

Facilitating the sharing and coordinated use of spatially referenced data in Delaware

Meeting Summary
Quarterly DGDC/SMAC Meeting
9:00 a.m., August 19, 2004
Delaware Center for Educational Technology
655 W. Glenwood Ave. (Suite 1)
Smyrna, DE

Attendance List:

Mike Mahaffie	State Planning Coord.
Dick Sacher	UD/RDMS
John Callahan.....	UD/RDMS
Tina Callahan.....	UD/RDMS
John Laznik.....	UD/CADSR
Shelly McCoy.....	UD/Morris Library
Chad Lauderbaugh	DeIDOT
Debbie Sullivan.....	DNREC
Miriam Pomilio	DNREC
Glenn Gladders.....	DDA Forest Service
Barbara Gladders	Div. of Public Health
George Yocher	Div. of Public Health
Wendy Modzelewski	DCET
Skip Hurst	Artesian Water
Jocelyn Lutte.....	Artesian Water
Sandy Schenck.....	DGS
Jennifer Jennings.....	DNREC
Michael Krumrine.....	DNREC
Brianne Press	URS
Lyn Anderson.....	Labor
Sandra Janowski	New Castle Co.
Chris Sommers	DC Group
Tripp Fischer.....	DNREC
Peter Owusu-Donker	Dover/Kent MPO
Tom Peralta	New Castle Co.
Lianna Schafer.....	Tim Schaeffer D.C.
Denise Hakanson	Tim Schaeffer D.C.

Welcome and Introductions

Mike Mahaffie began the meeting at approximately 9:05 a.m. The meeting started with attendees introducing themselves.

Information Updates

DataMIL Migration

Mike Mahaffie gave a brief update on plans to migrate the DataMIL from UD's Research and Data Management Services to the DGS and DTI. The project is on schedule, with many meetings taking place recently. A brief discussion included the notion of a DataMIL Steering committee and the possibility of eventually creating additional map services, beyond DataMIL. There was also a brief discussion of some of the other on-line mapping services in the state, such as those by DNREC and New Castle County.

Elevation Data Project

Sandy Schenck gave an update on the various projects that are now under way to collect elevation data for the state of Delaware. There had been an

effort to make one central project out of the interest in new elevation data. That attempt failed and the several agencies with funding to collect data for parts of the state determined to move forward. The Delaware Geological Survey and the US Geological Survey have worked together to craft a memorandum of agreement (MOA) to try to bring the existing projects into alignment and create the opportunity to find funding to complete the state. According to sandy, the projects that will go forward will yield LIDAR data and ultimately 2-foot contour data for all of Sussex County and the eastern part of Kent County. Once the MOA, now in draft form, is complete, Sandy will look for participants to help fund the completion of data collection for the rest of the state.

National Hydrography Dataset

Sandy Schenck gave an update of the USGS project to complete an update of the National Hydrography Dataset (NHD) for Delaware. The new NHD data combines the line-work from the USGS DLG data with richer attribute data, including stream names and stream reach codes. Sandy expects the whole of Delaware to be complete and part of the NHD within the next several months. Mike Mahaffie suggested having a workshop on NHD when the data becomes available in the fall. Sandy suggested having it at the UD in the GIS lab as a hands-on workshop.

GIS Education Committee Update

John Laznik gave an update on activities of the GIS Education committee. He outlined plans for GIS Day activities in November, which may include partnerships involving Dover Air Force Base and the Kent County 4-H. John also called for volunteers to make themselves available to schools that week and generally. He noted that what we used to think of as GIS Mentors should instead become GIS partners, to work on a more equal footing with teachers. John would like to create an ArcIMS site that offers geographic information keyed to teachers' classroom needs, rather than try to install GIS software in classrooms. There was also some discussion of the value of Geo-caching as a classroom activity and as a potential add-on to the 2005 GIS Conference.

There will be a workshop in October, focused on using technology in the classroom. DGDC members have taken part in that workshop in the past and should do so again.

Tina Callahan noted that there will always be some need to work directly with teachers who have a higher acceptance of newer software, and can convince their districts to install GIS software.

The Vern Svatos Memorial Award

Mike Mahaffie explained, for those who may not have known, about the recent loss to the Delaware GIS Community of Vern Svatos, who was a long-time supporter of the use and sharing of spatial data and served as a mentor to many in the community. Mike asked for volunteers to be on a committee to create and organize an annual award, in honor of Vern Svatos, for an individual who has furthered the use of GIS in Delaware. He noted that the idea, planning and process should be turned over to this committee.

Those volunteering were Lyn Anderson, Miriam Pomilio, Andrew Homsey, Sandy Schenck, Debbie Sullivan and John Laznik. Others who may want to volunteer should contact Mike Mahaffie/. Mike has agreed to help set up a first meeting. At that meeting, the group should elect its own chair to lead it from that point.

2005 Delaware GIS Conference Planning Update

Mike Mahaffie, as Chair of the Conference Planning Committee, gave an update on plans for the 2005 Delaware GIS Conference. The Conference planning group has met and has started outlining a plan for the conference. It is expected to still be a one-day conference, though there may be add-ons like workshops or social events. It is hoped that the conference will be held in Sussex County, if a venue that meets the committee's

requirements can be found. Mike also noted that Andrew Homsey has agreed to serve as Vice Chair and is expected to Chair the group for the 2006 Conference. A continual series of Chairs and Vice Chairs should help maintain continuity in the future without wearing out too many Chairs.

There was a brief discussion of possible content ideas for the Conference. Lyn Anderson suggested that there be more general content that will be of interest to those with less GIS experience. Tripp Fischer suggested a track relating to the use of GIS in the Classroom. John Laznik noted that the GIS Education Committee does hope to bring more students into the Conference.

How-To Session: Creating and Maintaining Metadata on the Delaware Geospatial Information Clearinghouse

Tina Callahan gave a presentation on creating and publishing metadata. She started the presentation with a short, original dramatic presentation – featuring herself, Lyn Anderson, Sandy Schenck, Mike Mahaffie and Dick Sacher – that highlighted the value of metadata in helping data users discover and better use data developed by others. Tina then gave a presentation (attached) on metadata, and presented a live demonstration of some of the approaches to creating and publishing metadata. She included a resource hand-out (also attached).

How-To Session: Accessing Data from DataMIL

John Callahan gave a presentation (attached) on the DataMIL and on accessing data from the DataMIL and from other on-line data streams. John also gave a live demonstration and led a brief discussion of the notion of several data stewards providing data in the manner. Currently, both DNREC and New Castle Co. have IMS web sites and the ability to serve data directly. John has also provided a handout (attached) on using OGC WMS Requests and Clients with example requests to DataMIL, which may be discussed at a future meeting.

Wrap Up

The meeting adjourned at approximately noon.

Delaware Geospatial Information Clearinghouse: What's the big deal?



Tina Callahan
RDMS
IT – User Services
University of Delaware



Outline

- Definitions
- Features of the Delaware Clearinghouse
- Demonstration
 - Creating Metadata
 - Publishing to the Clearinghouse
 - Browsing the Clearinghouse
- Future Directions

What is Geospatial Information?



- GIS data
- Map services
- Databases and data models
- Web sites
- Hardcopy maps
- Process models and scripts
- Projects

NSDI

- NSDI = National Spatial Data Infrastructure
 - “...technologies, policies, and people necessary to promote sharing of geospatial information.”
 - Established and coordinated by Federal Geographic Data Committee (FGDC)



FGDC Clearinghouse Activity



- Establish numerous clearinghouses of geospatial metadata
- 250+ clearinghouses worldwide
 - Each able to be searched (*independently or simultaneously*) by open and standard protocols

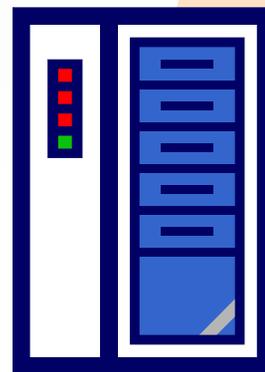




What is a Clearinghouse?

- A *detailed catalog service* of documentation about spatial information.

METADATA



- Stores metadata
- Indexes all metadata entries for faster searching
- Allows worldwide access to metadata entries

Clearinghouse Purpose



- Minimize duplication
- Foster data sharing
- Serve as a “one-stop” place to disseminate geospatial information
- Promote partnerships among participating agencies

What can I do with a Clearinghouse?



- Search current holdings in the catalog, e.g.,
 - keywords
 - themes
 - spatial extents
 - provider
- Link to:
 - browse graphics
 - web sites
 - geospatial information



Documentation = Metadata



- **Metadata is documentation** that is collected in a standard format to facilitate query and consistent presentation.
- Provides basic, helpful information about data
 - Title and description of geospatial information
 - Why were the data created?
 - Who created the data?
 - When was the data created?
 - How was the data created or modified?
 - How can users gain access to the data?

Publish Metadata?



- Upload metadata document
- Users (anywhere) can view metadata
- Advertises the existence of data, map services, and other spatial information



DATA USER



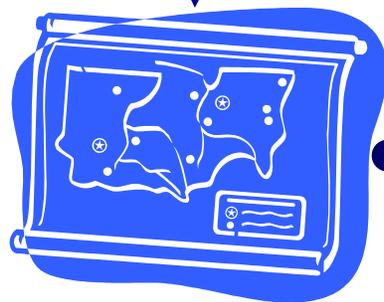
Creates
Data and
Metadata

Queries
Clearinghouse

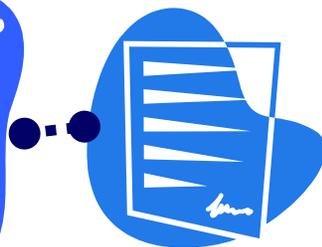
Clearinghouse
Responds

*Data resides
on local
machine*

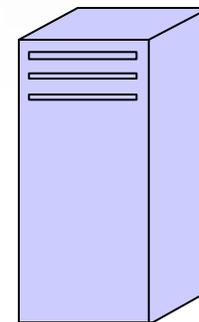
Publishes Metadata



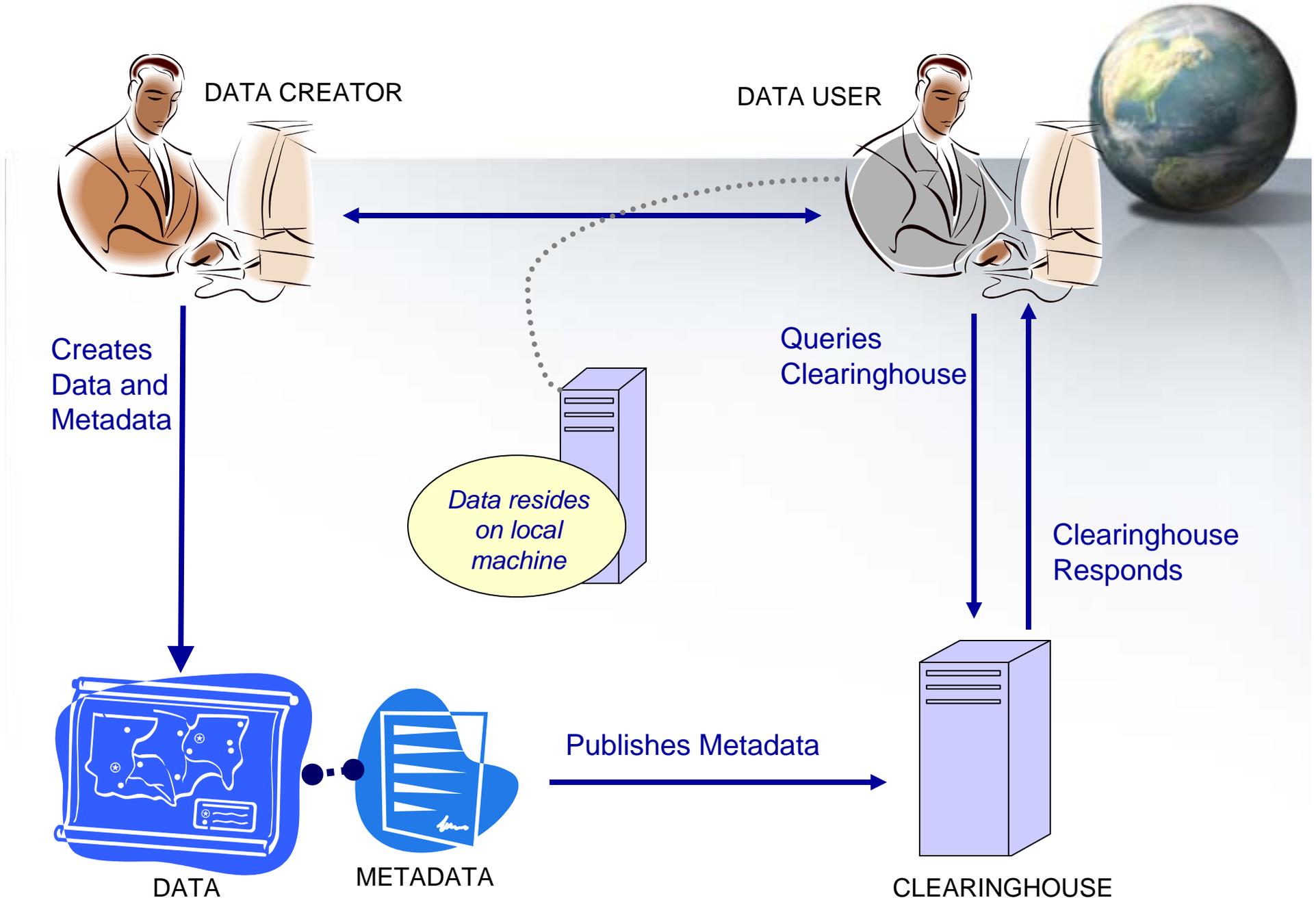
DATA



METADATA



CLEARINGHOUSE



The Delaware Clearinghouse



- Established in 1996
- Migrated to ArcIMS Metadata Server in 2002:
 - Automatic indexing for fast searching
 - Minimal validation (8 tags)
 - Drag and Drop Publishing through ArcCatalog
 - ArcCatalog has rich metadata editor
 - Delaware Metadata Explorer (DME)
 - Tighter integration with map services

The Delaware Clearinghouse



- New name!
 - Delaware **Geospatial Information** Clearinghouse
- New web site!
 - Provides basic information about NSDI, FGDC, Delaware geospatial activities, metadata creation, publishing and searching

Publishing to the Clearinghouse



- Metadata can be created for geospatial information
 - Data sets
 - Map services
 - Web sites, projects, consulting services, etc.
- Current standard is FGDC Content Standard for Digital Geospatial Metadata (CSDGM)
 - Minimum content provides basic information about the dataset, its creator, and contact info

Publishing to the Clearinghouse



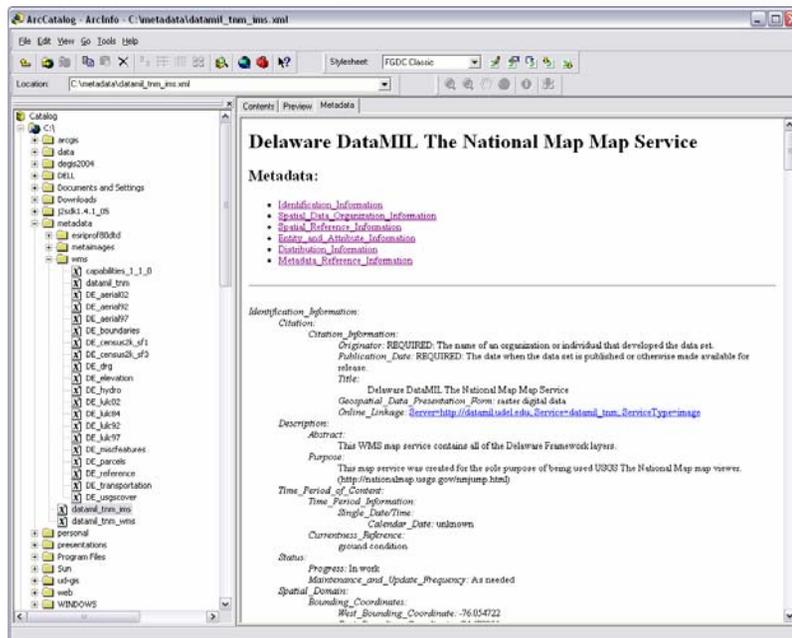
- Delaware recommended
 - Title, Abstract, Publisher, etc.
 - Spatial Reference Information
 - Bounding Coordinates
 - Currentness (time period)
 - Keywords and data type
 - From a select list
 - Contact Info

Publishing to the Clearinghouse



- Create user account on the Clearinghouse
- Two mechanisms to publish metadata in Delaware

ArcCatalog



File Upload Service



Searching the Clearinghouse



- DME search result provides
 - Brief metadata
 - Full metadata
 - Interactive map (if ArcIMS or WMS map service)
- Advanced searching through ArcCatalog
- Accepts Z39.50 calls
 - Still part of NSDI Clearinghouse Network!!

Future Directions



- Continue to support metadata creation and maintenance for Delaware information
- Move away from traditional thinking of datasets only...move towards geospatial information
- Establish new partnerships with Delaware-based agencies
- Possibly hold training sessions for metadata creation and/or publication



<http://www.nsd.edu/>

Questions/Comments:

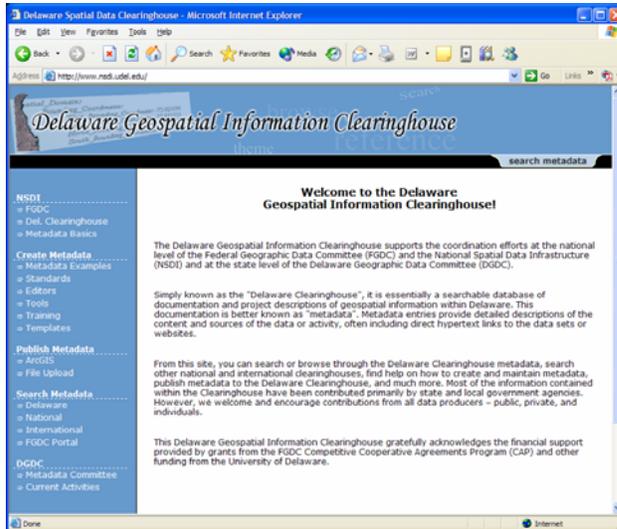
Tina Callahan

tinytina@udel.edu

302-831-3282

Delaware Geospatial Information Clearinghouse

<http://www.nsd.udel.edu>



New Web Site

From this site, you can:

- search or browse through the Delaware Clearinghouse metadata
- search other national and international clearinghouses
- find help on how to create and maintain metadata
- publish metadata to the Delaware Clearinghouse

Steps for Publishing Metadata to the Delaware Clearinghouse

Publishing metadata means that a metadata file describing a geospatial data set, model, project, or web site is uploaded to a searchable clearinghouse.

- **Step 1** - Obtain a Delaware Clearinghouse username and password for your organization (contact DelawareMetadata@udel.edu).
- **Step 2** - Create metadata in a standard format.*
- **Step 3** - Publish metadata:
 - Using ArcCatalog– Drag and drop metadata file from your local system into your organization’s directory on the Clearinghouse system.
 - Using File Upload Service – Use the Clearinghouse web form to upload your metadata file.

* **NOTE** - There are five required elements that must be entered in your metadata document, in order to successfully publish your metadata in the Delaware Clearinghouse.

Delaware Required Elements

1. **Title**
2. **Publisher**
3. **Spatial Extent**
4. **Keyword from ArcIMS Metadata Server List**[†]
5. **Resource Description**[†]

[†] Can be found on Delaware Clearinghouse web site under Publish Metadata.

Metadata Resources

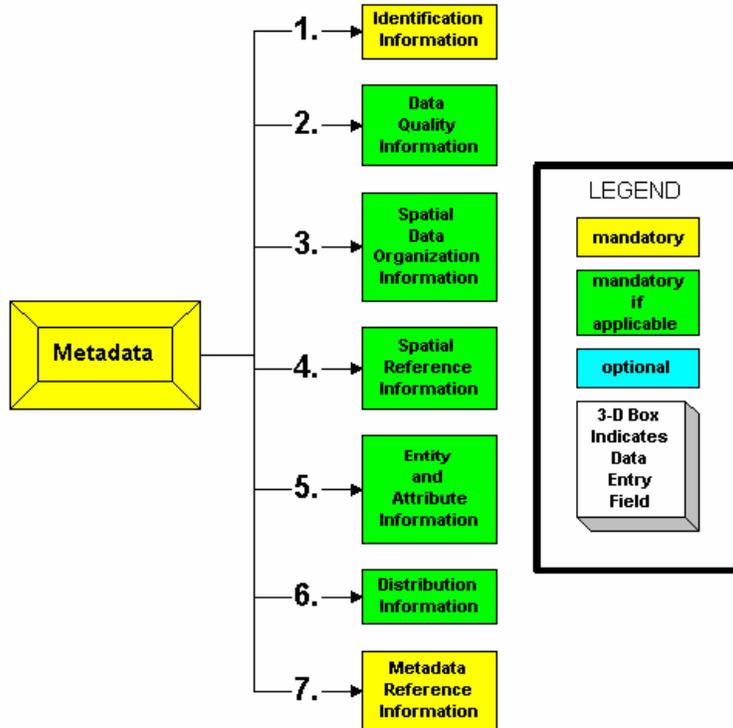
The Federal Geographic Data Committee (FGDC) currently endorses the Content Standard for Digital Geospatial Metadata (CSDGM) Version 2.

This standard requires, at minimum, the **Identification Information** and **Metadata Reference Information** sections. These provide a short description and contact information for further investigation.

Recommended Editors

Software

- ArcCatalog Metadata Editor by ESRI
- Spatial Metadata Management System (SMMS) by Intergraph
- CORPSMET95 by U.S. Army Corps of Engineers

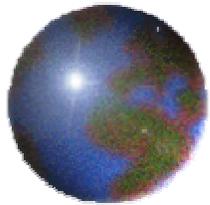


You may also wish to use ASCII template files to help create metadata. Visit the templates page (<http://www.nsd.edu/metatemplates.html>) to learn more on creating metadata from a text template.

Tools and Other Resources

- Clickable Image Map of Content Standard (<http://biology.usgs.gov/fgdc.metadata/version2/>)
- Metadata Validation Service (<http://geo-nsdi.er.usgs.gov/validate.php>)
- Metadata Parser (<http://badger.state.wi.us/agencies/wlib/sco/metatool/mp.htm>)
- Metadata “Cliff Notes” (<http://www.fgdc.gov/metadata/education/MetadataCliffNoteswTopicCategoriesMarch2004.pdf>)
- FGDC’s Online Resources for Metadata (<http://www.fgdc.gov/metadata/links/metalinks.html>)

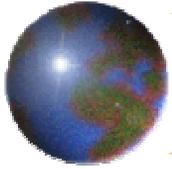
**For questions, comments, and suggestions, please contact
DelawareMetadata@udel.edu.**



Accessing Data from DataMIL

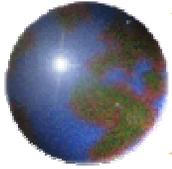
John Callahan
University of Delaware

August 19, 2004



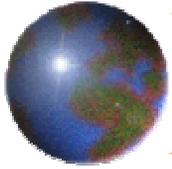
Presentation Outline

- ✦ The What and Why of the DataMIL Project
- ✦ What does “access data” really mean?
- ✦ Accessing data from DataMIL
- ✦ What about web services?
- ✦ “How-To” Demonstration



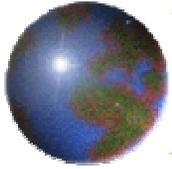
What is DataMIL?

- ✦ Delaware Data Mapping and Integration Laboratory (DataMIL)
- ✦ Built to **maintain** and **distribute** the base “framework” geographic layers for Delaware
 - ▣ Coordinated maintenance
 - ▣ Public access, Internet-based
 - Data, maps, services, standards, etc...



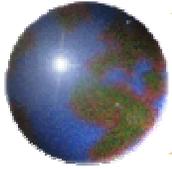
Framework Layers

- ✦ Boundary Monuments
- ✦ State/County Boundary
- ✦ State Outline
- ✦ Census Blocks
- ✦ Census Blockgroups
- ✦ Census Tracts
- ✦ Census ZCTAs
- ✦ USGS Boundaries
- ✦ Municipal Boundaries
- ✦ Geographic Names
- ✦ New Castle Tax Parcels
- ✦ Kent Tax Parcels
- ✦ Sussex Tax Parcels
- ✦ USGS Roads
- ✦ USGS Railroads
- ✦ DeIDOT Roads
- ✦ DeIDOT Railroads



Framework Layers

- ✦ Hydrography Lines
- ✦ Hydrography Areas
- ✦ Watersheds
- ✦ NGS HARN Locations
- ✦ Vertical Control Points
- ✦ Elevation Contours
- ✦ USGS NED
- ✦ USGS Quad Index
- ✦ UTM 1 KM Grid
- ✦ Misc Features Points
- ✦ Misc Features Lines
- ✦ Misc Features Areas
- ✦ USGS Surface Cover
- ✦ Land Use/Land Cover
- ✦ USGS NLCD
- ✦ Aerial OrthoPhotography
- ✦ Landsat
- ✦ USGS DRG

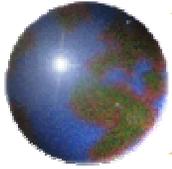


What is DataMIL?

- Portal Site
- Map Production Lab
- Discussion Forums
- Map services
- Feature services
- Partnerships (MOAs)
- Standards, policy, etc...

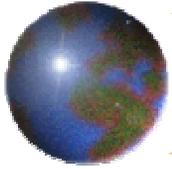
The image displays three screenshots of the DataMIL website and its features:

- Top Screenshot:** The main DataMIL portal page. It features a navigation menu with 'ABOUT DATAMIL', 'MAPPING', 'FORUMS', 'METADATA', and 'RESOURCES'. A 'Quick Links' section includes 'Project Summary' and 'Map Lab'. The main content area has a 'Welcome to the DataMIL' message and a 'News & Announcements' section.
- Middle Screenshot:** A screenshot of the 'Geographic Names (GNIS) Discussion Forum'. It shows a list of forum topics such as 'Newark High School', 'Shields School Name Wrong', and 'Delaware State College'. The forum interface includes search, refresh, help, and logoff buttons.
- Bottom Screenshot:** A screenshot of the 'Delaware DataMIL Map Production Laboratory'. It shows a map of Delaware with various geographic features. The interface includes a 'Quick Zoom' section, a 'Legend' section, and a 'Locator Map' section.

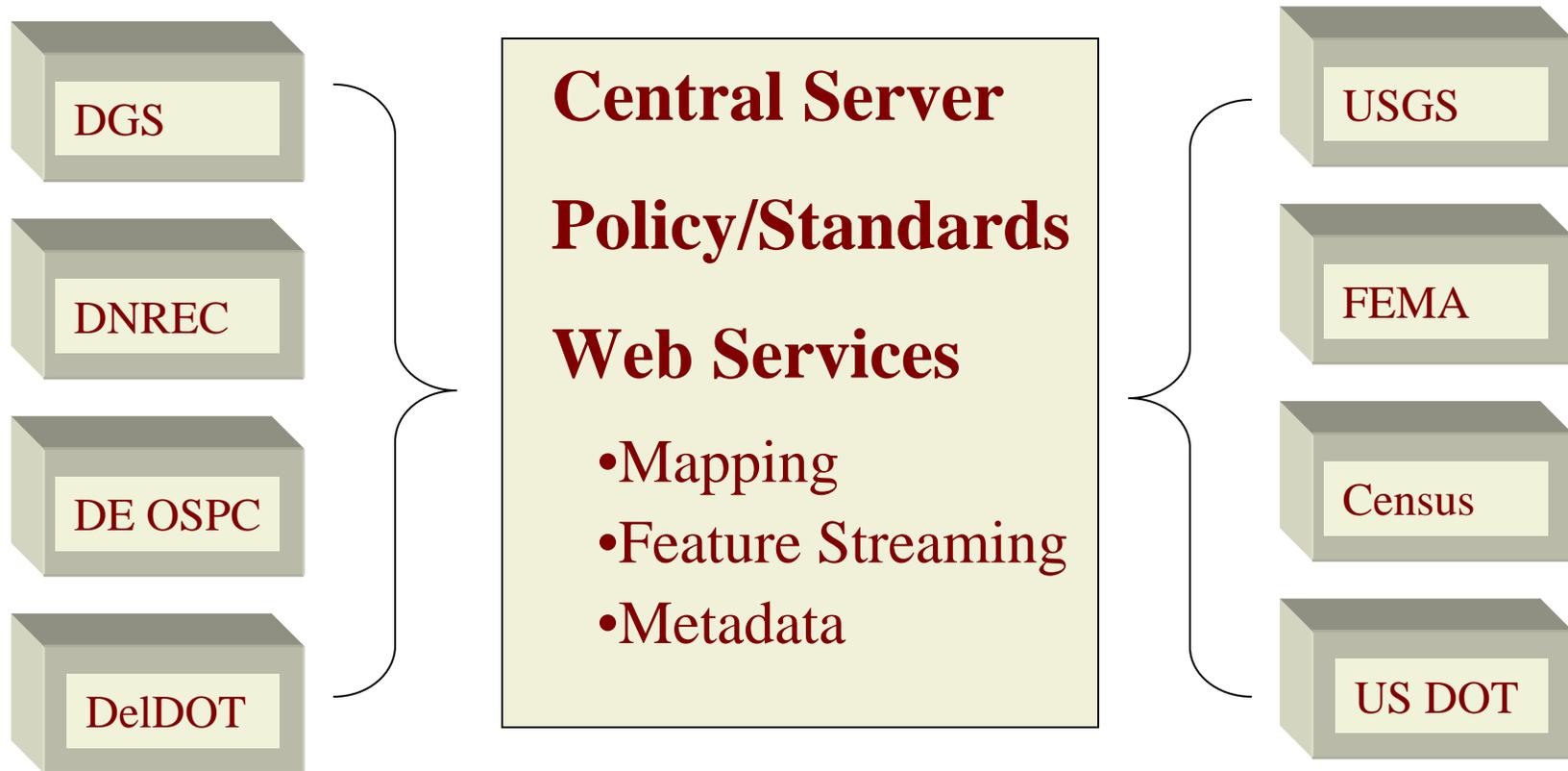


Why DataMIL?

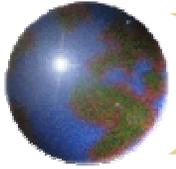
- ✦ Continual, coordinated maintenance of most important geographic data
 - ▣ increases efficiency
- ✦ Enables data sharing and feedback among local, state, federal, academia, private sector and public
- ✦ Key to effective information management, planning, and public policy



Delaware's Geography Network

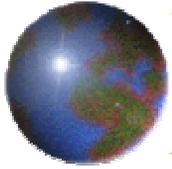


Multi-agency collaboration is key!



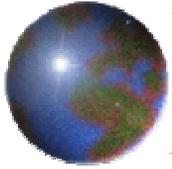
What does “Access” really mean?

- ❖ Two perspectives on accessing data:
 1. Display of map features and attributes
 - Mapping web sites, map services
 2. Download of actual data files
 - FTP, feature streaming



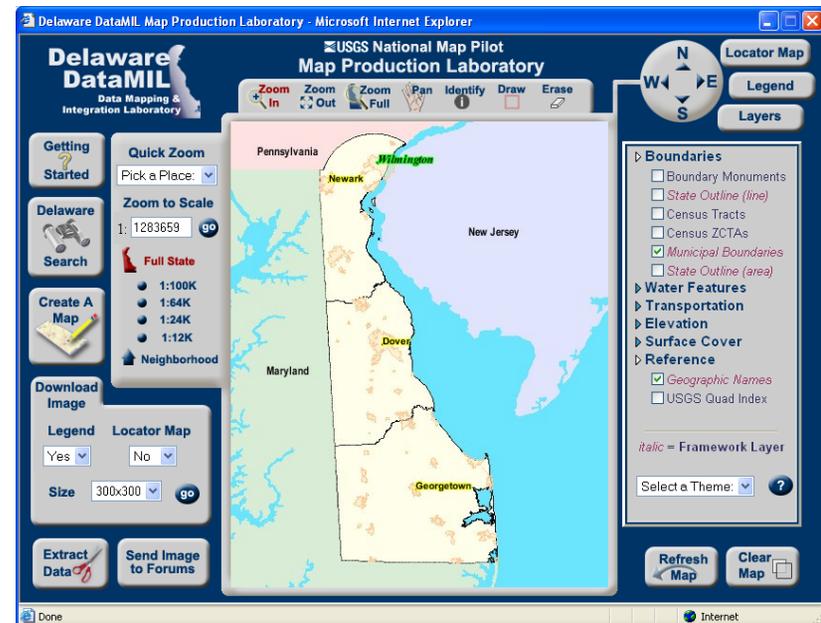
Accessing data from DataMIL

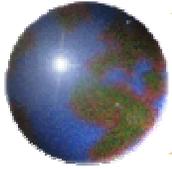
- ✦ Map Lab website
 - ▣ Display map and attributes on site
 - ▣ Extract vectors as shapefiles
- ✦ ArcGIS Desktop
 - ▣ Display map and attributes as map service
 - ▣ Data streamed as feature service
- ✦ OGC WMS and WFS services
 - ▣ Need a OGC WMS/WFS capable client
- ✦ FTP
 - ▣ Many (but not all!) available via download



Map Lab Website

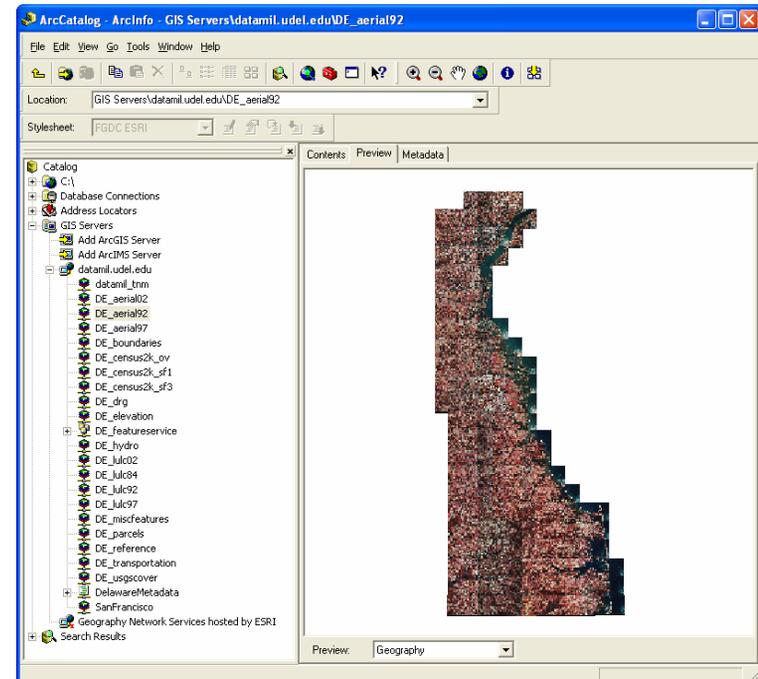
- Display feature layers
- Scale dependent
- Rendered
- Identify attributes
- Extract visible vectors as shapefiles
- "Clip-Zip-n-Ship"
- Metadata

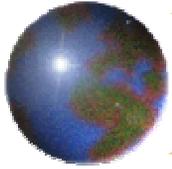




ArcCatalog/ArcMap

- ☉ Connect to "datamil.udel.edu"
- ☉ Map services
 - ☐ Display maps
- ☉ Feature services
 - ☐ Data streaming
- ☉ Use directly in ArcMap and other ESRI products





OGC WMS and WFS

- ⊕ Open GIS Consortium

- ⊕ Web Map Service

 - ⊕ Images, attributes

- ⊕ Web Feature Service

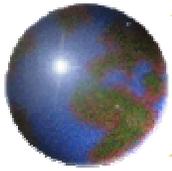
 - ⊕ Features streamed as GML

- ⊕ Based on HTTP requests

- ⊕ Interaction depends on quality of client



<http://www.opengis.org/>



FTP

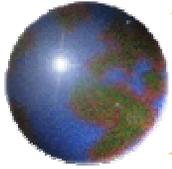
- Many data sets available via download from data stewards' location
- USGS DLGs, Municipal Boundaries, LULC, etc...
- DataMIL Portal tries to reference these locations

The screenshot shows a web browser window titled 'The Delaware DataMIL - Microsoft Internet Explorer'. The address bar shows the URL: <http://datamil.udel.edu/home.asp?main=vectorstocwtoodata>. The page content includes a navigation menu with 'ABOUT DATAMIL', 'MAPPING', 'FORUMS', 'METADATA', and 'RESOURCES'. The main heading is 'Delaware Vector Data'. Below this, there is a list of data layers:

- Municipal Boundaries
- Boundary Monuments
- State Outline (line)
- State Outline (area)
- Vertical Elevations
- New Castle County Parcels
- Kent County Parcels
- Sussex County Parcels
- Land Use/Land Cover
- DelDOT Roads
- DelDOT Railroads
- DNREC Watersheds
- USGS Watersheds

Below the list is a table with two columns: 'Layer' and 'Agency Info'. The table contains information for 'Municipal Boundaries' and 'Delaware Geological Survey'.

Layer	Agency Info
Municipal Boundaries	<p>Delaware Office of State Planning home page: http://www.state.de.us/planning</p> <p>Maintenance Status: Continual</p> <p>The Office of State Planning Coordination (OSPC) reviews all proposed municipal annexations under the Land Use Planning Act (LUPA) and the Livable Delaware legislation. Annexation proposals are mapped as part of this review. As annexations are approved, they are added to the OSPC Municipal Boundaries dataset.</p> <p>Further information on this data is on-line at http://www.state.de.us/planning/info/munbounds/munbounds.htm. The dataset itself can be downloaded (in Delaware State Plane, NAD 83 meters) at http://www.state.de.us/planning/info/munbounds/munbounds.htm</p>
Delaware Geological Survey	<p>Delaware Geological Survey home page: http://www.udel.edu/dgs/</p>

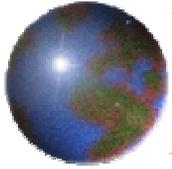


Web Services

- ✦ All data seen on Map Lab is also accessible through web map and feature services

- ✦ Additional services available:
 - ▣ Statewide imagery for 1992, 1997, 2002
 - ▣ Statewide landuse for 1984, 1992, 1997, 2002

- ✦ Web services have many advantages!



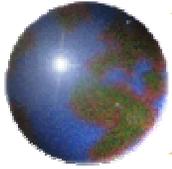
Web Services

✦ Some advantages:

- ✦ Operating system and hardware independence
 - Windows, Unix, Linux, Mobile
- ✦ Communication is standardized
 - XML, HTTP, TCP/IP, RSS, etc...
- ✦ Application consumption, modular

- ✦ “Black box” type of functionality

You don't have to maintain the data!



Web Services

❖ Some disadvantages

❖ Can be slow

- Dependent of Internet congestion and bandwidth capacity

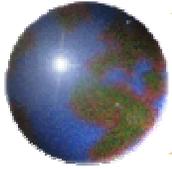
❖ Limited interaction with data

- Predefined symbology, scale dependency

❖ Difficult to find what you need

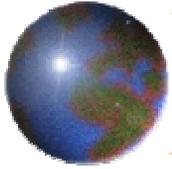
- However, online registries and clearinghouses are increasingly incorporating web mapping services

Comfortability: "If it's not mine, I can't use it!"



GIS Web Services

- ❖ Geographic and Location-Based (LBS)
 - ❖ Internet map serving
 - ❖ “Locator” applications
 - ❖ Mobile devices and field collection
 - ❖ Driving directions (MapQuest, MapPoint)
 - ❖ Automobile services and routing (OnStar, AAA)
 - ❖ Cell phone locating (e911 calls)
 - ❖ GPS tracking (conservation, habitat)
 - ❖ Time-series (traffic, weather, stream flooding)



Computing Evolution

- ✦ Explosion of capable PCs
- ✦ Low cost
- ✦ User friendly
- ✦ Cross discipline
- ✦ Internet

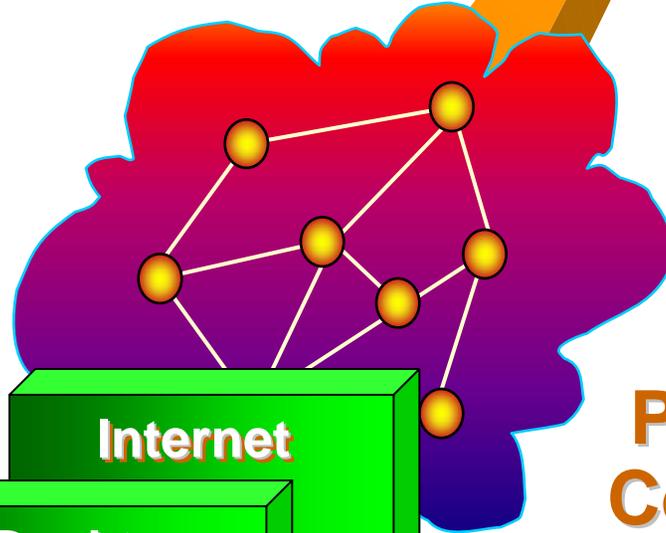
Mainframe

Mini

Workstation

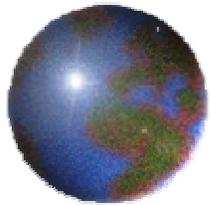
Desktop

Internet



Pervasive Computing

- ✦ Small Hardware (Nano)
- ✦ Wireless Internet
- ✦ Interoperable
- ✦ Embedded



Demonstration

Contact: John Callahan
RDMS, UD – IT
diodata@udel.edu

Overview of OGC WMS Requests and Clients with example requests to DataMIL

1. Web browser

Remember the DataMIL map services we saw in Exercise 1? Since the DataMIL web server complies with the OGC WMS 1.1.0 specification, we can view these map services through WMS requests. Let's make a few of these requests manually through the Internet Explorer web browser.

For details and a full description of the WMS 1.1.0 specification, read the [full documentation here](#). Also check out this very well-done summary of utilizing WMS 1.1.1, which is the new, current WMS version and to what DataMIL will be migrating to soon, <http://oceanesip.jpl.nasa.gov/esipde/guide.html>.

First, let's check out the capabilities file for a few of DataMIL's map services. In order to do this, you need to know the names of the services. This type of operation is not included in the OGC WMS or WFS specification. However, registries are being created to help with this problem. The WMS server administrator must manually modify each registry they belong to. This is not an ideal situation, but it is a place to start.

The basic format of the GetCapabilities request is as follows:

```
http://hostname/ + "WMS_server_engine" + VERSION=1.1.0 + REQUEST=GetCapabilities  
+ SERVICENAME="servicename"
```

Here are a few requests done for you. Take a look at the returned XML.

- o http://datamil.udel.edu/servlet/com.esri.wms.Esrimap?request=getcapabilities&version=1.1.0&servicename=DE_aerial02
- o http://datamil.udel.edu/servlet/com.esri.wms.Esrimap?request=getcapabilities&version=1.1.0&servicename=DE_lulc92
- o http://datamil.udel.edu/servlet/com.esri.wms.Esrimap?request=getcapabilities&version=1.1.0&servicename=DE_boundaries

OK, now that we've seen the capabilities for some map services, let's use this information to request a few maps. This can be done using the GetMap request directly in a web browser. You need to know quite a bit of information in order to make a GetMap request, as you see from the request format below. However, all of this information should be contained within the capabilities file. Therefore, automated programs can be written to parse the capabilities information and generate GetMap requests.

The basic format of the GetMap request is as follows:

```
http://hostname/ + "WMS_server_engine" + VERSION=1.1.0 + REQUEST=GetMap +  
SERVICENAME="servicename" + LAYERS=layer_list + STYLES=style_list +  
SRS=namespace:identifier + BBOX=xmin,ymin,xmax,ymax + WIDTH=output_width +  
HEIGHT=output_height + FORMAT=output_format + TRANSPARENT=true|false +  
BGCOLOR=color_value
```

As before, here are a few requests done for you.

- Get 2002 Aerial Imagery layer from DE_aerial02 map service:
http://datamil.udel.edu/servlet/com.esri.wms.Esrimap?version=1.1.0&request=GetMap&servicename=DE_aerial02&SRS=EPSG:102257&layers=2002%20Aerial%20Imagery&format=image/jpeg&width=800&height=600&bbox=173000.0,198000.0,182000.0,207000.0
- Zoom in on above map:
http://datamil.udel.edu/servlet/com.esri.wms.Esrimap?version=1.1.0&request=GetMap&servicename=DE_aerial02&SRS=EPSG:102257&layers=2002%20Aerial%20Imagery&format=image/jpeg&width=800&height=600&bbox=176500.0,202000.0,177000.0,204000.0
- Get Elevation Contours and USGS NED layers from DE_elevation map service:
http://datamil.udel.edu/servlet/com.esri.wms.Esrimap?version=1.1.0&request=GetMap&servicename=DE_elevation&SRS=EPSG:102257&layers=Elevation%20Contours,USGS%20NED&format=image/jpeg&width=800&height=600&bbox=173000.0,198000.0,182000.0,207000.0

The last topic to cover here is the GetFeatureInfo request. This request returns feature attributes based on an input X and Y location, analogous to the Identify command in a GIS. As in the GetMap request, information is needed a priori to making a request. Again, using the DataMIL services, let's make a few GetFeatureInfo requests.

The basic format of the GetFeatureInfo request is as follows:

```
http://hostname/ + "WMS_server_engine" + VERSION=1.1.0 + REQUEST=GetMap +  
SERVICENAME="servicename" + SRS=namespace:identifier +  
BBOX=xmin,ymin,xmax,ymax + WIDTH=output_width + HEIGHT=output_height +  
QUERY_LAYERS=layer_list + X=xcoordinate + Y=ycoordinate
```

As before, here are a few requests done for you.

- Get attributes from Land Use/Cover 2002 and Opening View layers in DE_lulc02 map service:
(View source to see result)
http://datamil.udel.edu/servlet/com.esri.wms.Esrimap?version=1.1.0&request=GetFeatureInfo&servicename=DE_lulc02&SRS=EPSG:102257&width=800&height=600&bbox=173000.0,198000.0,182000.0,207000.0&query_layers=Opening%20View,Land%20Use/Cover%202002&X=500&Y=500

2. **ArcExplorer**

Fortunately, ESRI has released an extension to ArcExplorer 4.0.1 - Java Edition that will enable the reading of WMS services (as well as WFS services and GML data.) The name of the extension is

Interoperability Extension for ArcExplorer—Java Edition and can be downloaded for free from the [Interoperability Technology Download Center](#). All of the map service interactions made with this extension, whether its zooming around or identifying, is made through one of the three WMS standard requests. This extension to ArcExplorer was released by ESRI only a few months ago.

Demonstration of Interoperability Technology Download Center.



3. **ArcMap**

Also fortunately, ArcMap is also capable of reading WMS services (as well as WFS services and GML data.) However, like ArcExplorer, an extension must be first downloaded and installed. A new toolbar will be added to ArcMap that will enable reading of these OGC formats. The name of the ArcMap extension is called the OGC Interoperability Add-On for ArcGIS and can be downloaded for free from the [Interoperability Technology Download Center](#). ArcGIS 8.3 is the only version currently supported. This is because new interoperability functionality will be included in ArcGIS 9.0.

Demonstration of OGC Interoperability Add-On for ArcGIS.



4. **Other clients**

There are essentially an unlimited set of clients that can make WMS requests and consume WMS services. These can be programs written in Java, .NET, C++, PHP, or literally almost any common programming language. Some web sites offer applications that can render WMS services, sometimes several services simultaneously. Other COTS packages provide functionality similar to ESRI family of products, either by the way of separate downloadable utilities or within the core product. Go to <http://www.opengis.org/> for detailed information about the WMS/WFS specification and available resources, clients, conformance testing, and other users.