and the Unix operating system on a Silicon Graphics workstation. The rationale was that the WWW is the premiere resource access mechanism available on the Internet today, and it will remain so for the foreseeable future.

The first ORNL DAAC home page was a relatively simple text description of the DAAC, its holdings, and contact information for obtaining the data. In addition, detailed descriptions of each dataset were available in HTML 2.0 format [1]. These dataset descriptions were already being used as part of the EOSDIS IMS system, so we decided to use them with the WWW pages. These text pages have since been improved and updated, and they continue to serve as an option for users who wish to obtain data by that avenue. They are located at http://www-eosdis.ornl.gov.

As the number of datasets and users grew and the DAAC's knowledge of WWW processes increased, we saw the need for a search and order system to guide users to data. In response to this need, in late 1995 we developed the Biogeochemical Information Ordering Management Environment (BIOME) search and order system using HTML 2.0 (with some 3.0 capabilities), located at http://www-eosdis.ornl.gov/X1/globe.html.

1.3 Unique Features of BIOME

BIOME uses many of the generic Web features that are in common use today. However, BIOME offers several advanced features that help users locate data quickly and easily. Some of those features are briefly described below; the subsections that follow describe each of these features in detail.

Browser-aware linking and dynamic paging. BIOME categorizes browsers based on their capabilities. The pages are modified according to the ability of the user's browser to display them. High-end browsers such as Netscape 2.0 can get pages with frames, tables and Java applets. Low-end browsers such as Lynx get character-only pages.

User mindset awareness. The site does not dictate the user's starting point. By design, there are several points from which a user can start depending upon what the user already knows about his/her search goals.

Metadata-based rapid access capabilities. BIOME's access to metadata stored in a relational database management system (RDBMS) allows efficient searching of hundreds of thousands of metadata records.

User-selected dynamic product packaging and delivery. Users can choose from multiple methods of data delivery (e.g., download, FTP, zipped, Mac format), with data formatted on-the-fly and automated as much as possible.

2. Browser-Aware Linking And Dynamic Paging

On-the-fly browser customization is one of BIOME's most innovative features. The Web interface developed at the ORNL DAAC allows any user with a Web browser and Internet access to search, order, and even download ORNL DAAC data directly to his/her machine. Because we have no way of knowing which browser a user might have and do not wish to exclude any potential users, we designed the interface to work with any browser capable of supporting forms, including non-GUI browsers (e.g., Lynx).

Our objective is to have any user from any browser worldwide be able to access and download data from the ORNL DAAC. Because many of our users are scientific researchers working in remote areas, we try to balance their needs

with those of users who have access to the latest technology.

The BIOME pages utilize the NCSA server "options" capabilities. That is, they use all of the *include*, *echo*, and *exec* options available. The *include* and *echo* options are used for convenience. The *exec* option is used to dynamically alter the function and appearance of the pages to optimize the appearance of the page on the user's browser.

2.1 Browser Identification and Classification

To facilitate browser identification, the BIOME page HTML document contains the line:

<!--#exec cgi="/cgi-bin/browser.sh"-->

This Bourne shell script is executed as the page is being constructed prior to being sent to the user's browser. The script examines the Unix environment variable HTTP_USER_AGENT, which contains the descriptive identification of the user's browser. The script launches a C program that parses the browser description and categorizes it into one of four classes of browsers:

1. Netscape-compatible and variants,
2. Mosaic-compatible and variants (various Mosaics, HotJava, etc.),
3. character based that can still handle forms (Lynx, etc.), and
4. incompatibles that cannot handle forms (Cello, etc.)

As new previously unknown browsers are seen by the system, the user is requested to call or email BIOME User Services with a description of the browser. The browser is then entered into one of the four classes listed above.

Browser classes 1 and 2 can show images whereas browser class 3 cannot. The difference between classes 1 and 2 is mostly the appearance of the displayed page. BIOME uses tables but the tables are carefully constructed so that browsers which cannot display tables can still display the table information in a legible manner. This is accomplished by carefully laying out the tables so that adding a "break" to the last data entry in a table row allows non-table browsers to display the row data on one line. Browsers that recognize tables ignore the extra break. Thus, with careful design, tables data can be made to display acceptably on both table and non-table browsers. Care is also taken to ensure that every image has an *alt*, or text alternative, that is meaningful to nonimaging browsers.

With the advent of Netscape 2.0 it may be necessary to subdivide the Netscape compatible category into Netscape 1.x and 2.x compatibility. In the short period from December 14, 1995 to January 3, 1996, twenty-six different browsers accessed BIOME.

2.2 Constructing Dynamic Pages

The user's browser class is stored in a file with the name based on the IP address of the user. This file is read by any other process that needs to know the browser class. This is how the pages are dynamically altered.

The BIOME page also contains the line:

<!--#exec cgi="/cgi-bin/is_gui.sh"-->

This is the first occurrence of the use of the browser class information stored previously. This script uses the browser class to determine if the user's browser is capable of displaying images. If so, the section of the page that allows the user to select information based on images is included in the page. If the browser class does not allow images, this portion of the page is not included for display. Thus, the page has been dynamically altered based on

the user's browser capabilities. In this way, the web site appears browser aware.

Each search method available to the user is linked to extensive help pages. These pages also are browser aware. The pages do not display help for what the browser cannot do.

By design, the links that exist on a page are there only because the user's browser can display the pages linked to. Other links to pages requiring image capabilities are all in page components shown only to browsers that can display images. In this way, the site appears to exhibit dynamic linking.

While the advantages of browser-awareness for the user are apparent, there are some disadvantages for the system maintenance personnel. Screens are designed around *include* statements that pull in the appropriate "modules" for each browser. Thus, there are a few additional files to be created and maintained; however, careful design of the interface has minimized these maintenance problems.

3. User Mindset Awareness

In general, users who are searching for information already have some initial information that they are trying to complete or expand. As explained previously, this web site contains a vast amount of information that can be difficult to search without a convenient starting point. The BIOME user interface supplies the user with several starting points based upon what the user already knows (see Figure 1).

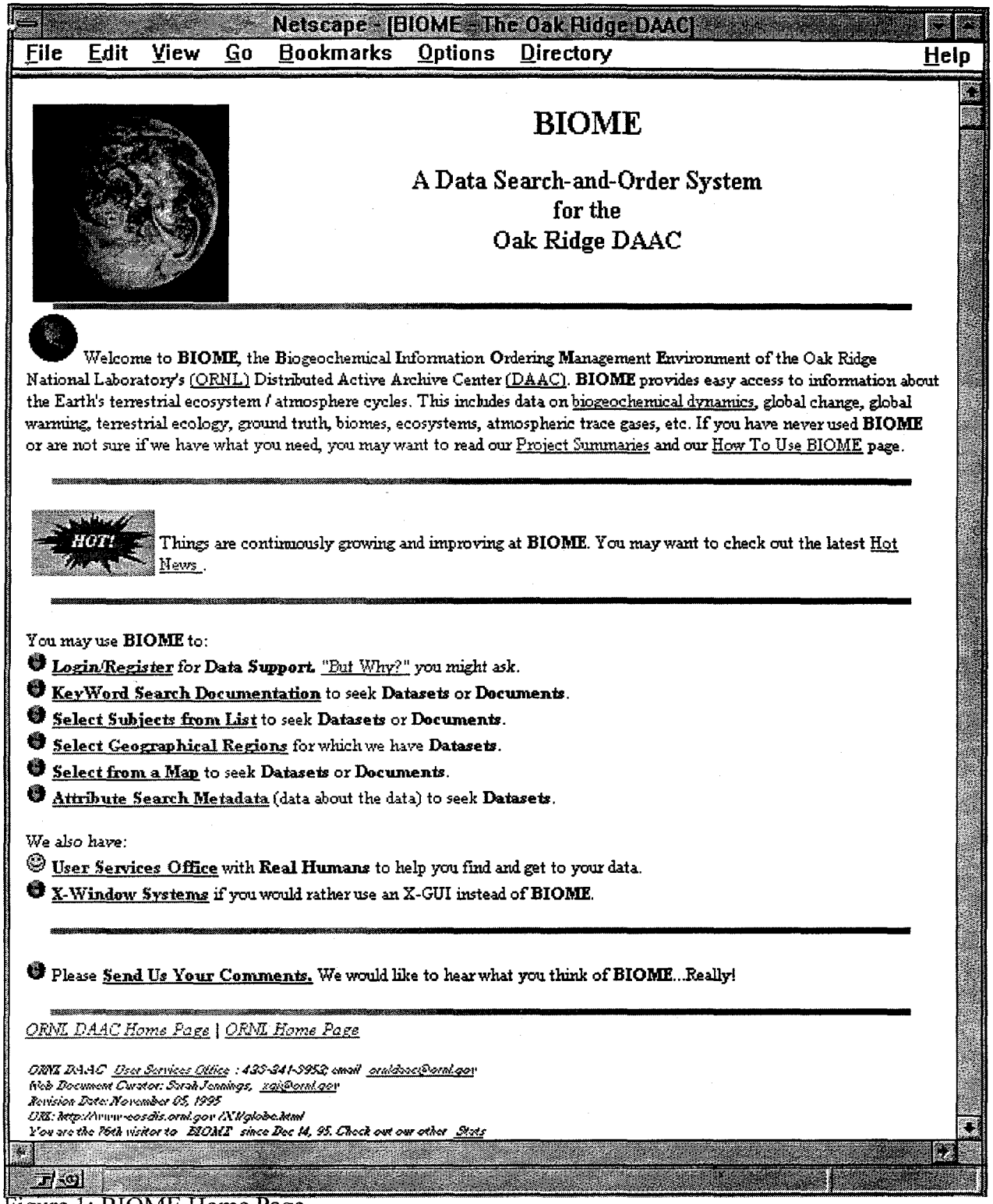

Figure 1: BIOME Home Page

The basic unit of storage at this web site is the "dataset." A dataset contains the results of one particular research effort. Each dataset can contain one or more data files. Most data files are in row and column format stored online as ASCII text. A user can search the system to get a file, several files, a dataset, several datasets, or any combination of files and datasets. There are hundreds of datasets and hundreds of thousands of files. So how does a user get started? There are five starting points within BIOME from which a user may choose:

1. attribute search,
2. keyword search,
3. subject search,

4. region search, and
5. map search.

3.1. Attribute Searching

Attribute searching, as shown in Figure 2, allows the user to search the DAAC metadata database by some attribute(s) of the dataset for datasets of interest. BIOME displays a list of data attributes from which to select the search criteria (i.e., dataset name, investigator, source, sensor, or geophysical parameter). This selection option provides the user with a continuously shrinking results set until the user has the desired dataset(s).

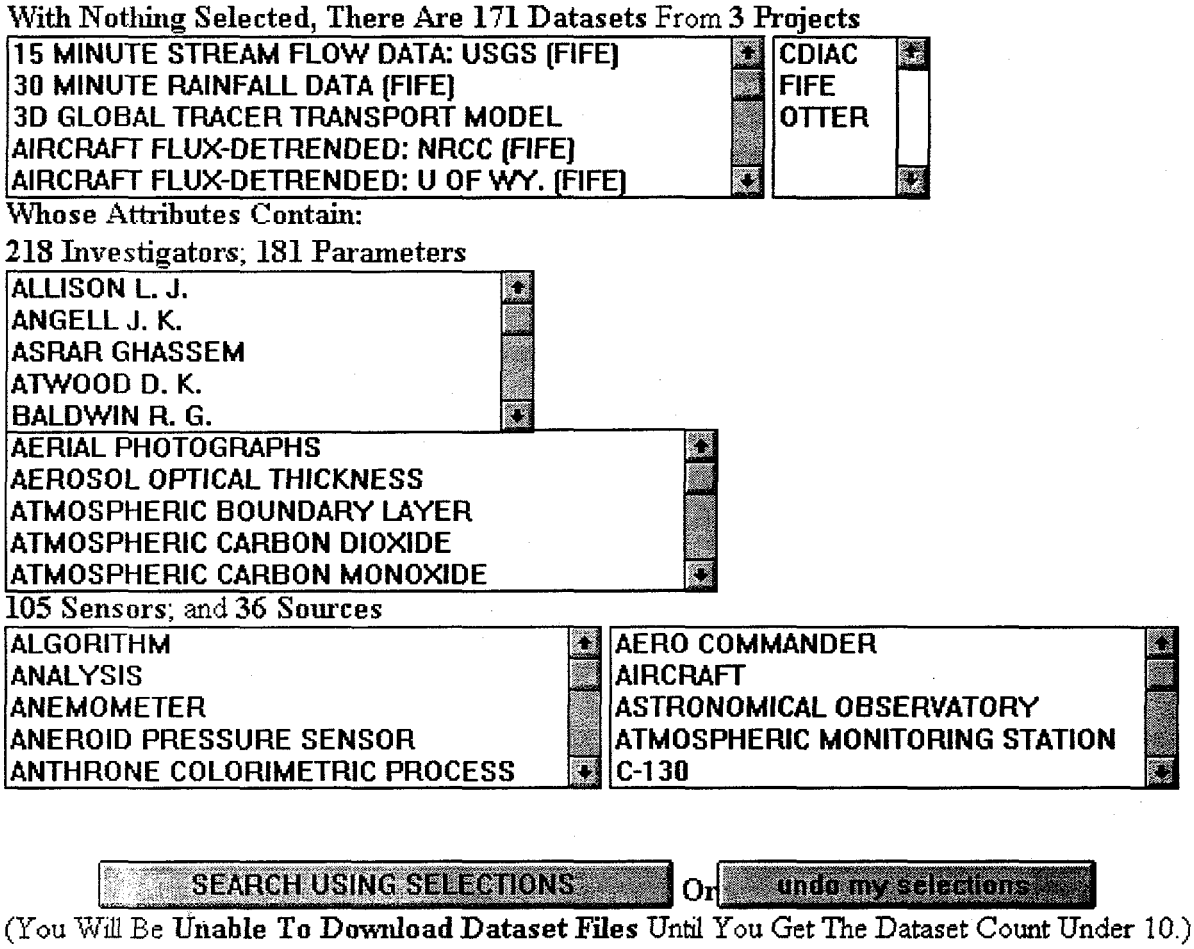

Figure 2: Attribute Search Screen

Attribute searching assumes that the user is fully aware of what this web site contains and how to get it. The user is allowed to go directly to the information desired without distraction.

Attribute searching uses a search engine that is built over a Sybase database. The database is searched for matches to a user's input, and the search results are put into a results form and returned to the user's browser. This search engine is described in detail in Section 4.

3.2. Keyword Searching

For keyword searching the user enters a word, phrase, or Boolean combination of words and phrases. This selection criteria is then passed to a text search engine based on the Unix "grep" command. This command uses the user's input to search through all the data documentation to arrive at a list of datasets that meet the selection criteria. The search engine searches documents describing the datasets to create a list of documents that meet the search criteria.

These documents are then mapped to their corresponding datasets.

Keyword searching is the opposite of attribute searching. Here, it is assumed that the user knows nothing about what information this site contains. The user can enter virtually anything and the search engine will try to find a Boolean match.

3.3. Subject Searching

The data at this DAAC covers a variety of different subjects. e.g. greenhouse gases. However, these wide subject categories may not be specifically mentioned in the documentation or the metadata. To assist the user in searching for information about a general subject, we have categorized datasets into various subject areas. The user can select one or more subjects from a subject list, and the interface searches a database table for the subject selected and returns the name of all datasets associated with that subject.

3.4. Region Searching

Because the ORNL DAAC archives data from field investigations, many datasets are associated with specific geographic regions (although some of the data is global in scope). This search method allows the user to select one or more geographic regions. Examples of geographic regions include the Indian Ocean, Oregon USA, and Mongolia.

The latitudes and longitudes of the defined region are retrieved from the database; then those values are compared to the latitude and longitude for each data file as listed in the metadata. All datasets that contain files with latitude and longitude values within the specified ranges are identified, and the datasets to which the files belong are identified. BIOME then returns a list of all the datasets containing data about the selected region(s).

3.5. Map Searching

The Web server also has access to geographic maps that highlight the areas for which this DAAC has data. The user can select a point and the system returns all the datasets that contain data about the selected point. There is a world map, hemispheric maps, and continental maps.

Map searching works in a manner very similar to geographic region searching. The maps are clickable images where the pixel location corresponds to a map position. The latitudes and longitudes of the defined map position are retrieved from the database; then those values are compared to the latitude and longitude for each data file as listed in the metadata. All datasets that contain files with the selected latitude and longitude within their latitude and longitude ranges are identified, as are the datasets to which the files belong. BIOME then returns a list of all the datasets containing data about the selected location.

3.6 Search Results

In all cases described above, the initial search results are shown on a screen similar to the attribute search screen. The metadata search loop may be repeated as many times as necessary to narrow a search down to just exactly what a user wants. A flow diagram that illustates this process is shown in Figure 3.

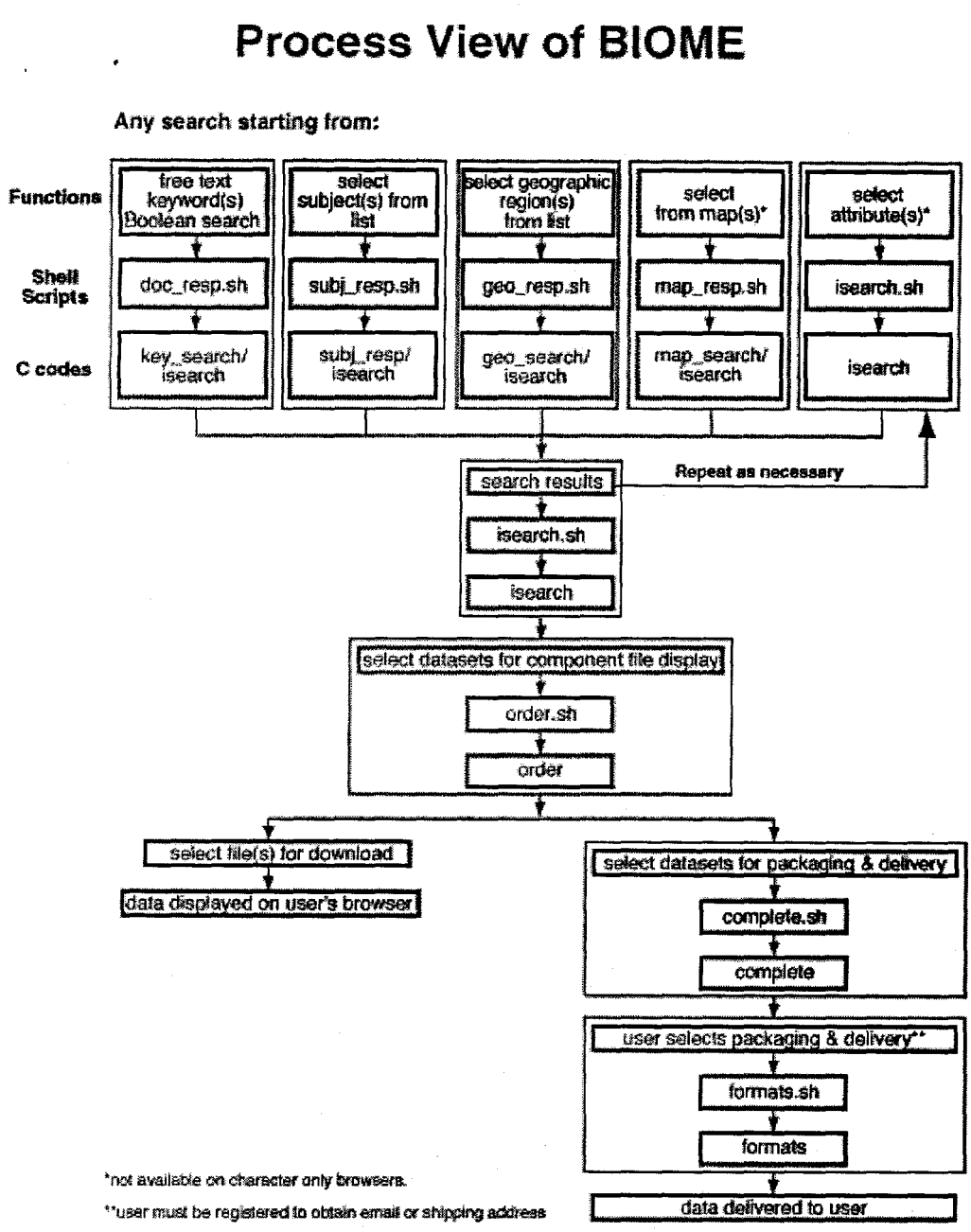

Figure 3: Process View of BIOME

4. Metadata-Based Rapid Access Capabilities

The metadata at this web site is contained in a Sybase database. There are two major components to this database: the dataset tables and the file or "inventory" tables. The dataset tables contain the broad attributes that apply to a complete dataset. The inventory tables contain those attributes that apply only to a particular file belonging to a dataset. Together, these tables constitute the metadata database. The actual scientific data is stored separately from the metadata. The location of the data files is included in the metadata database.

Because Sybase has a very clean and efficient interface to the C programming language, we made the decision to create small, specific C processes that perform very specific retrieval and page assembly functions for the web server. This means that a page will contain different components depending upon the results of a query.

The database was originally designed to be used for retrieval of metadata for display to an X-Windows display

system. In order to keep from having to support two sets of tables, those same tables were used for the retrieval of web-based display data. Extra indexes and cross mapping tables were added when necessary to allow the needs of the web pages to be met with the existing database design. The result is a database that responds with completed pages in seconds and supports both the X and web interfaces. Usage has shown that in most cases the network is still the slowest part of any retrieval.

Any page that requires components to be built from a data query are called from a cgi-bin script. The script is always a Bourne shell script that handles any setup and environmental issues as well as providing the browser with the first few items of page output from cgi-bin scripts. The script always calls C code modules to do the actual query and finish the page output.

All forms pages are GET posted. Some forms also pass arguments in the page link call. The C code modules get the forms information from the GET input but also retrieve special information from the link call. Some pages are NOT forms but pass information through their link calls to other pages which ARE forms.

For example, the dataset results from a previous page are passed to a subsequent page to be used as part of the query so that the user gets more refined results with each query. The user can then order a complete dataset from a page that is not a form but was created as the result of a previous query. The link always calls the same page but passes as part of the link call the dataset name to be ordered. The called page reacts to the dataset argument by including information about that dataset in the custom-generated instructions on how to specify delivery.

5. User-Selected Dynamic Packaging and Delivery

Once the user has selected down to the dataset(s) of interest, he/she can elect to display the file metadata associated with that(those) dataset(s). It is at this point that the user has the option of downloading data files directly to the browser or selecting complete datasets of files to be collected and either made available by FTP or recorded onto some media and shipped to the user.

It is also at this point that the web site insists that the user be "registered" to allow the User Services group to contact them if necessary, to provide an email address for FTP instructions, or to provide a shipping address for any delivery requests on hard media.

FTP delivery requests are as automated as possible. To be considerate to others on the network, all requests are compressed into a single file but in the platform format requested by the user. BIOME does not restrict users in their end product format. A Unix user can have FTP data formatted into Mac Stuffit if the order requestor is on a Unix system but the data user has a Mac.

The web site maintains Unix (tar, compress, gzip), PC (PK-zip), and Mac (Stuffit) packaging software that is invoked whenever the user requests FTP delivery. The user is emailed an order confirmation when the order is placed and then emailed FTP instructions when the order is ready, usually within a few minutes. This is all done without any human intervention although every action is logged for human review later.

Hard media requests require User Services intervention. A hard media request causes an email to go to User Services with the user's data request and shipping information. The requested data is placed into a special area for processing by User Services for that user. User Services merely loads the tape or floppy or CD, records the data, and packages and ships the media.

Most users use FTP transfers that are fully automated. Users with special needs can still opt to request hard media and have it delivered.

6. Future Plans

Over the next few years the DAAC will be incorporating vast numbers of new datasets. Within two years it is expected that our number of files could easily triple, quadruple, or more. At that point the search mechanism could be sorting through a quarter of a million files. BIOME was designed to accommodate additional files and search mechanisms as needed.

The ORNL DAAC is also making plans to add search capabilities for near-line imagery files that will be stored in a mass-storage system. A browse capability that will allow users to view imagery data is planned and the necessary programs to search and retrieve near-line data are being written.

In addition, a tabular grapher is being developed that allows users to see a graph of their data. A series of graph templates instruct the image generator how to interpret the tabular data. Each data file is assigned to a template. This technique allows one graphic engine to display all the different layouts of tabular data.

The browser-aware capability of BIOME will be utilized to determine if the user's browser can execute JAVA applets. The BIOME server can then create a JAVA applet on-the-fly which when downloaded and activated will graph the user's just-downloaded tabular data. If the user's browser is VMRL capable, BIOME will create a 3-D graph that can be viewed from any angle.

The web developers are also planning to create a database table of small *.gif* images that are reductions of the real images. These can be quickly sent to image-displayable browsers for viewing by the user. The user can then select the real image from the sample image. The real image can then be downloaded if small or packaged for FTP or hard media shipment if large.

7. Conclusion: Lessons Learned

In summation, BIOME provides WWW access to a large number of tabular and imagery datasets dealing with ecological and environmental research. The challenge is to help users find data of interest to them from the hundreds of thousands of available data files without overwhelming them. BIOME allows individuals to easily search an otherwise bewildering array of data products and retrieve/order the data online.

In accomplishing this task the ORNL DAAC learned a number of lessons that are applicable to other search and order systems on the WWW. Foremost among these is that management of a database this size requires metadata. Metadata can be extremely human-intensive, especially where various types of data from disparate sources are involved. Managing the metadata requires a RDBMS, and dealing with large amounts of data requires a robust server.

Documentation is also very important. A search and order system is of little use if it can't provide at least an abstract describing the data to a potential user. It is also important that users retrieve companion files to the data, e.g., documentation, software, etc.

Good design allows a server to optimize network response times, although it is more work in the design phase. Running a large-scale system on a server also requires full-time babysitting. The System Administrator(s) should expect to be on 24-hour call and have pagers that notify them of any serious server problems. Provisions must also be made for orders that are too big to download. These options include FTP, tape, and CD-ROM.

Most important, providing data to a world-wide community requires support for a wide range of skill and knowledge levels, as well as various browsers and platforms - including Unix, PC, and Mac. To accomplish this, the DAAC developed a browser-aware search-and-order system that allows users to begin their search at any one of five starting points. Users have the freedom to search for data in the way that best meets their needs using a system that is tailored to take advantage of the capabilities of the particular browser being used.

As in many fields, the challenge is not merely to accomplish the task, but to make it look easy. In this BIOME excels. In the words of a BIOME user, "I have been very impressed with the way in which you have made data accessible for retrieval. The query system is very user friendly and unbelievably easy to use."

8. References

1. Meyer, T., Suresh, R., Ilg, D., and Moxon, B., Mosaic, HDF and EOSDIS: Providing Access to Earth Sciences Data, Electronic Proceedings of the Second International WWW Conference '94: Mosaic and the Web, URL: http://www.ncsa.uiuc.edu/SDG/IT94/Proceedings/EarSci/meyer/ilg.html
2. Marshall Space Flight Center's HyDRO, http://wwwdaac.msfc.nasa.gov/ims/hydro.html
3. Lemay, Laura, Teach Yourself Web Publishing with HTML in a Week, Sam's Publishing, 1995.
4. Lemay, Laura, Teach Yourself More Web Publishing with HTML in a Week, Sam's Publishing, 1995.

9. Authors

Jon W. Grubb
Energy, Environment, and Resources Center
University of Tennessee
10521 Research Drive, Suite 100
Knoxville, TN 37996, USA
grubb@gandalf.rmt.utk.edu
Jon W. Grubb is a Research Associate at the University of Tennessee Energy, Environment, and Resources' Pellissippi Research Institute, and serves as the WWW Programming Specialist for the ORNL DAAC.

Sarah V. Jennings
Transportation Center
University of Tennessee
10521 Research Drive, Suite 200
Knoxville, TN 37996, USA
xqj@ornl.gov
Sarah V. Jennings is a Research Associate at the University of Tennessee Transportation Center's Pellissippi Research Institute and serves as WWW Curator and Documentation Specialist for the ORNL DAAC.

Teresa G. Yow, Ph.D.
Computational Physics and Engineering Division
Oak Ridge National Laboratory
P.O. Box 2008, M.S. 6407
Oak Ridge, TN 37831, USA
tgy@ornl.gov
Dr. Teresa Yow is a Systems Analyst in the Computational and Physics Engineering Division of ORNL. She is database designer and database administrator for the ORNL DAAC.

Patricia F. Daugherty
Environmental Sciences Division
Oak Ridge National Laboratory
P.O. Box 2008, M.S. 6407
Oak Ridge, TN 37831, USA
pvd@ornl.gov
Patricia F. Daugherty is a Systems Analyst in the Environmental Sciences Division of ORNL. She serves as the Systems Engineer for the ORNL DAAC.

* Research sponsored by NASA under Interagency Agreement DOE No. 2013-F044-A1 under Lockheed Martin Energy Research Corp., contract DE-AC05-96OR22464 with the U.S. Department of Energy.

Copyright Notice

Mail to :
WWW5 c/o INRIA
Direction du Developpement, Bat 25
Domaine de Voluceau, 78153 Le Chesnay Cedex.
France

Author's Permission

I, the undersigned, am the Author of the paper entitled:

BIOME: A Browser-Aware Search and Order System

("Paper") submitted to the conference organizers for the 5th International World Wide Web Conference ("Conference") to be held in May 6-11, 1996.

I, or my employer as appropriate, will retain copyright in the Paper subject to the conference organizers' right to do the following:

i) publish or arrange to publish the Paper as part of the Conference proceedings;

ii) copy and distribute the Paper in its entirety in print and electronic form, including placing the Paper on the World Wide Web, and grant others permission to do the same; and

iii) copy and distribute excerpts from the Paper,

provided that all copies of the Paper contain a proper copyright notice and/or attribution of authorship, as called for.

I and/or my employer represent and agree that:

i) the Paper has not previously been submitted for publication elsewhere.

I also understand and agree that I am not entitled to compensation in return for submitting the Paper for publication by the conference organizers.

Author	Employer (if the Copyright Holder)
Teresa G. Yow	Lockheed-Martin Energy Research Corp.
Name	Name
Teresa G. Yow 1-30-96	Donald Hamm 2/1/96
Signature Date	Authorized Signature Date

Copyright Notice

Mail to :
WWW5 c/o INRIA
Direction du Developpement, Bat 25
Domaine de Voluceau, 78153 Le Chesnay Cedex.
France

Author's Permission

I, the undersigned, am the Author of the paper entitled:

BIOME: A Browser-Aware Search and Order System

("Paper") submitted to the conference organizers for the 5th International World Wide Web Conference ("Conference") to be held in May 6-11, 1996.

I, or my employer as appropriate, will retain copyright in the Paper subject to the conference organizers' right to do the following:

i) publish or arrange to publish the Paper as part of the Conference proceedings;

ii) copy and distribute the Paper in its entirety in print and electronic form, including placing the Paper on the World Wide Web, and grant others permission to do the same; and

iii) copy and distribute excerpts from the Paper,

provided that all copies of the Paper contain a proper copyright notice and/or attribution of authorship, as called for.

I and/or my employer represent and agree that:

i) the Paper has not previously been submitted for publication elsewhere.

I also understand and agree that I am not entitled to compensation in return for submitting the Paper for publication by the conference organizers.

Author

Patricia F. Daugherty
Name

Patricia F. Daugherty 1/31/96
Signature Date

Employer (if the Copyright Holder)

Lockheed-Martin Energy Research Corp.
Name

David R Human 2/1/96
Authorized Signature Date

Copyright Notice

Mail to :
WWW5 c/o INRIA
Direction du Developpement, Bat 25
Domaine de Voluceau, 78153 Le Chesnay Cedex.
France

Author's Permission

I, the undersigned, am the Author of the paper entitled:

BIOME: A Browser-Aware Search and Order System

("Paper") submitted to the conference organizers for the 5th International World Wide Web Conference ("Conference") to be held in May 6-11, 1996.

I, or my employer as appropriate, will retain copyright in the Paper subject to the conference organizers' right to do the following:

i) publish or arrange to publish the Paper as part of the Conference proceedings;

ii) copy and distribute the Paper in its entirety in print and electronic form, including placing the Paper on the World Wide Web, and grant others permission to do the same; and

iii) copy and distribute excerpts from the Paper,

provided that all copies of the Paper contain a proper copyright notice and/or attribution of authorship, as called for.

I and/or my employer represent and agree that:

i) the Paper has not previously been submitted for publication elsewhere.

I also understand and agree that I am not entitled to compensation in return for submitting the Paper for publication by the conference organizers.

Author

Sarah V. Jennings
Name

Sarah V. Jennings 1-30-96
Signature Date

Employer (if the Copyright Holder)

Lockheed-Martin Energy Research Corp./
Name The University of Tennessee

David R Hamm 2/1/96
Authorized Signature Date

Copyright Notice

Mail to :
WWW5 c/o INRIA
Direction du Developpement, Bat 25
Domaine de Voluceau, 78153 Le Chesnay Cedex.
France

Author's Permission

I, the undersigned, am the Author of the paper entitled:

BIOME: A Browser-Aware Search and Order System

("Paper") submitted to the conference organizers for the 5th International World Wide Web Conference ("Conference") to be held in May 6-11, 1996.

I, or my employer as appropriate, will retain copyright in the Paper subject to the conference organizers' right to do the following:

i) publish or arrange to publish the Paper as part of the Conference proceedings;

ii) copy and distribute the Paper in its entirety in print and electronic form, including placing the Paper on the World Wide Web, and grant others permission to do the same; and

iii) copy and distribute excerpts from the Paper,

provided that all copies of the Paper contain a proper copyright notice and/or attribution of authorship, as called for.

I and/or my employer represent and agree that:

i) the Paper has not previously been submitted for publication elsewhere.

I also understand and agree that I am not entitled to compensation in return for submitting the Paper for publication by the conference organizers.

Author

Jon W. Grubb
Name

Jon W. Grubb 1/31/96
Signature Date

Employer (if the Copyright Holder)

Lockheed-Martin Energy Research Corp./
Name The University of Tennessee

David C Hamrin 2/1/96
Authorized Signature Date