



METROGIS

FIRST GENERATION GEOSPATIAL SERVICES BROKER

PROJECT REPORT

Prepared by the
Land Management Information Center
Minnesota Department of Administration
December 27, 2007

Executive Summary	v
Background	1
Project Purpose	1
Project Personnel	1
The Solution – <i>GeoService Finder</i>	2
General Description	2
Functions of the Catalog	3
The Catalog’s Hardware and Software Environment	4
Standard Used for the Catalog	5
Considerations for Listing Software within the Catalog.....	6
Functions of the Library.....	7
Library Distribution Hardware and Software Environment	7
Library Execution Hardware and Software Environment	8
Hosting Services and Software at LMIC	11
Conclusion	12
Definitions and References	15
Appendices	17
A: Crosswalk between Minnesota’s Geospatial Services Inventory Metadata and ISO Services Metadata	17
B: Catalog Example.....	19
C: Library Examples	21
Figures	
1. Catalogs in the Library World	2
2. The 20 catalog elements contained in the GeoSpatial Services Inventory	3
Table	
1. Configuration of each of LMIC’s current GIS servers	9

Executive Summary

The purpose of this project was to determine the feasibility of building and supporting a web-based application that could search for and access Geographic Information System (GIS) software and applications. Such a mechanism can be referred to as an early implementation of a *GIS Services Broker*, consisting of computer hardware and software along with human administrative functions that provide a means to list, query, search for, discover, store, acquire and/or execute GIS computer programs. A robust GIS services broker will ultimately enable organizations to reduce their efforts to develop, maintain, support and host GIS services as well as expand the number and variety of GIS tools available to meet business demands.

This project was undertaken by the Land Management Information Center (LMIC), Office of Geographic and Demographic Analysis, Minnesota Department of Administration, as a MetroGIS Regional GIS Project funded by the Metropolitan Council. All project development work was performed by LMIC staff with a Steering Committee comprised of individuals from MetroGIS member organizations providing direction, testing and input. The project team met several times to define and refine the broker concept, project approach and deliverables. Project deliverables include a working services catalog, library functionality, and this report of project activities and findings. Project funds were only used for staff time, not for any hardware or software.

The *Catalog* is a Web based service that provides for the listing, searching and discovering of GIS software and/or services. The project incorporated a portion of the pending North American Profile of the international ISO19115 Geographic Information Metadata standard into the catalog design. Based on direction provided by the project's Steering Committee, the catalog contains only the minimum necessary fields to identify, describe and locate potential software and services and does not provide a repository for full services metadata. A significant portion of project time was spent defining the characteristics, content and functionality of the Catalog. LMIC will host this Catalog on an ongoing basis at <http://www.lmic.state.mn.us/GeoServiceFinder/>.

Library functionality is provided through the Internet and includes the storing and distribution of software in addition to the capacity for execution of some services. LMIC resources were used to build the project's Library. LMIC has stored several software routines within the library, including GeoMoose, and has several services available for execution, such as WMS Imagery. LMIC's Library functionality will continue to be available to MetroGIS through calendar year 2008 so that further exploration of GIS brokering capabilities can be examined. LMIC's interactive services will be made available on an ongoing basis and can be utilized and incorporated into MetroGIS's GIS business solutions.

LMIC has found that catalog administration and software storage within the library do not require significant staff resources. However, providing Library execution services can consume significant and diverse resources.

It may be necessary for a site providing services to MetroGIS members to support multiple operating systems (e.g., Windows and Linux); multiple data bases (e.g., MySQL, MS SQL and ORACLE); as well as multiple development environments in order to be compatible with the varied technical environments of MetroGIS members. If the concept of a services broker is more fully implemented, additional hardware, software and staff resources would likely be required. Standardization of the technology employed by organizations could improve compatibility.

LMIC believes that over time a robust GIS services broker environment should be more fully defined and implemented. Just as MetroGIS has successfully cultivated a culture of data sharing, LMIC believes that with similar attention, MetroGIS can establish a reliable shared services environment. Achieving such a goal will require the identification and coordination of service providers and broad use of compatibility standards. Toward that goal, some cultural changes will need to be introduced that will optimize the investments of all the organizations involved. These should include the need for service providers to maintain highly available and responsive services that ultimately earn the trust of users who come to rely on them and thus refrain from implementing redundant functionality.

Background

Project Purpose

The Metropolitan Council, on behalf of MetroGIS, contracted with the Land Management Information Center (LMIC), Minnesota Department of Administration in late December 2006 to prepare a first-generation mechanism to aid the MetroGIS community to identify and share geospatial software and services. Central to this mechanism was the investigation of a geospatial software and services “broker” to be used to provide information about software components, applications and *services*¹ created and made accessible by the GIS user community in Minnesota. The project Catalog is a more robust extension of the Minnesota Geospatial Services Inventory², a shared services survey tool and catalog developed by the Governor’s Council on Geographic Information (GCGI) in 2006. Deliverables provided as part of this project satisfy a number of the functions proposed for the MetroGIS ApplicationFinder in 2004. This report has been prepared to partially satisfy the terms of the Metropolitan Council/LMIC contract. LMIC is grateful to MetroGIS and the Metropolitan Council for allowing us to collaborate on this project.

Project Personnel

The project team consisted of: the LMIC Development Group (Christopher Cialek, Jim Dickerson, Andrew Koebrick, Fred Logman (project manager), Brent Lund, Pete Olson and Nancy Rader) and a Steering Committee composed of GIS specialists from several MetroGIS member organizations.

The Development Group created a project plan that included active participation by the Steering Committee in most project phases. The Steering Committee provided input and guidance for the project. All significant design and functionality decisions were made based on direction from the Steering Committee. Members of the Steering Committee included:

- Bob Basques City of St. Paul
- David Bitner Metropolitan Airports Commission
- Joella Givens MN Department of Transportation
- Josh Gumm Scott County
- Randall Johnson MetroGIS
- Randy Knippel Dakota County
- Alison Slaats Metropolitan Council

The Solution – *GeoService Finder*

General Description

The project is delivering an application with the working title: *GeoService Finder* (<http://www.lmic.state.mn.us/GeoServiceFinder/>) that provides three components: 1) a public CATALOG that provides structured descriptions of services that developers are making broadly available, 2) a software repository LIBRARY that provides capacity to centrally store some of the components described in the catalog, and 3) a web-based HOSTING ENVIRONMENT that provides search, registration, authoring, editing, publishing, and administrative functionality to the catalog and library. These three components, together with the administrative services required to run, update and maintain a comprehensive system, constitute a rudimentary *brokering* capability.

This solution seeks to implement a modest functioning general purpose *Enterprise Broker* as conceived in the 2005 white paper, *Minnesota State GIS Enterprise Conceptual Architecture Design*³.

The model implemented for this project is also similar to that promoted in the Open Geospatial Consortium (OGC) concept of a *Catalog Service*⁴ [Figure 1]. In that model, a *catalog entry*⁵ summarizes the content of a geospatial service. An organized collection of catalog entries forms a *catalog*⁶, used to assist in the discovery and retrieval of those services.

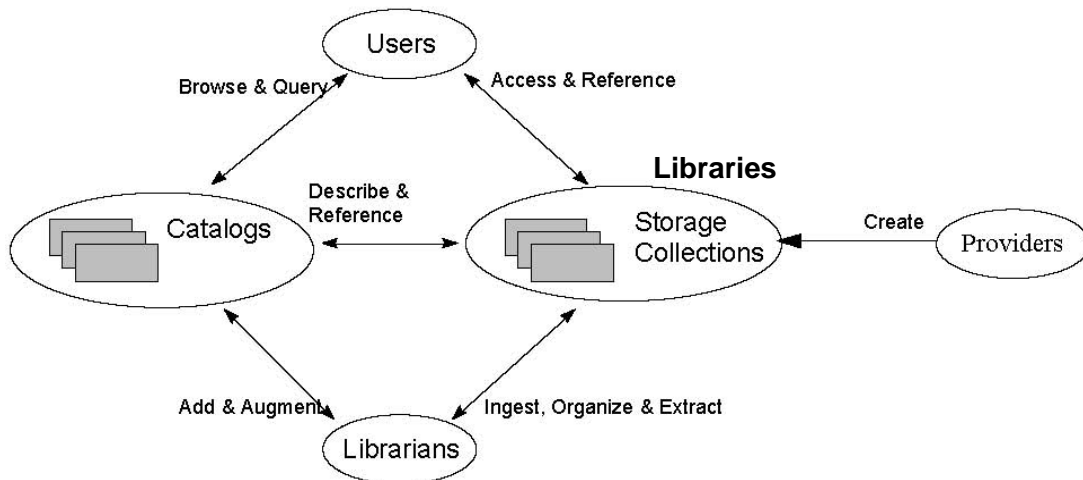


Figure 1. Catalogs in the Library World; from OGC Abstract Specifications Topic 13: Catalog Services.

Catalog entries can reference a location at which a service may be further described, launched, or accessed. When services are collected in a single location for the purpose of providing efficient access, the model refers to that entity as a *Storage Collection*. For our purposes we use the term *Library*.

Functions of the Catalog

This project's first deliverable is a software catalog based on the Minnesota Geospatial Services Inventory, but rewritten to better meet the needs of MetroGIS. The first project activity involved an in-depth review of the Geospatial Services Inventory to establish a minimum necessary set of fields that would make up the MetroGIS shared software Catalog. In one early meeting, records were populated in the Geospatial Services Inventory and the value of each entry field was scrutinized by Steering Committee members. Discussions included the purpose/need, definition/description, ease of entry and understanding of what was being requested for each field. As part of the discussion, the Steering Committee determined that this was not to be a services metadata repository but a much simpler services catalog. Further, full services metadata should be generated by the developer for shared software; the Catalog should link to the full metadata, not store it.

During this review, several fields were identified as not being necessary, other fields were modified to better meet the needs of the MetroGIS user community, and a few fields were combined.

As part of the discussion it was determined that Resource Type (element #5) should be expanded from three to four options:

- *Remote application*: an interactive application run on a remote server that a client accesses through an internet browser. The client is not required to run any additional software.
- *Standalone application*: software and data that can be downloaded and run locally.
- *Component*: code that can be downloaded and then integrated into routines and executed locally.

Figure 2. The 20 catalog elements contained in the Governor's Council Geospatial Services Inventory

1	Resource name
2	Description
3	Availability
4	Audience
5	Resource Type
6	Conditions of use
7	Features
8	Geographic coverage
9	Data used
10	Coordinate system and datum used for data
11	Requirements for use
12	Requirements for deployment
13	Standards used
14	Service dependencies of application
15	Developer organization
16	Source organization
17	Link to resource
18	Notes
19	Contact information for resource
20	Contact information for survey follow up

Items in grey are those that were eliminated from the full set of elements in the Minnesota Geospatial Services Inventory to produce the catalog element set (black) for the MetroGIS shared services Catalog.

- *Service*: an application run at a remote site that a client accesses through the internet; the client needs to run additional software (e.g., using ArcGIS to access photography via a WMS image server, DataFinder Café).

The Steering Committee also requested on-line definitions (i.e., help) be included for each Catalog field. Additional modifications, including changing dropdown list configurations, were requested. The Steering Committee also desired to have the look and feel of the site upgraded to make it more user-friendly.

In reviewing all of the requested changes, LMIC's web developer determined that it would be cleaner to rewrite the application than to attempt to modify it. The rewrite also provided an opportunity to reduce hard-coded portions of the application and replace them with more content in a database structure. This will make the application easier to maintain.

The Catalog's Hardware and Software Environment

Existing LMIC environment: *GeoService Finder* is a web application which runs on the LMIC server named WEB. WEB runs Apache web server under Linux, which is the primary web server used by the Office of Geographic and Demographic Analysis (GDA). The application provides a web interface, which allows the user to find geographic services and applications once they have been cataloged. It also allows services and applications to be described and added to the list of services.

As the application is just a small part of the website, its administration, backup and support are all handled as part of the normal maintenance and support of the web server. *GeoService Finder* adds only a trivial amount to the load and the storage requirements of the server. The application is written in Mod_perl using the Perl Apache-ASP module to create the page on the server. It also uses a set of function libraries written at LMIC to simplify page generation and user authentication. On the client side, the Catalog application uses the jQuery JavaScript libraries to simplify AJAX calls which allow the page to change dynamically with the user's input. Data is stored in a back-end MySQL database.

While systems maintenance for the application is handled as part of routine web site administration, there is some minimal application-specific administration required. When new catalog entries describing services or software are added by developers, the catalog entries are only accepted conditionally, and will not appear to everyone on the site until they have been approved (published) by an administrator, verifying the submission before marking it as accepted. Though this process has not been finalized, it would probably entail at least verifying that the service exists, that it works and possibly verifying the credentials of the submitter. The time commitment to perform these verification functions is estimated to require 15 to 25 minutes per service entry.

Recommended MetroGIS environment: This application was designed and constructed to run in a Linux environment. The Catalog service requires some components which exist only on a Linux server. The most recent Linux distributions have all the necessary tools to set up the application. Standard Linux software will include MySQL for the

database, Apache for the web server and Mod_perl for server side programming. The scripting language, Apache-ASP, can be installed from the CPAN Perl repository. On the client side, the jQuery JavaScript library can be downloaded from the *jquery.com* site. The rest of the Catalog code includes Perl libraries and the *GeoService Finder*. A reasonably skilled Linux administrator should have no difficulty supporting this application.

Running the application under Windows, however, would present challenges, although it would not be impossible. There are two possible paths. The first is to attempt to use Linux tools on Windows to minimize rewriting of code. In this case, one would install Apache, MySQL and Mod_perl on Windows. This has not been tested by LMIC. Another alternative, which would fit existing servers better, would be to use IIS and whatever database was available on the server. Since Apache-ASP claims to be a close clone of Microsoft's ASP for IIS, the ASP portion of the code should be easy to port. Further, the differences in SQL and MySQL are fairly small, at least for what this application uses. A considerable amount of Perl code would need to be translated to a Microsoft server-side language. This is likely to constitute the largest effort necessary in migrating the application to a Windows environment.

Recommendation: Continue running the catalog service under Linux. It is recommended to run the application at LMIC, which is willing to provide hosting services to MetroGIS.

Standard Used for the Catalog

International metadata standards have been developed for data and for services, and models are currently being developed to define how catalogs of data and/or services could work. The primary international standards body working on geographic metadata issues is ISO⁷; other national standards groups coordinate with ISO's metadata efforts, including the Open Geospatial Consortium (OGC), the Federal Geographic Data Committee (FGDC) and the American National Standards Institute (ANSI).

In 2003, ISO published an international standard that provides a common framework for describing geospatial data and services: **ISO19115 Geographic information – Metadata**⁸. The United States and Canada are currently working in a joint effort to develop a specific implementation of ISO19115 to identify geospatial metadata that are needed for North American organizations to describe their geospatial data and related Web services. That new standard is called the *North American Profile of ISO 19115* and is currently in draft form⁹. *NAP Metadata* provides a detailed structure to describe both data and services.

LMIC staff is participating in the review of the proposed *NAP Metadata* standard. The Steering Committee determined that the *GeoService Finder* project should follow and use that emerging standard wherever possible. Delays in completion of this project were directly related to the desire by both the LMIC project team and Steering Committee to apply the standard.

Note: The *NAP Metadata* standard is currently in the latter stages of development, but is thought to be close enough to completion to be used as a framework for the Catalog. A

cross reference between the Catalog fields used in *GeoService Finder* and the *NAP Metadata* standard is included in Appendix A to this report.

Considerations for Listing Software within the Catalog

The following are not hard-and-fast rules but more in the form of best practice suggestions to assist those who are considering sharing software or services they developed to determine if it is appropriate to do so. They are for the most part in the form of questions and are not in any specific order or priority.

1. Does the software work? Has the software or service been fully tested so that it is largely “bug” free?
2. Is this a test or development version? We are interested only in “production” versions. Software and services can have multiple releases with updated and added features.
3. Is the software something that others would want and can use? Does it have applicability beyond a single organization?
4. Has the software already been entered into the Catalog? We do not want redundant entries.
5. Is this just advertising or promotion of a product, service or entity? However, note that software and services can be listed for which there is a license or use fee.
6. Is there documentation that accurately describes the software or service? We suggest that there be full documentation with an abstract that is accessible through a link from this Catalog.
7. If this is a data distribution service that is being considered, is it original data? We are hopeful that there will be single sources for any specific data set.
8. Can the entries that need to be made in the Catalog be made accurately?
9. If there are multiple components necessary to run the software, are they all being made available and/or listed so that they can be acquired? Is the code self-contained?
10. For software, is there adequate internal documentation within the code so that a relatively average programmer could understand the logic and flow?
11. Are the persons to be named in the Catalog as contacts ready, able and willing to receive and address queries about the software or service?
12. Do you have the right to list and distribute the software or service?

Functions of the Library

The project's second deliverable is the demonstration of a prototype software Library. For this project "Library" included two distinct components.

- A repository for software code and documentation be it a remote application, standalone application, component or service.
- The computer hardware and software telecommunication resources necessary to host services.

Over the past couple of years, LMIC had developed a library for its internal use and also designed and implemented several on-line services available to the public. This capability has been extended to this project. In reviewing the LMIC Library function and services execution environment, it was determined that LMIC has the capacity to make these available to MetroGIS as part of this project if they individually or collectively chose to utilize them.

Library Distribution Hardware and Software Environment

Existing LMIC Library Environment: LMIC currently distributes a limited amount of software via an anonymous FTP site at <ftp://ftp.lmic.state.mn.us/pub/software>. Several packages are stored in directories at this site. The directories typically contain an archive file (e.g., .zip or .tgz) of files necessary to install and/or run the program as well as a README file with instructions to download and install. Also there usually are web pages describing the software and pointing to the ftp location.

LMIC's ftp distribution site runs under Linux using VSFTP (Very Secure FTP server) on a dual processor Xeon server. The software directory currently consumes about 27 MB of disk space. There are usually fewer than 20 software downloads per day. Even with much higher utilization, no serious load on the server would be anticipated.

At this time, a vast majority of the software distributed by LMIC originated at LMIC and a single staff member is responsible for updating version changes. MetroGIS as part of this project and for a few additional months can, if desired, make use of LMIC's site by sending programs and documentation to LMIC (pete.olson@state.mn.us) who will move them into the proper directories. Should there be a large number of requests, LMIC may consider creating an account to allow MetroGIS to maintain their own software via FTP and thus reduce LMIC's administrative commitments and potentially provide quicker turn-around.

Security for LMIC's software library follows industry best practices techniques, such as: limiting services on the machine, protecting necessary internal services with a firewall, and running the FTP service as a restricted user. Server updates are performed regularly.

Backups of LMIC's library are performed as part of the office's routine server backup schedule. Live backup is done nightly to two backup servers, one of which is off-site to provide for continuity of services in an emergency. Data stored within the software library may also be available from its source.

Human resources to run the LMIC software library have been kept to a minimum. Administrative tasks, such as backup and patching, require no additional IT resources since they are already being done for the other services each device provides. In the past, upkeep of the software library has been minimal. A more active library would require more upkeep time, but should not significantly impact system administrative tasks or time requirements.

Recommended MetroGIS environment: A software library such as the one at LMIC requires very little capacity and could be set up on a pre-existing server; either an FTP or a Web (http) server could be used. Such servers run either Linux or Windows; the choice of OS largely depends on existing servers and the technical expertise of the support staff. FTP servers traditionally have been used for software distribution, largely based on maintenance, robustness and security considerations. However, Web servers also work well and are often easier for some end users to access. The choice may depend on what servers presently exist with the needed capacity.

Library Execution Hardware and Software Environment

Existing LMIC environment: GDA/LMIC uses four servers to run several GIS applications. All four servers run the Apache Web Server under Linux. Although LMIC is not currently running any GIS applications in a Windows server environment, there is a Windows 2003 server, running Microsoft IIS, available.

Table 1 (below) describes LMIC's GIS servers. All have excess capacity with none averaging over 1% utilization and with maximum utilization during peak loads generally around 5 to 10%.

LMIC's primary platform is Linux for a number of reasons. Most of LMIC's technical expertise is in Linux and a wide variety of free and open source software allows the building of custom applications easily and cheaply in that environment. Linux has generally been more secure than Windows (although recent versions of Windows server – as opposed to desktop – have improved considerably over previous releases). Additionally, applications running under Linux have not had as many security problems, and the Linux architecture is more likely to prevent security bugs from allowing the complete compromise of a server. Linux has also proven easier to keep patched, as reboots are practically never required during patch installation, thus allowing maximal uptime.

Server	OS	Processor(s)	Vintage	GIS Apps
<i>geoint</i>	Gentoo Linux	2 x 2.6 Ghz	2004	Mapserver, WMS images
<i>mapserver</i>	Fedora 7 Linux	2.4 Ghz	2004	Mapserver, GeoGateway
<i>geoserver</i>	Red Hat 4 Linux	4 x 2.8 Ghz	2006	ArcIMS
<i>web</i>	Fedora 7 Linux	4 x 2.8 Ghz	2007	Mapserver, services catalog
<i>survey</i>	Windows 2003	2.8 Ghz	2007	None

Table 1. Configuration of each of LMIC's current GIS servers.

LMIC tries to keep its sites and applications as secure as possible. Firewalls allow only the services (e.g., HTTP and FTP) we are providing to be seen by the Internet. These services are run under restrictive user accounts that prevent a service security hole from compromising the whole system. Patches and updates are applied on a weekly basis. Logs are checked daily for unusual events. Industry newsletters are checked for bulletins pertaining to any of our installed software.

The data on all LMIC servers is backed up to drives on two backup servers, one of which is located offsite for continuity of operations in an emergency. Archival copies of the data also exist on tape and portable hard drives.

Approximately 0.5 FTE is dedicated to the administration and upkeep of all LMIC servers. This includes both GIS services and GDA's more general web services as there is considerable overlap in the tasks for keeping these systems running and secure. If each environment was run separately, it would probably require roughly 0.4 FTE each.

Applications currently running at LMIC:

- WMS from the WMS Image Server:** The Open Geospatial Consortium (OGC) defines several kinds of GIS services which may be provided in a WMS environment. These include Web Mapping Service (WMS), Web Feature Service (WFS) and Web Coverage Service (WCS), which return geospatial data in various forms. There is also a Catalog Service which returns information on servers providing the services listed above. A WMS service returns maps formatted as images based on a service request.

LMIC's WMS Image Server provides statewide and metro area imagery from several different dates ranging from 1991 to 2006 at several different resolutions. It also serves scanned images of the 1:24,000, 1:100,000 and 1:250,000-scale USGS quad sheets (Digital Raster Graphics – DRG), current as of 1996 with a few updates since. The application was written at LMIC and uses MySQL as its RDBMS. This service currently satisfies about 10,000 image requests per day.

- **WMS, WFS and other maps from Mapserver:** Mapserver is an open source mapping application developed at the University of Minnesota. It can provide GIS data using WMS, WFS or its own protocols. WFS provides actual geographic data formatted as XML rather than maps derived from the data. Data provided through WFS can be used by GIS applications for analysis and mapping. The National Map project uses data from WMS services, and there is an experimental project serving WFS data for use in municipal boundary adjustments. The data used by these services is file-based at present, but in the future an Oracle database may be utilized.
- **WMS and other maps from ArcIMS:** ArcIMS is a proprietary mapping package licensed through ESRI. It can generate maps from either WMS or its own AXL formatted requests. LMIC runs multiple instances of ArcIMS. The National Map project accesses maps from an ArcIMS service. The data used in the services is file-based, though other applications on the same server make use of data from Oracle databases.

Recommended MetroGIS environment: Hardware requirements depend heavily on the complexity of the services being hosted and the number of anticipated users. Existing servers with unused capacity might provide an option. Alternatively, commodity four- and eight-processor servers (with two dual- or quad-cores) are readily available for under \$10,000. This class of servers should be more than sufficient for all but the largest computing loads.

The choice of operating system depends on the services supported, along with the experience of assigned technical staff. Note: some applications may require that a specific OS be run. If technical staff can support the environment, running both Linux and Windows on the same server is feasible utilizing a virtual manager such as Vmware or Xen.

Here are some OS considerations, using as examples the three service applications run at LMIC:

- **WMS Image Server:** This service runs only on Linux. Though the necessary external components (mysql, jpeg and png libraries) are available on Windows, porting the code to the Windows environment would be difficult enough as to probably not be worth doing. An advantage of this kind of service is that it uses only cost-free components. The software will be free, regardless of how many servers might be required to satisfy customer requirements.
- **Mapserver:** There are installable Mapserver packages built for Windows. It would probably be easier for non-Linux shops to set up Mapserver on Windows than Linux. Linux requires the typical configure/make/install cycle which would be familiar to

Linux/UNIX administrators. Porting the rest of the applications should be as easy as moving mapfiles and html pages.

- **ArcIMS:** ArcIMS can be installed on either Linux or Windows and moving applications from Linux to Windows would again be relatively easy. Note that the reverse is not true; some ArcIMS Windows applications make use of facilities such as .NET or ASP for which equivalents are not readily available in Linux. Also, many ArcIMS extensions only include Windows versions of the software.

Recommendation: it would be ideal for MetroGIS to offer both Linux and Windows services environments.

Hosting Services and Software at LMIC

Public organizations, like MetroGIS, are invited to use LMIC's library environment to make software available to others, if they do not have the capacity to do so themselves for this project and on a limited basis. Submissions can be made as an e-mail attachment, via FTP to our FTP server, or on physical media such as a DVD or USB drive depending on the content and size of the submission. Any service or software submitted must be entered into the *GeoService Finder* Catalog. The name of the Catalog entry must be provided so that it can be cross-referenced with the software/service being provided. The Catalog entry must be in "request publication" status.

Software submissions for hosting on the LMIC library must include an archive file (zip or tgz) containing the software and a file named README.TXT. The README file must describe the software, including instructions for building and running, so that a potential user could tell whether it was worthwhile for them to download the archive. It should also include information on how and where to unpack the archive once it is downloaded.

The archive file must contain the software, which may consist of executable code, source code or both. It should also contain any necessary information on compiling or installing the program. There must be sufficient user-level documentation such that ordinary semi-technical GIS users can figure out how to make it work.

Upon receipt, LMIC staff will check the usability, completeness, and documentation of the software and add it to the library. As part of our normal logging, we will keep track of all downloads of the software package.

Software to be run as a service at LMIC must also consist of an archive file of the software and a README. Additionally, one or more data files or archives must be included to supply any data the service requires. The archive and README files must contain the same information as for the software library, with enough detail so that LMIC staff can build and run the service. If help is required from the software contributor to get the service running, documentation should be updated to avoid whatever problems were encountered by the LMIC staff.

LMIC will add software packages to its software libraries, to the extent staff time is available. Further, the ability to run services may depend on available hardware and software. LMIC should be able to run most Linux/UNIX services, and many Windows

services. LMIC will track the usage of the service and provide summary information to the contributor upon request.

The contact at LMIC for submitting software and services is: Pete.Olson@state.mn.us
Please make all requests through this contact by email.

Conclusion

Based on the experiences of this project, LMIC believes that a shared GIS software environment can be implemented and sustained and that software and services developed by one organization can provide benefits to others. In order for a shared services environment to be successful, an organization will have to commit on an ongoing basis to providing “broker” services consisting of hardware, software and staff resources to provide software and services to other organizations. In order to acquire maximum benefit of shared services to the community of users, organizations will need to trust and depend on other entities to provide some of their software and services to meet their business needs.

Next Steps

Promotion. MetroGIS will need to actively promote the use of the Catalog and Library among its members. One way to encourage use would be for MetroGIS to enter basic information into the Catalog for a number of software/services with the expectation that the developer entity will complete the Catalog information and make the software/service available. MetroGIS could also contact community members and request listing of specific software/services of which they are aware. To assist, LMIC is willing to: 1) provide one or two demonstration workshops, 2) promote and advertise the Catalog through the GIS/LIS Consortium Newsletter, and 3) list some of its software/services in the Catalog and make them available through the Library.

Shared Commitment. Use of shared services by the MetroGIS community will require organizations being willing to provide some level of assistance and support to others. It will also require the mind shift that not all software/services need to be developed or run by each individual entity. It will take time for people to make the transition from being self-sufficient to trusting and being dependent on others.

Experienced-Based Evaluation. After some period of active use (e.g., 6 to 12 months), a formal evaluation of the benefits and issues associated with using and supporting the Catalog and Library should be made. The evaluation should provide the business case for subsequent MetroGIS shared software/services activities.

Standards. In conjunction with the Governor’s Council on Geographic Information, LMIC will review and evaluate geospatial software/services metadata standards that are published. LMIC will also promote the adoption and use of geospatial software/services metadata standards among State agencies.

Potential Follow-on Activities

MetroGIS has expressed the desire for the ability to search for and acquire both geospatial data and software through a single web-based process. This concept was discussed at a Steering Committee meeting. The discussion included several possible approaches, but did not identify any recommended solution. Conceptually, this is a combination of the *DataFinder* functionality coupled with a software/services broker function. Evaluating this possibility was not part of this project and LMIC does not have a specific recommendation for MetroGIS at this time. What this functionality would look like, how it would perform and what tools should be used to build it are not known at this time. LMIC believes that development of this type of functionality should be based on the organizations' business drivers. In order for it to be successful, it will require that software/services metadata standards have been adopted and followed.

Tools like the Z39.50 search protocol, a Google type search or Wiki may provide the means to explore multiple catalogs hosted at different sites for desired software/services and/or data. The Z39.50 search protocol is now being successfully used within *DataFinder* and the *GeoGateway* to locate data at a number of sites.

LMIC is interested in partnering with MetroGIS and other entities to continue to explore, test and utilize the GIS software/service broker concept.

Definitions and References

¹ **Services:** Definition – reusable, self-contained collections of executable software components. They may be pieces of software adaptable in different operating systems, networks and application frameworks. A service is not bound to a particular program, computer language or implementation. They are the building blocks for creating highly integrated and distributed application systems.

² **Minnesota Geospatial Services Inventory** A web-based inventory developed by the Minnesota Governor’s Council on Geographic Information to gather information about geospatial applications resources to identify collaboration opportunities among public and private organizations (see: www.lmic.state.mn.us/GeoSpatialServices/)

³ **Minnesota State GIS Enterprise Conceptual Architecture Design;** 2005; MN Governor’s Council on Geographic Information. Defines a high-level architecture for information technology and web-mapping interoperability in support of the goals outlined in the state’s strategic plan for GIS; 22p, 178 Kb PDF, <http://server.admin.state.mn.us/resource.html?Id=17091>

⁴ **The OpenGIS™ Abstract Specification Topic 13: Catalog Services; Version 4;** 1999; OpenGIS™ Project Document Number 99-113.doc. The term “Catalog” describes the set of service interfaces which support organization, discovery, and access of geospatial information. Catalog services help users or application software to find information that exists anywhere in a distributed computing environment. The purpose of this Abstract Specification is to create and document a conceptual model sufficient enough to allow for the creation of implementation specifications, www.opengeospatial.org/standards/as

⁵ **Catalog Entry:** Definition – a Catalog Entry describes or summarizes the contents of a set of geospatial data, and is designed to be queried. A Catalog Entry is usually a subset of the complete metadata for the described geospatial dataset [or service]. However, a Catalog Entry can be the complete set or a superset of the corresponding metadata. To avoid confusion with general metadata, we abstract the metadata needed for data discovery into an object type and call it a Catalog Entry. A Catalog Entry object allows its content and structure to be queried, identified, described, and retrieved. [OGC Topic 13, p. 8]

⁶ **Catalog:** Definition – a Catalog is a collection of Catalog Entries that is organized to assist in the discovery and retrieval of services which are of interest to the user. [OGC Topic 13, p. 8]

⁷ **International Organization for Standardization.** Note that ISO is not an acronym; instead, the name derives from the Greek word *iso*, which means equal. Founded in 1946, ISO is an international organization composed of national standards bodies from over 75 countries. For example, ANSI (American National Standards Institute) is a member of ISO. ISO has defined a number of important computer standards, the most significant of which is perhaps OSI (Open Systems Interconnection), a standardized architecture for designing networks. (source: www.webopedia.com/TERM/I/ISO.html)

⁸ **ISO 19115:2003 Geographic information – Metadata** standard defines the schema required for describing geographic information and services. It provides information about the identification, the extent, the quality, the spatial and temporal schema, spatial reference, and distribution of digital geographic data and is applicable to: 1) the cataloguing of datasets, clearinghouse activities, and the full description of datasets, and 2) geographic datasets, dataset series, and individual geographic features and feature properties. The standard defines mandatory and conditional metadata sections, metadata entities, and metadata elements; the minimum set of metadata required to serve the full range of metadata applications (data discovery, determining data fitness for use, data access, data transfer, and use of digital data); optional metadata elements - to allow for a more extensive standard description of geographic data, if required; a method for extending metadata to fit specialized needs.

Though ISO 19115:2003 is applicable to digital data, its principles can be extended to many other forms of geographic data such as maps, charts, and textual documents as well as non-geographic data. For more information see:

http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=26020

⁹ **North American Profile of ISO19115:2003 – Geographic information – Metadata.** More information at <http://www.fgdc.gov/standards/projects/incits-11-standards-projects/NAP-Metadata>

CROSSWALK BETWEEN MINNESOTA'S GEOSPATIAL SERVICES INVENTORY METADATA AND ISO SERVICES METADATA

Prepared by LMIC for the MetroGIS Service Broker Project Steering Committee

MN # / NAP #	FIELD NAME	FIELD TYPE	FIELD DESCRIPTION	REQUIRED ?
1	Resource name		Name by which the cited resource is known	
5.14.1	<i>title</i>	<i>free text</i>	<i>Name by which the cited resource is known</i>	<i>Mandatory</i>
5.14.4	<i>edition</i>	<i>free text</i>	<i>Version of the cited resource</i>	<i>Optional</i>
2	Description		Briefly describe what this service or application does.	
5.3.2.2	<i>abstract</i>	<i>free text</i>	<i>Brief narrative summary of service contents</i>	<i>Mandatory</i>
3	Availability		When will this resource be available for use?	
5.3.2.5	<i>status</i>	<i>code list</i>	<i>The development phase of the service.</i>	<i>Mandatory</i>
4	Audience		For what type of users was this application or service designed?	
5.3.2.3	<i>purpose</i>	<i>free text</i>	<i>Summary of the intentions for which the service was developed.</i>	<i>Optional</i>
5	Resource Type	checklist (closed)	What type of resource is this?	Mandatory
N/A			<i>(No NAP–Metadata counterpart)</i>	
6	Conditions of use		Are there any restrictions or conditions of use placed on this resource?	
5.4.2.3	<i>use Constraints</i>	<i>Code list</i>	<i>Restrictions or limitations or warnings to protect privacy, intellectual property or other special restrictions on the resource or the metadata</i>	<i>Optional</i>
8	Geographic coverage		What geographic area is this resource designed to serve?	
5.13.1	<i>description</i>	<i>free text (compiled from closed check lists)</i>	<i>Text which describes the spatial and temporal extent of the dataset.</i>	<i>Optional</i>

MN # / NAP #	FIELD NAME	FIELD TYPE	FIELD DESCRIPTION	REQUIRED ?
15	Developer		Contact information for a representative from the organization that developed the resource	
5.16.4	<i>contactInfo</i>	<i>CI_Contact</i>	<i>Information required enabling contact with the responsible person and/or organization</i>	<i>Mandatory</i>
16	Distributor		Contact information for a representative from the organization that provides access to the resource	
5.16.4	<i>contactInfo</i>	<i>CI_Contact</i>	<i>Information required enabling contact with the responsible person and/or organization</i>	<i>Mandatory</i>
17	Link to resource		Identify the resource Web link	
6.20.2	<i>protocol</i>	<i>Free text</i>	<i>The connection protocol to be used such as http, ftp, etc.</i>	<i>Mandatory</i>
6.19.2	<i>linkage</i>	<i>url</i>	<i>URL for additional metadata or other use information</i>	<i>Mandatory</i>
20	Catalog Entry Author		Contact information for the author of this catalog entry	
5.16.4	<i>contactInfo</i>	<i>CI_Contact</i>	<i>Information required enabling contact with the responsible person and/or organization</i>	<i>Mandatory</i>

The *GeoService Finder* home page.

Home | Northstar | Governor | Intranet
Monday January 07, 2008 01:26:06 PM CST

Dept. of Administration / Office of Geographic and Demographic Analysis / Land Management Information Center

Advanced Search

GeoServiceFinder

Links

- Home
- Browse
- Search
- Log in

Options

- Print Friendly
- Preferences
- Help

Intranet Options

- SQL: Show | Hide
- Menus: Show | Hide

Dept. of Administration:

▼ Divisions

GEOSERVICEFINDER

Share your Geospatial services with other developers and data users!

1. Internet applications with mapping elements,
2. On-line Internet-based "services" that developers can make use of when creating new applications (e.g. a geocoding engine or an image serving source), and
3. any software components that you have developed and are willing to share with others (e.g. a development template for Minnesota MapServer).

If you are responsible for developing or supporting technical capabilities such as these, please take the time to tell us about it by filling out a brief questionnaire. For your convenience, please consult the following table for examples of the types of resources we are hoping to identify:

- [Browse](#): Currently documented services in catalog.
- [Search](#): Catalog of services.

You will need to create an account and log in to access the questionnaire. It is designed to identify and document each service or application as a metadata record. It should take you no more than 10 minutes per application or service to complete the survey.

PARTICIPATE

- [Register](#): Create your own user account in an easy three-step process.
- [Login](#): Already have an account? Sign in to GeoSpatialFinder

Technical problems? Contact: admin.webmaster@state.mn.us About this site

Example of *GeoService Finder* browse results

Dept. of Administration / Office of Geographic and Demographic Analysis / Land Management Information Center

Advanced Search

GEOSERVICEFINDER INVENTORY

DISCLAIMER

Metro GIS and the Minnesota Office of Geographic and Demographic Analysis and the individuals and organizations that provided these data make no representations or warranties, express or implied, with respect to these data. There is no guarantee or representation to the user as to the accuracy, currency, suitability, completeness, or reliability of these data for any purpose whatsoever. These data may be subject to periodic change without prior notification. The user accepts these data 'as is', and assumes all risks associated with its use. The user agrees not to transmit these data or a copy in any form or provide access to it or any part thereof, to another party unless the user shall include with these data a copy of this disclaimer.

Metro GIS the Office of Geographic and Demographic Analysis and the individuals and organizations that provided these data assume no responsibility nor are they individually or collectively liable for any direct, indirect, special, incidental, actual, compensatory, consequential or any other damages or costs incurred as a result of any user's use or understanding of, or reliance on these data.

By clicking on or viewing any of the following data records, I acknowledge and agree to the terms of this disclaimer.

Add your own services to this list! To contribute, you will need to create an account and fill out a brief form.

- [Interactive Map on Local Ordinances Regulating Livestock](#): This interactive map provides information on local ordinances regulating animal agriculture in Minnesota's counties. The information includes the most common areas of regulation such as setbacks and separation distances, conditional use permits, feedlot size limitations, and minimum acreage requirements. It also provides local contact information and links to local ordinances when available. The map provides a representation of county regulations as they exist in Spring 2006. It does not summarize the regulations or provide an assessment as to the effectiveness or appropriateness of the provisions within ordinances nor does it assert that the most commonly occurring provisions are better than others. Only county regulations are available at this time; township regulations will be added in the near future. The Livestock-Related Ordinances Interactive Map allows you to: Select and zoom to specific counties Retrieve livestock-related ordinances Access county websites Access 2003-2004 aerial photographs provided by USDA Farm Service Agency.
- [AirPhotos Online](#): APO does two things: 1) it allows the public to browse low resolution versions of aerial photography collected by the DNR Resource Assessment group and 2) users can purchase access to high resolution versions.
- [AniMap](#): Displays occurrence information for common animal species found in Minnesota.
- [Business Recruitment and Site Location](#): Web application that identifies available sites for businesses seeking options for location. Service shows site location and provides tools to identify available labor force within commuting distance.
- [cadastral layer](#): partially completed cadastral layer of varying level of accuracy
- [Data Deli Web Mapping Service](#): Provides access to a suite of spatial data layers using the OGC Web Mapping Services protocol.
- [dBox](#): Application development framework for use with MapServer.
- [DNR Data Deli](#): Allows users to download geospatial data files, with accompanying documentation.
- [GeoMoose](#): GeoMoose is open-source web mapping software available to anyone at no cost. Using GeoMoose, anyone, especially city, county, or other governmental units, can create interactive mapping applications for their website or simply put basic GIS capabilities on the desktop of anyone in their organization. GeoMoose was created by the City of St. Paul and enhanced by the OpenMIND Project, a collaborative effort involving agencies in Minnesota and North Dakota funded by an FGDC grant. OpenMIND focused GeoMoose on local government needs and packaged it so it can be easily downloaded, configured, and deployed using basic web publishing skills. No programming is required. Based on open standards and open-source software, entire applications can be built without having to purchase any software. GeoMoose is designed around a services-oriented architecture, which means it can use other web servers on the Internet and distributed application components on your own servers. Map layers can come directly from web mapping services published by a variety of government agencies or by accessing your own data using MapServer. This minimizes the need to copy and process large volumes of data. Other web-based information services can be accessed to integrate associated systems dynamically based on user interaction with the application. As a result, GIS applications can be provided on most servers or workstations without requiring special performance capabilities, disk space, or database software. For more information on GeoMoose, see <http://www.geomoose.org/moose> For more information on MapServer, see <http://mapserver.gis.umn.edu/>
- [Land Management Information Center's Geospatial Image Server](#): The Land Management Information Center's Geospatial Image Server has been developed to provide versatile access to large statewide raster databases according to the Open GIS Consortium's Web Map Service (WMS) standards.
- [macnoise.com interactive mapping application](#): Allows residents near MSP International Airport to determine their eligibility for mitigation programs and provides access to

GeoService Finder's catalog entry form

GeoServiceFinder entry form - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Dept. of Administration / Office of Geographic and Demographic Analysis / GeoServiceFinder

Chris Cialek's Workspace

User name: chris.cialek@state.mn.us
 Contact support
 Application: GeoSpatial (change)

Welcome Add content My content Search My profile Logout

GEOSERVICEFINDER ENTRY

Form preferences
 • Show names in ISO:19115 form

Title ⓘ Name by which the cited resource is known. Maximum field length is 250 characters. (required)
 GeoMoose

Edition ⓘ Version of the cited resource.
 1.0.0

Abstract ⓘ Brief narrative summary of the service contents. Maximum field length is 250 characters. (required)
 GeoMoose is open-source web mapping software available to anyone at no cost.

Abstract continued ⓘ A continuation of the brief abstract above. Please do not repeat text, as these fields will be displayed as a continuous paragraph in full record display mode.
 Using GeoMoose, anyone, especially city, county, or other governmental units, can create interactive mapping applications for their website or simply put basic GIS capabilities on the desktop of anyone in their organization.
 GeoMoose was created by the City of St. Paul and enhanced by the OpenMIND

Status ⓘ The development phase of the service. (required)
 Completed Planned
 Historical archive Required
 Obsolete Under development
 On going

Service type ⓘ The service type name from a service registry (required)
 Remote application: an interactive application run at a remote site that a client accesses through an internet browser. The client does not need to run any additional software.
 Standalone application: software and data that can be downloaded and run locally
 Component: code that can be downloaded then included in routines and executed locally
 Service: a service run at a remote site that a client accesses through the internet, the client needs to run additional software (e.g. using ArcGIS to access photography via a WMS image server).

Purpose ⓘ Summary of the intentions for which the service was developed.
 GeoMoose was particularly designed to meet the needs of local government to publish maps on the web. It has been packaged it so it can be easily downloaded, configured, and deployed using basic web publishing skills.

Use constraints ⓘ Restrictions or limitations or warnings to protect privacy, intellectual property, or other special restrictions on the resource or the metadata.
 Copyright License
 Patent Intellectual property rights
 Patent pending Restricted
 Trademark Other restrictions

Extent ⓘ Describes the spatial (horizontal and/or vertical and temporal coverage in the service).
Scope
 International
 Entire U.S.A
 Multiple states
 Minnesota
 Twin Cities
 Metropolitan Region

Distributor ⓘ Identification and means to contact people/organizations associated with the service.
 Are you the contact for this item? (Chris Cialek, chris.cialek@state.mn.us)
 Contact is another person
Name: Dickerson, Jim
Organization: LMIC
Address: 658 Cedar St.
Phone, work:
Email: jim.dickerson@state.mn.us

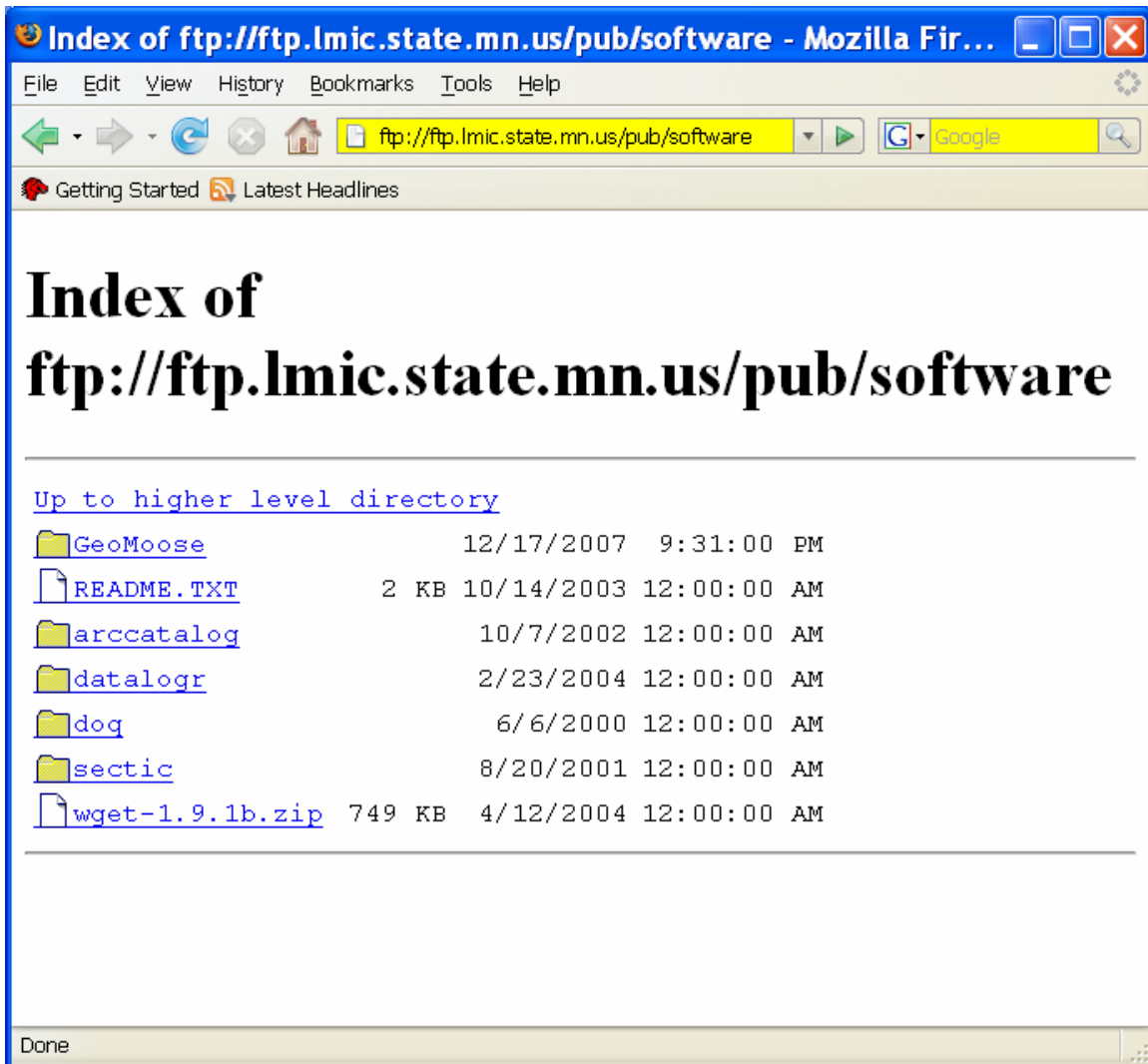
Developer ⓘ Recognition of those who contributed to the service.
 Are you the creator for this item? (Chris Cialek, chris.cialek@state.mn.us)
 Contact is another person
Name: Knippel, Randy
Organization: Office of GIS
Address: 14955 Galaxie Ave
Phone, work: 952-891-7080
Email: randy.knippel@co.dakota.mn.us

Protocol ⓘ The connection protocol to be used such as http, ftp, etc. (required)
 ftp

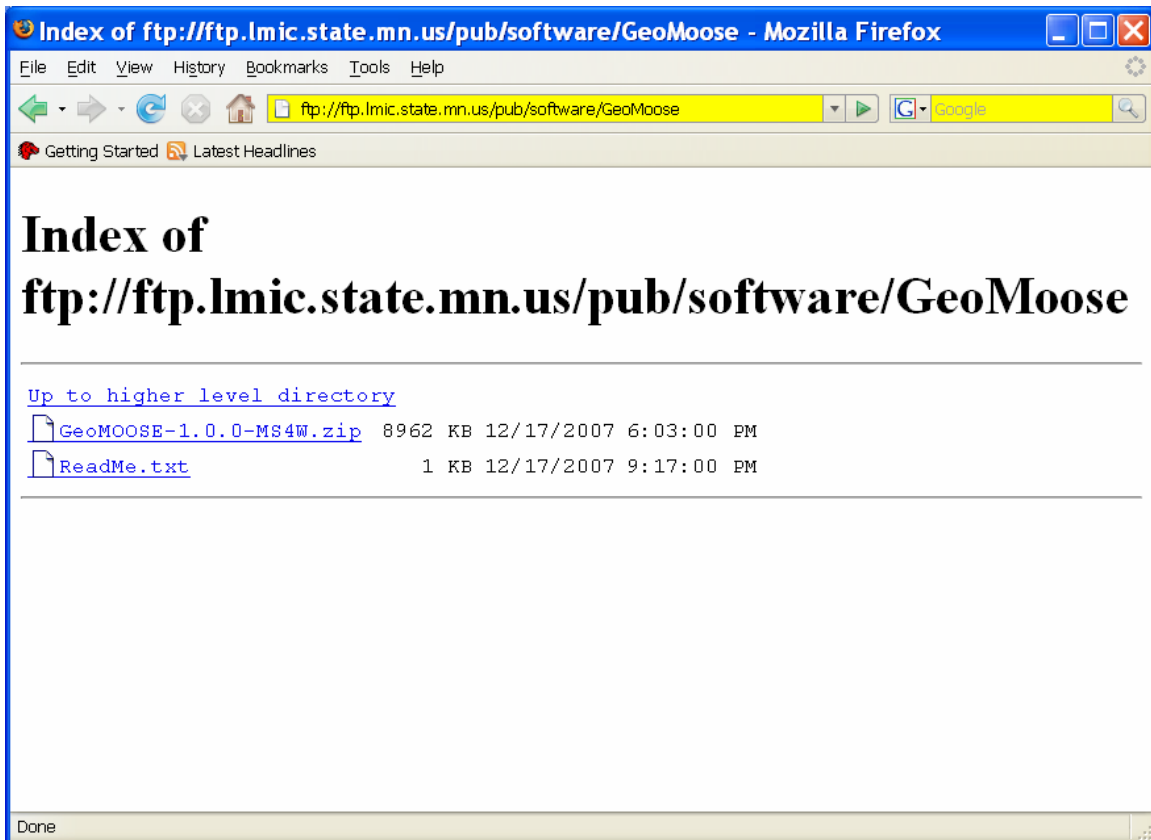
Linkage ⓘ Internet location (address) for on-line access which uses a Uniform Resource Locator address or similar addressing scheme such as www.isotc211.org or ftp.isotc211.org. (required)
 ftp.lmic.state.mn.us/pub/software/GeoMoose/

Save Save and exit Discard changes

LMIC's software library site



GeoMoose application in the library



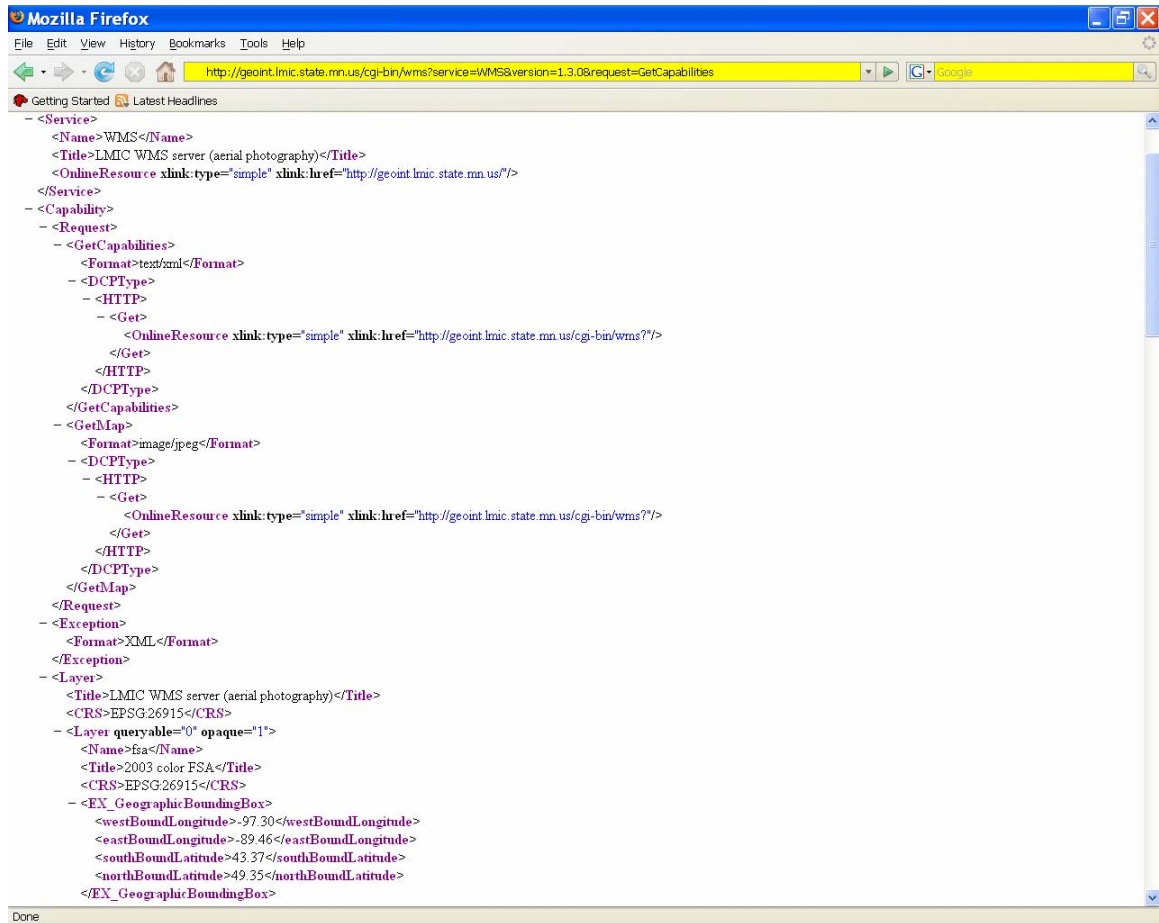
Some documentation describing the WMS server

The screenshot shows a Mozilla Firefox browser window displaying the 'Land Management Information Center: WMS Imager Server Description' page. The browser's address bar shows the URL: http://www.lmic.state.mn.us/chouse/wms_image_server_description.html. The page header includes the 'Admin Minnesota' logo and navigation links for 'Home | Northstar | Governor | Intranet' with a timestamp of 'Friday January 04, 2008 12:24:45 PM CST'. The breadcrumb trail reads: 'Dept. of Administration / Office of Geographic and Demographic Analysis / Land Management Information Center'. The main content area is titled 'LMIC'S MINNESOTA GEOSPATIAL IMAGE SERVER' and describes the server's purpose. It lists 'SPECIFICATIONS' and 'DATA LAYERS SERVED', with a 'New!' notice for recent updates. A section titled '1. Digital orthophotography' contains a table with the following data:

Geographic Area	Year	Season	Originator*	Type	Resolution	Metadata	Notes
Almost statewide	2006	Summer	FSA	color	2-meter		Some areas in northern Minnesota and the Twin Cities were not flown
Statewide	2003-04	Summer	FSA	color	1-meter		Most imagery is from 2003; missing areas were filled 2004.
Statewide	1991-92	Spring	USGS	black-&-white	1-meter		
Twin Cities	2006	Spring	USGS	color	0.3-meter		Minneapolis - St. Paul area
Ramsey County	2006	Spring	USGS	color	0.15-meter		Data converted from state plane coordinates to UTM
Twin Cities	2004	Spring	NGA; USGS	color	0.3-meter		Minneapolis - St. Paul area
Twin Cities	2000	Spring	Met Council	black-&-white	0.6-meter		7-county Twin Cities
Twin Cities	1997	Spring	Met Council	black-&-white	0.6-meter		7-county Twin Cities

* FSA = Farm Service Agency, U.S. Department of Agriculture

Top portion of response to GetCapabilities request from wms server



```
Getting Started Latest Headlines
- <Service>
  <Name>WMS</Name>
  <Title>LMIC WMS server (aerial photography)</Title>
  <OnlineResource xlink:type="simple" xlink:href="http://geoint.lmic.state.mn.us?"/>
</Service>
- <Capability>
- <Request>
  - <GetCapabilities>
    <Format>text/xml</Format>
    - <DCPType>
      - <HTTP>
        - <Get>
          <OnlineResource xlink:type="simple" xlink:href="http://geoint.lmic.state.mn.us/cgi-bin/wms?"/>
        </Get>
      </HTTP>
    </DCPType>
  </GetCapabilities>
  - <GetMap>
    <Format>image/jpeg</Format>
    - <DCPType>
      - <HTTP>
        - <Get>
          <OnlineResource xlink:type="simple" xlink:href="http://geoint.lmic.state.mn.us/cgi-bin/wms?"/>
        </Get>
      </HTTP>
    </DCPType>
  </GetMap>
</Request>
- <Exception>
  <Format>XML</Format>
</Exception>
- <Layer>
  <Title>LMIC WMS server (aerial photography)</Title>
  <CRS>EPSG:26915</CRS>
  - <Layer queryable="0" opaque="1">
    <Name>Esa</Name>
    <Title>2003 color FSA</Title>
    <CRS>EPSG:26915</CRS>
    - <EX_GeographicBoundingBox>
      <westBoundLongitude>-97.30</westBoundLongitude>
      <eastBoundLongitude>-89.46</eastBoundLongitude>
      <southBoundLatitude>43.37</southBoundLatitude>
      <northBoundLatitude>49.35</northBoundLatitude>
    </EX_GeographicBoundingBox>
```

Example map returned by GetMap request to WMS. Request url was

<http://geoint.lmic.state.mn.us/cgi-bin/wms?service=WMS&version=1.1.1&request=GetMap&layers=fsa&bbox=500000,500000,501000,5001000&height=600&width=600>

