



How to Participate in the Geography NetworkSM

Building Map Services Using ArcIMS[®]

An ESRI[®] White Paper • July 2001

Copyright © 2001 ESRI
All rights reserved.
Printed in the United States of America.

The information contained in this document is the exclusive property of ESRI. This work is protected under United States copyright law and other international copyright treaties and conventions. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or by any information storage or retrieval system, except as expressly permitted in writing by ESRI. All requests should be sent to Attention: Contracts Manager, ESRI, 380 New York Street, Redlands, CA 92373-8100, USA.

The information contained in this document is subject to change without notice.

U.S. GOVERNMENT RESTRICTED/LIMITED RIGHTS

Any software, documentation, and/or data delivered hereunder is subject to the terms of the License Agreement. In no event shall the U.S. Government acquire greater than RESTRICTED/LIMITED RIGHTS. At a minimum, use, duplication, or disclosure by the U.S. Government is subject to restrictions as set forth in FAR §52.227-14 Alternates I, II, and III (JUN 1987); FAR §52.227-19 (JUN 1987) and/or FAR §12.211/12.212 (Commercial Technical Data/Computer Software); and DFARS §252.227-7015 (NOV 1995) (Technical Data) and/or DFARS §227.7202 (Computer Software), as applicable. Contractor/Manufacturer is ESRI, 380 New York Street, Redlands, CA 92373-8100, USA.

ESRI, ArcIMS, ArcView, and the ESRI globe logo are trademarks of ESRI, registered in the United States and certain other countries; registration is pending in the European Community. ArcExplorer, ArcGIS, and ArcSDE are trademarks and @esri.com, Geography Network, geographynetwork.com, and www.esri.com are service marks of ESRI.

The names of other companies and products herein are trademarks or registered trademarks of their respective trademark owners.

How to Participate in the Geography Network

Building Map Services Using ArcIMS

An ESRI White Paper

Contents	Page
Introduction	1
Geography Network Overview	1
1. Web Site (www.geographynetwork.com)	1
2. User Communities	1
3. Content Providers	1
Publishers	2
Contributors	2
Publishing Map Services Using ArcIMS	2
1. Configure Internet Mapping System	2
Hardware	2
Software	3
Data	3
Network	4
Staff	4
2. Develop and Publish Map Services	4
Define Map Service	4
Author and Publish Map Services	6
3. Register Map Services at the Geography Network	7
Accessing Map Services	8
Why Join the Geography Network as a Publisher?	8
The Geography Network Publisher Program	9
The Future of the Geography Network	9

How to Participate in the Geography Network

Building Map Services Using ArcIMS

Introduction

The Internet has enormous potential for publishing and distributing geographic information. For most organizations, the greatest cost of developing a geographic information system (GIS) is the acquisition and maintenance of data. Though geographic data has never been more plentiful than it is today, much of it remains difficult to find and access in formats that can be easily used. The Internet is helping to solve this problem by offering a technology for data sharing and discovery that is becoming pervasive. By leveraging the power of the Internet, the Geography NetworkSM is providing access to geographic information in open formats that can support users of all types.

Geography Network Overview

The Geography Network is a framework for sharing and discovering GIS data and services on the Internet. It is based on the concept of a geospatial data clearinghouse developed by government organizations around the world. It provides a mechanism for GIS users to publish and access GIS data and services worldwide. The Geography Network consists of three parts:

- 1. Web Site**
(www.geographynetwork.com)
The Web site serves as a clearinghouse to discover and access geographic content registered in the Geography Network. The site is built around a catalog of the Geography Network content and provides tools to locate and access maps, data, and more.
- 2. User Communities**
These are groups of organizations or individuals that use Geography Network content to support their professional or personal interests. User communities are often organized around a geographic area of interest (e.g., Texas) or an industry area of interest (e.g., natural resources). These communities may access Geography Network content in different ways (e.g., directly through GIS tools or indirectly through custom Web applications).
- 3. Content Providers**
Content providers are government and commercial organizations that provide access to thousands of content elements including maps, data, geoservices, and solutions. The content is maintained in a distributed environment so that it may typically be accessed directly from the source. Geography Network content providers are identified as either *publishers* or *contributors*.

Publishers Publishers offer access to dynamic *map services* and *solutions* using Internet mapping technology such as ESRI® ArcIMS® software. A map service is a "live" map that can be displayed in a GIS or Web application. For example, the United States Geological Survey (USGS) offers a map service that presents a view of its National Elevation Database (NED) along with several reference layers. A solution is a custom application that can be accessed through a Web browser. For example, ESRI offers a flood risk mapping application that enables Web users to determine the flood risk for a certain street address. A publisher may choose to offer their content for free or for a fee.

Contributors Contributors publish links to static geographic data and maps that users can access or download from the Web. For example, many Web sites include links to geographic data files that can be downloaded for use with GIS software such as ArcView® or ArcExplorer™. Contributors may offer their content for free or for a fee.

In this document, we will focus on how a content provider can publish map services on the Geography Network using ArcIMS.

Publishing Map Services Using ArcIMS

There are three basic steps to publishing a map service on the Geography Network. These steps may be performed either by the data provider or by another organization that is hosting the content. In general, ESRI encourages data providers to publish their own content to ensure that it represents the latest data available and is presented as intended by the provider. However, ESRI recognizes that many data providers do not have the system or staff resources needed to support an Internet mapping system and may elect to have this function performed by another organization (e.g., an application service provider [ASP]).

Below is an overview of the steps to publish a map service on the Geography Network.

1. Configure Internet Mapping System

Publishers will first need to configure an Internet mapping system to publish content and support user requests. The size of this system can vary significantly, depending on the anticipated usage, but the system will always need to include hardware, software, data, network, and staff components. Below are some of the more important considerations in configuring a system.

Hardware

An Internet mapping system built using ArcIMS can be deployed on either a Windows (NT or 2000) or UNIX (Solaris or AIX) hardware platform. While the choice of platform may depend on several factors (e.g., hardware cost, availability, performance, and stability), ESRI generally recommends that the publisher select the platform with which their systems staff is the most experienced and comfortable.

After choosing a platform, the next consideration will likely be system sizing. A "low-end" system might include as little as one to two Windows single-processor servers with 256 MB of RAM and 20 GB of storage. A system like this might be able to support 10–25,000 map requests per day. A "high-end" system might consist of several Windows or UNIX servers with multiple processors each, multi-GB of RAM, and up to 1 TB or more of storage. A system like this might support more than 1,000,000 map requests per day. For data providers interested in providing a commercial level of access to their content, ESRI recommends they configure a system to support at least 100,000 map requests per day. Over time, the system capabilities can then be increased if additional

usage is anticipated. Most participants, however, will be able to configure smaller systems.

It is valuable to build redundancy into the system at the various tiers (Web server, map server, data server), if possible. This provides for fail-over capabilities and makes maintenance easier to manage as you can administer one part of the system while the other is still operating.

Software The software needed to power an Internet mapping system includes, at a minimum, Web server software (such as Netscape's iPlanet, Microsoft's Internet Information Server, or Apache) and Internet map server software (such as ESRI's ArcIMS). These software tools will enable a data provider to author map services of geographic data and publish them over the Internet.

The choice of Web server software may depend on the chosen hardware environment (e.g., Windows or UNIX) as well as any *middleware* software that may be used to support any serverside business logic. To support the Geography Network, data providers may publish their map services using the ArcIMS servlet connector. The servlet connector will support ArcXML requests from the Geography Network Web site as well as GIS clients such as ArcGIS™ 8.1 and ArcExplorer 3.1 Java Edition. To support other applications that may be built using the map services, data providers may build custom applications using development tools such as Active Server Pages (ASP), JavaServer Pages (JSP), or ColdFusion that could effect the choice of a Web server.

Data At the core of your Internet mapping system will be the geographic database. This database may include both vector and raster data sets. Perhaps the most important consideration in deploying the database to support your mapping system is the format in which the data will be stored. To work with ArcIMS, vector data may be stored as either ArcSDE™ layers or shapefiles. Raster data may be stored in a wide variety of formats, as referenced in ArcIMS technical specifications. The most popular raster formats include ArcSDE, TIFF, GeoTIFF, MrSID, and JPG.

Data Format: For publishers anticipating significant levels of requests (e.g., greater than 25,000 requests per day) and multiple simultaneous users, ESRI recommends storing data in a database management system (DBMS) accessed through ArcSDE rather than a file format (e.g., shapefile or MrSID). Storing the data in a DBMS provides better management of simultaneous requests to the database (i.e., minimizes file contention) and offers greater scalability than storing data in a file format.

Data Content: One of the most important factors in the performance of a map service is the content of the data. If the map layers that are being displayed contain too many features or the features are too detailed for the scale at which they are being displayed, the map service performance will suffer. If there are performance issues with a map service, the solution often involves the processing of the data that is being published. This may include *generalizing* features that are too detailed, *dissolving* features by a selected attribute by which they are being rendered, or creating a new layer with a subset of features from another layer (e.g., major roads).

Network Your Internet mapping system will need sufficient network bandwidth to support traffic both within the mapping system (i.e., between the networked servers) and with the Internet. For the internal network between your servers (e.g., Web server, map server, and data server), ESRI recommends at least a 100 Mbps connection. This will minimize the time needed to transfer data between system components to support various server requests. If high availability is a critical issue, publishers may want to establish a redundant network on a separate switch or hub to be used as needed.

The bandwidth requirements for your external network to the Internet may vary significantly, depending on the volume and type of requests that are being supported. Client requests to the system (e.g., ArcXML requests for maps) are typically very small and have a negligible effect on available bandwidth. The primary consumption of network bandwidth for an Internet mapping system results from delivering map images or data streams to the client. When publishing maps as an image service, publishers can estimate the amount of bandwidth required with the following formula:

(Average Image Size x Requests per second) x 8 = Mbps

Example 1: (100K JPG x 50 Requests per second) x 8 = 40 Mbps (Large T3)

Example 2: (10K PNG x 10 Requests per second) x 8 = 0.8 Mbps (Standard T1)

If you can estimate the average size of the images being served and the maximum number of requests per second, you can estimate the maximum amount of external network bandwidth that will be required to support those services.

The amount of bandwidth required to support a feature service is more difficult to estimate. Because the data itself is being streamed to the client, the network bandwidth requirements will depend on the number and size of the features being served. Before the data is transferred to the client, the map server compresses the data. The typical compression rate for feature services is 10–20 times. To determine the bandwidth required to support feature services, publishers will need to test services under normal use conditions and monitor network usage.

Staff The key to the successful implementation and maintenance of an Internet mapping system is the systems staff. The size of the systems staff may range from one to many individuals depending on the complexity of the system and the skill sets of the staff. The staff members will need to be able to configure and manage all system components listed above. Most Internet mapping system teams include both traditional information technology staff (IT) who can support hardware, software, and network configuration as well as GIS staff who can support data processing and management and map publishing.

2. Develop and Publish Map Services

After the Internet mapping system is configured, the data provider can begin to build the map services to be published on the Geography Network.

Define Map Service

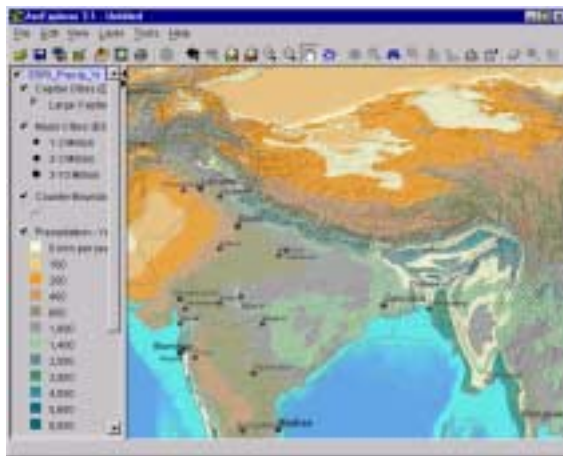
Publishers will first need to define what services will be published for the user. This step will include decisions on what data layers are available, which layers work well together (in terms of content and scale), which layers provide the greatest user value, and which layers complement other services available through the Geography Network.

For example, a data provider with three data layers (e.g., wetlands, endangered species, and marine habitats) may decide to publish one map service that contains all of these layers or three separate map services with one layer each. The map services could be intended to be used on their own or with other map services (e.g., shaded relief imagery or federally managed lands) available on the Geography Network.

The Geography Network offers many different map services that may complement map services offered by data providers. These include street maps, shaded relief imagery, land cover imagery, population density, vegetation zones, demographic statistics, ecoregions, and many more. These might be *comprehensive* map services that contain basic basemap layers (e.g., administrative boundaries, water features, and city points) along with thematic layers (e.g., precipitation and temperature zones), or they may be *thematic* map services that include only one or two specific layers (e.g., housing developments and business locations).

Geography Network users will typically be accessing map services in one of two ways: Web browser or GIS application. Users accessing these services with a Web browser will typically want comprehensive map services because they will be viewing one service at a time. For example, a Web user interested in the environmental quality of their neighborhood may want to see a map service that includes toxic hazard locations overlaid on a traditional street map.

GIS users may prefer a mix of comprehensive and thematic map services that they can use with their local data or other map services. GIS software, such as ESRI's ArcView 8.1 or ESRI's free GIS data viewing software, ArcExplorer 3.1 Java Edition, can be used to integrate content from multiple sources (e.g., basemap data from the USGS, flood data from Federal Emergency Management Agency [FEMA], and hazard data from the Environmental Protection Agency [EPA]). These services may come from one or more map servers and be integrated with local data sources as well. The Geography Network offers both comprehensive and thematic map services to support these types of requirements.



Precipitation Zone and Shaded Relief Map Services in ArcExplorer 3.1



U.S. Street Map Service Displayed in ArcView 8.1

Author and Publish Map Services

Once the map services are defined, the publisher can use the ArcIMS Manager tools to author and publish the map service. The ArcIMS Author tool will allow users to define the layers to be displayed in a map service and set their scale dependencies and symbology. When the map service is completed, it can be saved as an ArcXML configuration file (AXL) and published on a server using ArcIMS Administrator.

Performance Issues: Perhaps as important to the value of a map service as the content and presentation of the map is the performance of the service. If the service does not perform adequately for users, it will not likely be used as intended by the publisher. For this reason, publishers will want to test map services using tools such as the ArcIMS HTML Viewer to be sure they perform well. ESRI tries to configure map services so that the map images generate within an average of approximately two seconds per map. If the map images take much longer to generate (e.g., 5 to 10 seconds), the maps probably contain too many features, or features that are too detailed for the display scale, and the services will need some tuning. The publishers may need to adjust the scale dependencies of the layers being drawn or perhaps create "generalized" or "dissolved" versions of certain data layers so that less detailed features, or fewer features, are being displayed at smaller scales.

When the map service performance is being tested, the ArcIMS server *log files* can be very helpful in determining the cause of performance issues. For example, if a map service rendering 10 layers is taking eight to 10 seconds to generate an image, the log files can help determine if one or two specific layers are causing the delay. The log files will show the time to find and retrieve features for each data layer being rendered as well as the cumulative time for the map request. ESRI recommends that publishers view the log files (e.g., image server or feature server logs) whenever publishing or testing new map services.

Another factor that may affect map service performance is the image output format. ArcIMS image services can be published in either GIF, JPG, PNG 8-bit, or PNG 24-bit format. If the content being presented in an image service includes more than 256 colors (e.g., satellite imagery), then the image service should be published using JPG or PNG 24-bit format. These formats will each support more than 256 colors and will not require that the image colors be resampled during image output. The time required to resample down to 256 colors for GIF and PNG 8-bit formats can require an additional three to four seconds per map during output.

Projection Issues: Publishers should also consider the projection in which the data is being stored and presented as a map service. In most cases, ESRI encourages data providers to serve data in geographic coordinates (decimal degrees) so that the map services may be more easily integrated with other map services without projection on the fly. This is especially important for map services that are intended to be overlaid on other sources available through the Geography Network. Web applications may request reprojected versions of data from a server, but this can be a time-consuming process depending on the number of features being served. Some GIS software, such as ArcView 8.1, will automatically reproject map services published in different coordinate systems if the map service is published with its coordinate system information. If a data provider wants to enable their services to be used by GIS tools, they should include the proper

coordinate system tags (e.g., *featurecoordsys* and *filtercoordsys*) in the ArcIMS AXL configuration file.

Security Issues: Security is an important issue for all organizations publishing content on the Internet. The two primary security concerns for map services are (1) who can access the map service and (2) how the map services can be used. When publishing a map service, the publisher may want to limit access to certain individuals or organizations. This may be true for commercial content (e.g., commercial aerial imagery) or for content of a sensitive nature (e.g., government parcel records). Publishers can use the security mechanisms built into ArcIMS 3.1 to enable access to map services by only authorized users. The ArcIMS 3.1 security enables publishers to limit map service access to users with a specific username and password or IP address.

When publishing a map service, the content provider should also consider how the map service should be provided to the user. A map service may be presented as either an *image service* or *feature service*. An image service presents the results of a map request as a Web graphic (i.e., GIF, JPG, or PNG format). A feature service presents the results of a map request as a stream of vector data that is interpreted and rendered by an intelligent client application such as ArcView 8.1 or ArcExplorer 3.1 Java Edition. Image services are appropriate for map services that may be used in both Web and GIS applications, whereas feature services would typically be used for GIS applications only. Because feature services stream vector data to a client application, the user has more access to the data being published in the service and can do more with the map service. For example, the user of a feature service could re-render a map based on a different attribute in the map service data.

With some client applications (such as ArcView 8.1), users can select and save features published through a map service (either image or feature) to store and use locally at a later time. If desired, publishers can limit the number of features that can be retrieved from the server at one time by setting a feature limit for data layers in the map service. Feature limits can be set in the ArcIMS AXL configuration file for each data layer. Feature limit settings can provide a valuable security mechanism for ArcIMS feature services because they will prevent users from requesting very large amounts of data that could adversely affect server performance.

WMS Services: If you would like to publish map services that support the Open GIS Consortium (OGC) Web Map Server (WMS) protocol and the ArcXML protocol, you can publish your ArcIMS map services using the ArcIMS WMS Servlet Connector. The ArcIMS ServletConnector fully supports the OGC WMS 1.0.0 implementation specification. By publishing your map services using the WMS Servlet Connector, you will be able to support users with WMS client applications.

3. Register Map Services at the Geography Network

Once a map service is developed and published on a map server, the publisher can "register" the map service at the Geography Network site so users can find the map service. The publisher will be asked to provide some basic information about their organization (name, location, description, Web site, and contact) to set up an organization profile for presentation to users. The publisher can then enter information about individual map services that have been published.

The map service information that is requested is intended to meet the minimum Federal Geographic Data Committee (FGDC) metadata requirements to support basic searching and evaluation by prospective users. There will be one metadata record for each map service so it may need to describe the content, coverage, and currency of several data layers (states, counties, ZIP Codes, cities, highways, streets, rivers, and landmarks) as a whole. Publishers will be able to update this information over time as map services are added, deleted, or changed. All information can be provided through a basic Web browser interface and is stored on an ESRI server.

Accessing Map Services

Once a map service is registered and reviewed by the Geography Network team, it will be made available through the Geography Network Web site. Web users can access the map service using the Geography Network Explorer application available on the site. The Geography Network Explorer is a custom Web application that is built to request map images from remote map servers. With the Explorer, users can perform basic pan and zoom operations on map services as well as generate printable versions of the maps including legends.



Click "View Map" to Display Map



Navigate Map Service

If the map service is published with ArcIMS, GIS users can access the services using software such as ArcView 8.1 or ArcExplorer 3.1 Java Edition. Each of these software packages is fully integrated with the Geography Network and can access map services through a customized version of the Geography Network Explorer. Users are only enabled to access "public" map services that are registered with the Geography Network. Publishers may restrict access to their map services, if desired, using the security tools built into ArcIMS 3.1.

Why Join the Geography Network as a Publisher?

There are many benefits to joining the Geography Network as a publisher. Besides accessing a built-in and ready-to-go infrastructure for disseminating data, whether free or for a fee, publishers will find the Geography Network gives organizations

- A better way to discover geographic data and services
- Round-the-world, round-the-clock access to maps, data, and solutions
- Presentation of content in a unique and easy-to-access way
- Tight integration with ESRI's ArcGIS and other client technology

- A framework converging Web and GIS tools to use data in new ways
- Exposure through Geography Network marketing campaigns

Government organizations will also find that the Geography Network

- Makes it easier to disseminate information inside the organization
- Makes it easier to share information with other (external) organizations
- Facilitates e-government

Commercial organizations will find that the Geography Network

- Enriches their product offering
- Exposes them to a potentially large global audience
- Gives them a new mechanism for promoting data and services to additional markets
- Provides a setting that facilitates exposure to GIS users, software developers, ASPs, and other Web communities
- Gives them a platform for building new services on top of data to provide value-added services
- Provides a sophisticated commerce system for handling time and volume subscription access to data and services
- Provides revenue generation through the Geography Network commerce system

The Geography Network Publisher Program

ESRI has developed programs for both government and commercial organizations to participate in the Geography Network. There are no fees associated with participating in the Geography Network as a publisher or contributor. The Geography Network Publisher Program is intended to support organizations that wish to share geographic data and services for free or for a fee. If you would like more information on how to participate in the Geography Network, please contact:

Kim Burns–Braidlow, Government Program Manager (kburns@esri.com)
Julie Wright, Commercial Program Manager (jwright@esri.com)

The Future of the Geography Network

Over time, the Geography Network will grow and evolve as users discover and apply the concepts of this system for their own work. To support this growth, tools have been placed in ESRI's ArcGIS software enabling users to quickly access and use services on the Geography Network. GIS users can access an enormous amount of data directly through their desktop applications and integrate it with local data. We believe that the ability to incorporate multiple data sets in ArcGIS and access them by way of the Geography Network will facilitate even greater participation and collaboration in the decision making that affects industries and communities around the world.