Web GIS Software Comparison Framework

– D R A F T –

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INTRODUCTION

The term “web GIS” refers to applications that distribute spatial data to users through a web browser. Depending on software capabilities, users can display, query, and analyze geographic data remotely through a web browser interface.

Because it is a relatively inexpensive way of disseminating spatial data and basic GIS functionality, web GIS has become widely used by both public and private organizations. A good portion of the basic functionality of desktop GIS is now available to users interacting with GIS databases via the World Wide Web or an intranet.

Benefits of web GIS include:

- Capability to distribute GIS data and functionality to a wide audience
- Users do not have to have purchase GIS software.
- Users typically do not need extensive training

Drawbacks of Web GIS include:

- Response time can be extensive, depending on a number of factors such as connection capacity, data volume, network traffic, and processor power.

Components of a typical Web GIS system include:

- Data
  - Spatial (map) data – data with a positional or geographic component, in some data file format (e.g. SHP, DWG, SDF, DGN) or stored in a spatial database (e.g. Access, Oracle Spatial, Oracle Locator, SDE)
  - Attribute data – characteristics or properties of map features, stored as textual or tabular data, typically in a relational database
- Software
  - Web GIS server application (the focus of this document)
  - server middleware - to interpret requests from clients, interact with the web GIS application, and package the data for transfer via the web
  - Web server – e.g. Apache, Internet Information Server
  - Client web browser – e.g. Internet Explorer, Mozilla
  - Client-side applet or plug-in – requirement depends on the technology
  - Web-database application software – e.g. PHP, ASP.NET, ColdFusion
- Hardware
  - Central server computer
  - Client computers
  - Connection through the Internet or, for intranet sites, through a LAN or WAN

The variety of applications for web GIS is surprisingly varied - from simple address look-ups, to searching for store locations, to interactive mapping of demographic data. Some examples:

- Display municipal infrastructure and operational information - maps of street networks, parks, utilities, polling locations, zoning districts, etc.
- Access water quality data by water sampling location
- Search for jobs and job training near users’ homes
- View maps of current forest fires with fire perimeters
- Make transportation data and maps available to staff to help in project planning
- Display world map showing value of products imported by country

Today, the number of vendors offering web GIS software is large (for example, a 2001 review in GeoData listed 32 applications. This report focuses on four of the leading packages: Autodesk MapGuide, Intergraph GeoMedia, University of Minnesota MapServer, and ESRI ArcIMS.

The criteria for evaluation included:

- Data and file formats supported
- Viewer, Authoring and Server technology
- Built-in Capabilities
- Programming and customization required
- Vertical Applications available
- Compatibility and Interoperability
- Licencing and Maintenance Costs

KEY ISSUES

A number of “usability considerations” are discussed in this section; each of which has a significant impact on how the system can or will be used.

Data Model

The nature of the data (i.e. vector or raster) that are transferred to the client is an important consideration, with advantages and disadvantages as outlined in table 1 below.

Table 1. Comparison of Data Models for data transferred to client

Criteria	Raster	Vector
Performance	Slower, due to the file size of images and dependence on server for all operations (e.g. zoom, pan, or query).	Faster data loading and operations after initial plug-in or applet loading
Format	Images transferred as GIF, JPG, PNG files	Vector data transferred as SHP, SDF, CGM and other formats
Client	“thin client” - requires a browser and no additional software	“thick client” - some processing takes place on client-side, by use of a plug-in that must be downloaded and installed
Functionality	limited of zoom, pan, selection of an area, identifying features is available	more functionality, including selection of individual features, and simple analytical processes
Response	Each request requires a server call, making interactivity slower	Some processing is performed on the client for much faster response

Client Plug-In

Closely tied to the data model used for data delivery, is the requirement for additional software to enhance the functionality of the client web browser. Although whether or not a viewer plug-in is required may seem like a trivial detail, it is actually a key consideration in the implementation of Web GIS. Whether or not a plug-in will be a benefit or detriment depends mostly on the nature of the intended audience as explained below and summarized in figure 1.

- **specialized audience** (such as municipal staff) - a plug-in provides the benefits of moving more of the processing to the client machine and reducing dependence on the central server since some operations can be handled on the client side (e.g. zoom in, selection of features). The amount of effort for the actual installation of the plug-in can also be minimized in a networked environment. Once loaded, greater functionality will be available and will be handled more quickly with a plug-in, although slightly more time may be required for the initial load when accessing the web GIS site.

Audience:	*Public* ←		→ *Specialist*	
CLIENT:	*Thin*	*Medium*	*Thick*	*GIS Client*
Client Tasks	Map Display	Map Display Map Browsing Query Input	Map Display Map Browsing Spatial Query	Map Display Map Browsing Spatial Query GIS Analysis Map Drawing
Transfer	Raster Maps	Raster/Vector	Vector Maps	Raw Data
Server Tasks	Map Browsing Spatial Query GIS Analysis Map Drawing	Query Execute GIS Analysis Map Drawing	GIS Analysis Map Drawing	File Serving
SERVER:	*Heavy*	*Medium*	*Light*	*Web Server*

- **general audiences** (such as the public) - the requirement for a plug-in is a nuisance and will often deter causal users from using the site since their dependence on the GIS is limited. The initial load is typically faster without a plug-in, but subsequent operations are usually slower.

Many web GIS applications offer both thick and thin client options. Some applications can make use of a mixed model – with some data transferred as rendered imagery (e.g. background map) and some data (e.g. vehicles in a linear network) transferred as vector data.

Cartographic Aids

The limited view area and resolution of most computer monitors, especially in relation to large format paper maps, reduce the effectiveness of the communication. A couple of simple GIS features help to alleviate this limitation.

Map Tips

The quality (and therefore the readability) of annotation suffers primarily because of the limited resolution available for map display on a computer monitor. Map tips, which function like tool tips to provide additional information when the screen pointer hovers over an object, can be used to display attributes of map features dynamically, thus minimizing the amount of required text and aiding readability.

Reference Map

GIS users must typically strike a compromise between detail and coverage, i.e. a “zoomed-in” view showing lots of detail with limited coverage or a “zoomed-out” view showing greater coverage and limited detail. A reference map can be used to helps overcome this limitation by displaying current view extents in relation to the overall coverage, and in some cases, allowing the user to control the view extents by manipulating their representation on the reference map.

Table 2: Software Comparison

Criteria	Autodesk MapGuide	Intergraph GeoMedia WebMap	UMN / Open Source MapServer	ESRI ArcIMS
1.0 PRODUCT OVERVIEW	**This section provides a little background on the web GIS software application and its developer, and includes a few application highlights.**			
1.1 Background	Autodesk, the leading computer-aided design (CAD) software company entered the GIS market in the mid 1990s, recognizing that a huge number of digital maps had been created using its proprietary DWG format with Autodesk Map 2.0, built on a foundation of AutoCAD release 14. Concurrently, Autodesk acquired web GIS technology from Argus in Calgary, Alberta, where the worldwide development center remains today. MapGuide was integrated early in their GIS software development.	Intergraph has been in business for about 35 years and was initially well known internationally for their line of interactive computer graphics hardware and software. Among other things, they are now a leading GIS software manufacturer that recently introduced the latest version of its GeoMedia WebMap product, version 6.0.	Originally developed at the University of Minnesota (UMN) through the NASA-sponsored ForNet project, a cooperative effort with the Minnesota Department of Natural Resources. Continued support has been provided through the NASA TerraSIP project, involving UMN and a consortium of land management interests. MapServer is an Open Source development environment for constructing spatially enabled Internet-web applications. The software is enhanced and maintained by an increasing number of developers (nearing 20) from around the world and is supported by a diverse group of organizations. One of the major developers is DM Solutions in Ottawa, with several projects funded to some degree through federal government initiatives.	ESRI is a privately-held company that has been in business for over 30 years. It sells a full line of GIS products, under its ArcGIS banner. Some of the capabilities of ArcIMS are image rendering, feature streaming, data extraction, geocoding, and spatial and attribute queries. A wide variety of clients can receive map information from a Web server using ArcIMS. The client can be: (1) a wireless device such as a cellular phone or a personal digital assistant (PDA), (2) a lightweight browser-based client, or (3) a full-featured GIS desktop computer.
1.2 Highlights	▪ Free viewer plug-in for end users ▪ Supports many formats without data conversion ▪ Can use compact SDF (spatial data file) to deliver data and mapping to the end user, which allows for faster delivery than most other formats ▪ Enables users of mobile and handheld devices (using Win CE) to access interactive maps and other data. ▪ Share spatial data using the Open GIS Consortium (OGC) Web Map Service (WMS) 1.1.1 Implementation Specification for data exchange.	▪ Uses the same objects as the core GeoMedia products (GeoMedia and GeoMedia Pro) thus providing a consistent development environment amongst all products. ▪ Spatial analysis tools are available on web clients. ▪ Supports many input data formats without conversion ▪ Supports both Raster and Vector output ▪ Raster output available in JPG, PNG, or GIF format, and requires no additional client software. ▪ Vector data can be served in two formats: o CGM (computer graphics metafile) - for viewing in either the ACGM or Java Applet viewers o SVG (scalable vector graphics) - for viewing in SVG viewers, SVG is a W3C recommendation as an open source vector graphics format ▪ Advanced features available in WebMap Professional include writing to the database from remote locations, analyzing data with dynamic segmentation and performing real-time GIS analysis. ▪ Selected individuals can be given permissions to create and store information on the database from their remote location. ▪ Highly scalable architecture ▪ Wizard-driven web application generation and maintenance allows the creation of web site without the need for programming, using a menu-driven interface to configure the web design. Users can also create customized tools. ▪ Reporting functions through a variety of spatial and attribute selections, measuring tools and advanced printing to scale with user-definable legends are also available. ▪ Redlining capabilities out of the box	▪ Builds on other popular Open Source or freeware systems including Shapelib, FreeType, Proj.4, GDAL/OGR. ▪ Free alternative. ▪ Good when need for highly customized applications with unique requirements ▪ Good for distributed data environments ▪ Built with proven open source technologies ▪ Provides a rich environment for developing applications that integrate disparate data. ▪ Provides a scripting interface for MapServer for the construction of Web and stand-alone applications. ▪ Loadable module that adds MapServer capability to your favorite scripting language. MapScript currently exists in PHP, Perl, Python, Ruby, Tcl, Java, and C# flavours.	▪ Integrate data from multiple sources (Internet or local) and serve it on the Web. ▪ Make your maps, data, and metadata accessible using a variety of clients (mobile, desktop, browser). ▪ Highly scalable server architecture. ▪ Can serve data in two different formats, raster and vector ▪ Raster distributed in JPG, PNG, or GIF format which requires no additional client software ▪ Vector: delivery requires a Java plug-in on the client side, which is downloaded and installed automatically ▪ Vector streaming technology provided through the use of ArcXML

Criteria	Autodesk MapGuide	Intergraph GeoMedia WebMap	UMN / Open Source MapServer	ESRI ArcIMS
2.0 DATA	**This section discusses the capability of each Web GIS application to work with various data formats for both input (data sources) and output (publishing and delivery). Refer to the discussion of Data Models above if necessary to better understand the issues related to working with vector and/or raster data.**			
2.1 Formats - Source	▪ MapGuide imports a number of industry-standard spatial databases, GIS file formats and CAD formats without data conversion, including ESRI shapefiles, AutoCAD 2000 and 2002 DWG, Oracle Spatial ▪ Point and annotation data in any OLE DB source can also be used (but not for line and polygon features). ▪ Integrates ECW, MrSID, and other georeferenced raster files, as well as non-georeferenced raster files such as TIFF, GIF, PNG, and JPEG. ▪ A wide variety of spatial data and file formats can be converted to SDF (Spatial Data Format) including ESRI coverages, Intergraph DGN, MapInfo Interchange, and CSV files can be converted for use in MapGuide. ▪ MapGuide Server supports simultaneous connections to multiple database servers, allowing access to a variety of data sources in different locations. MapGuide Server can connect directly with any ODBC-compliant database, including Oracle Spatial, without requirements for additional software such are ArcSDE.	▪ Web Map use on-the-fly projection and transformation to enable analysis from different data sources, including Oracle, Microsoft SQL Server, Microsoft Access, IBM DB2, ArcInfo, ArcView, MicroStation, MapInfo, AutoCAD, MGE and FRAMME.	▪ MapServer can utilize many data source types. ▪ The default format is the ESRI shapefile. ▪ TIFF/GeoTIFF, EPPL7, and many others via GDAL ▪ ESRI Shapefiles (standard format), PostGIS, ESRI ArcSDE, Oracle Spatial, MySQL and many others via OGR ▪ OGR is a C++ open source library (and command line tools) providing read (and sometimes write) access to a variety of vector file formats including ESRI Shapefiles, MapInfo mid/mif and TAB formats. ▪ OGR allows MapServer users to display several types of vector data files in their native formats. For example, MapInfo MID/MIF and TAB data do not need to be converted to ESRI Shapefiles when using OGR support with MapServer. ▪ Can be compiled to support spatially enabled databases such as PostgreSQL-PostGIS, Geography Markup Language (GML), MapInfo, delimited text files, and more formats ▪ MicroStation DGN pre-v8 via OGR (with entire file is represented as one layer named "elements"). ▪ Map projection support. On-the-fly map projection with thousands of projections through the Proj.4 library	▪ ArcIMS supports a variety of data sources: geodatabases, shapefiles, coverages, GRID data, CAD drawing files, ArcSDE layers, and images. ▪ Supports all data types supported by ArcGIS including geodatabases, coverage annotation, network data (dynamic segmentation), versioned layers in ArcSDE, and CAD drawing files (DGN, DWG, and DXF). ▪ Relies on middleware to convert multiple types of data and these extra procedures of converting data formats may reduce the performance of web mapping. ▪ ArcMap Server is included to provide an image service for any of the many formats that ArcGIS can read, more cartographic presentation flexibility
2.2 Formats - Output	▪	WebMap has three data delivery formats: SVG, CGM and Raster: ▪ Raster distributed in JPG, PNG, or GIF format which requires no additional client software. ▪ Vector distributed in ActiveCGM (computer graphics metafile) format. Which requires ActiveCGM plug-in on the client-side ▪ vector output can also be in SVG format	▪ Open GIS Consortium (OGC) web specifications ▪ WMS (client/server), non-transactional WFS (client/server), WMC, and WCS	▪
2.3 Preparation and Preprocessing	▪ GIS file formats and CAD formats without data conversion, including ESRI shapefiles, AutoCAD 2000 and 2002 DWG, Oracle Spatial, Microsoft Access and SQL Server, dBASE as well as data in any OLE DB source. ▪ Though a SDF (Spatial Data Format) loader, ESRI coverages, Intergraph DGN, MapInfo Interchange, and CSV files can be converted for use in MapGuide. ▪ Also imports ECW, MrSID, and other georeferenced raster files, as well as non-georeferenced raster files such as TIFF, GIF, PNG, and JPEG.	▪ Conversion not needed since WebMap reads Oracle, Microsoft SQL Server, Microsoft Access, IBM DB2, ESRI file formats, MicroStation, MapInfo, AutoCAD, MGE and FRAMME, ODBC-compliant, OGC GML, OGC WFS ▪ Bitmap, JPEG, TIFF, GeoTIFF, MrSID, ECW, USGS DOQ, CCITTG4	▪	▪
2.4 Attribute Database Interface	▪ PHP, ASP.NET	▪ ASP and ASP.NET	▪ PHP, Perl, Python	▪ Supports major database vendors: Oracle, Autodesk CAD format, TIGER files and SQL.
2.5 Metadata	▪ Map Window File (MWF), can be saved in XML format (MWX)	▪ Using provided templates, developers can create and edit map definition files (MDFs) through the Administrator Module to serve many different end-user needs	▪ Map File - a structured text configuration file for your MapServer application. It defines the area of your map, tells the MapServer program where your data is and where to output images. It also defines your map layers, including their data source, projections, and symbology. It usually as a .map extension. ▪	▪ Metadata service and explorer are included ▪ ArcCatalog can be used to generate metadata and publish in AXL (Arc XML), OGC CSW (Catalog Service Web 2.0), and in older standards (Z39.50, OAI, Open Archives Initiative)

Criteria	Autodesk MapGuide	Intergraph GeoMedia WebMap	UMN / Open Source MapServer	ESRI ArcIMS
3.0 TECHNOLOGY				
3.1 Components	▪ MapGuide Viewer (freely available for download by any user), MapGuide Author, and Map Guide Server. ▪ MapGuide Author o Integrates GIS and CAD data and helps design intelligent maps, while also determining the amount of access and level of interactivity to end users. o Authoring environment includes: o Thematic map settings and symbology o Attribute display by scale o Complete layer setup and definition o Automatic labeling by scale o Customizable popup menu o Print preview ▪ MapGuide Viewers o freely available for download o 1-3 MB in size for full (vector) functionality o Plug-in for Netscape, ActiveX Control for Microsoft Internet Explorer, or Java Viewer for Sun and Macintosh OS's. o MapGuide LiteView available for cross-platform viewer with limited functionality. o Runs as a Java servlet and converts map output into PNGs. ▪ MapGuide Server o Microsoft® Windows® 2003 Server, Windows 2000 Server (SP4), or Windows NT® 4.0 (SP6a) With the following: o Microsoft Internet Information Server 4, 5, or 6 (IIS 6 with Windows 2003 Server only) or SunSM ONE Web Server 6.1 o Allows for scalable, fault-tolerant, 32-bit, multithreaded architecture. o MapGuide server uses a GUI-based administrator that configures start/stop service, log file generation, and resource security which is easy to learn and use to quickly get up and running. o Handles simultaneous connections to multiple database servers and is scalable to take advantage of multiprocessor architectures. o No additional middleware required to connect to any ODBC database, including Oracle	▪ There are three main components of the GeoMedia WebMap product: GeoMedia WebMap, WebMap Professional, and WebMap Publisher. **1. WebMap server application** ▪ In WebMap 6.0, there are a number of web services that come out-of-the-box (ie. generate map, etc…). These can be set up using a GUI interface similar to that for setting up websites with Publisher. ▪ WebMap server handles requests by a mapping web application to produce map output. The capabilities of the WebMap server are extremely scalable (number of map servers) **2. LocationServer** ▪ IntelliWhere® LocationServer is a Web Services platform that delivers and receives location-based information. It accepts Web Service requests from any application, and using a powerful array of geospatial and data management functions, processes these requests and delivers location-based results back to the calling application in the format requested ▪ Web services include address geocoding, reverse address geocoding, coordinate location, feature query location, MPS (mobile positioning system) location, route generation (based on either driving distance or map distance) in WebMap Professional ▪ LocationServer can be used for routing and on the fly publishing of data for mobile devices ▪ LocationServer uses the WebMap server to generate routing information (i.e. shortest distance between two points) **3. GeoMedia Web Publisher** ▪ Publisher is used to produce and maintain maps through a GUI interface. It consists of two parts: (1) Publisher Administrator for defining map setup (and more) and (2) Publisher web application that presents this setup as a web site ▪ The Administrator is a custom function that runs in GeoMedia (or GeoMedia Professional) and exports the contents of a GeoWorkspace, including connections and map windows, from GeoMedia to the Publisher database. This database is then read and interpreted by the web application, which presents the maps (and other data) accordingly. Because the database contains data describing the geographical data, it is referred to as the meta database.	▪ MapServer is a CGI program that sits inactive on your Web server. When a request is sent, it uses information passed in the request URL or a HTML form and in the Map File to create an image of the requested data. ▪ Includes MapScript that allows popular scripting languages such as PHP, Perl, Python, and Java to access the MapServer C API. ▪ MapScript: developed (using SWIG) and maintained by DM Solutions Group in Ottawa, Ontario. ▪ If your data have a spatial component, and you can get to the data via your favorite scripting environment, then you can map it with MapScript. For example, using Perl's DBI module it is possible to integrate data from just about any database vendor (e.g. Oracle, Sybase, MySQL) with traditional GIS data in a single map graphic or web page. ▪ MapServer CGI - The binary or executable file that receives requests and returns images, data, etc. It sits in the cgi-bin or scripts directory of the http server. The Web server user must have execute rights for the directory that it sits in, and for security reasons, it should not be in the web root. ▪ HTTP Server - serves up the html pages when hit by the user's browser. You need a working HTTP (Web) server, such as Apache or Microsoft Internet Information Server, on the machine on which you are installing MapServer. ▪ A simple MapServer application consists of: o HTML Pages - the interface between the user and MapServer. They normally sit in Web root. In its simplest form, MapServer can be called to place a static map image on a html page. To make the map interactive, the image is placed in an html form on a page. o CGI programs are 'stateless', every request they get is new and they don't remember anything about the last time that they were hit by your application. For this reason, every time your application sends a request to MapServer, it needs to pass context information (what layers are on, where you are on the map, application mode, etc.) in hidden form variables or URL parameters. ▪ A simple application may include two html pages: o Initialization File - uses a form with hidden variables to send an initial query to the http server and MapServer. This form could be placed on another page or be replaced by passing the initialization information as variables in a URL.	▪ Creating a Web site with ArcIMS can be accomplished in two ways: o (1) The simplest method is to use a part of the program called ArcIMS Manager. This is a wizard-driven application for authoring and publishing maps on the Web, and no programming is required. o (2) For more customization and flexibility, map creation and publishing in ArcIMS can be developed in three stages, each with its own specialized applications: ▸ Stage A: create a "map configuration file" with ArcIMS Author in ArcXML format or with ArcMap. Author renders polygons, lines, and points. It also specifies symbols to be used on the map and sets up capabilities such as querying and geocoding. ▸ Stage B: create a map service in ArcIMS Administrator. Information can be sent to clients in one of two modes: (a) HTML view would be used if you need viewing and querying only. Clients are sent image files in GIF or JPEG format. (b) To use Java view, a Java plug-in is required, but this allows user interaction, analysis, and vector features. ▸ Stage C: design a Web site using Designer and specify the interface components and layout. ▪ ESRI ArcIMS (Internet Map Server) works in Java environment with server and a client based GIS components for processing queries. ▪ ArcIMS is a multi-tier architecture consisting of the presentation, business logic and data storage tiers, in addition to a set of applications for management. ▪ The framework also requires the Web server, JavaVM, and the servlet engine. ▪ ArcIMS Viewers - HTML and Java enabled web browsers or through ArcGIS Desktop. ▪ ArcIMS Application Server - tracks the requests for information and distributes them to the appropriate spatial server. ▪ ArcIMS Application Server Connectors - needed to either pass the ArcXML straight through or translate third party syntax such as ColdFusion, Active Server Pages (ASP), .NET, or JavaServer™ Pages (JSP) prior to forwarding the ArcXML request to the Application Server (i.e. requires "middleware" XML translators). ▪ ArcIMS Spatial Server - processes requests for maps and attribute information. Provides functional capabilities for accessing and bundling maps and data into the appropriate format before sending the data back to a client. ▪ ArcIMS Manager - wizard-driven application for authoring and publishing maps on the Web, no programming is required.Combines all the components of ArcIMS into one user interface. ▪

Criteria	Autodesk MapGuide	Intergraph GeoMedia WebMap	UMN / Open Source MapServer	ESRI ArcIMS
3.2 Plug-in Requirement	▪ To provide a full range of display and processing features, users must download and install a plug-in. ▪ However, due to competitive pressures from ESRI and other web GIS vendors that offered a raster-based non plug-in version, MapGuide recently released a cross-platform viewer with limited functionality, MapGuide LiteView. LiteView runs as a Java servlet and converts Autodesk MapGuide output into PNG images. ▪ The downloaded plug-in viewer provides live vector data combined with raster data and much greater functionality, including multiple modes of selection, buffering, queries, access to layers, control over print output, and redlining. However, a few additional functions such as buffering and measuring can be added to the LiteView with customization, making it equivalent in features to ArcIMS HTML view. ▪ An Autodesk MapGuide LiteView application and an application developed for the Autodesk MapGuide ActiveX Control can both point to the same MapGuide MWF file, making it possible to deliver maps to all client viewers without creating different versions of the same data.	▪ Requires Industry standard ActiveCGM (Computer Graphics Metafile) plug-in on the client-side. ▪ Plug-in must be installed by the user unless using the java applet viewer ▪ To view data in the CGM format, the user either needs to install the ACGM active X control or just use the JMapView Java applet viewer ▪ To view data in SVG format, the user needs to have SVG viewing capability. SVG is a W3C recommended vector data format. As such, there are multiple possible viewers to meet end user needs. Currenlty, Adobe has an excellent viewer and Corel has another viewer, both are freely available).	▪ No plug-in required ▪ May need Flash or PDF viewing capability on the client, if viewing output in those formats	▪
3.3 Hardware Requirements	▪	▪	▪	▪ 256 MB of RAM is required for the Web server, and 827 MB of disk space is used for complete installation
4.0 FUNCTIONALITY	**This section begins by addressing the capabilities that are built into the base software application and additional functionality that are available in vertical (add-on) applications. It then moves into Customization and discusses development environments. Note: please refer to the tables at the end of this document which lists the specific "out-of-the-box" tools available with each of the Web GIS applications.**			
4.1 Built-in Capabilities	▪ There is no built in data editing; a toolkit is needed. ▪ Two powerful development tools: the Dynamic Authoring Toolkit and the SDF COM Toolkit. ▪ No redlining functionality out of the box. ▪ The developer must be familiar with HTML web design. ▪ No easy setup wizard for beginning users.	▪ GeoMedia technology provides a visual authoring tool that makes generating a Web Service as easy as setting up a Web site in GeoMedia WebMap – no programming required. ▪ Wizard driven web application generation and maintenance ▪ Redlining capabilities out of the box	▪ Quadtree spatial indexing for shapefiles. ▪ Fully customizable, template driven output. ▪ Feature selection by item/value, point, area or another feature. ▪ TrueType font support. ▪ Support for tiled raster and vector data. ▪ Map element automation (scalebar, reference map, and legend). ▪ Scale dependent feature drawing and application execution. ▪ Thematic map building using logical or regular expression based classes. ▪ Feature labeling including label collision mediation. ▪ On-the-fly configuration via URLs. ▪ On-the-fly projection. ▪ Flexible "out of the box", but has a correspondingly steep learning curve.	▪ Out-of-the box direct data editing. ▪ Wizards and templates guide you through tasks for authoring and publishing maps. ▪ Comes with ArcManager which consists of: ▪ Author - used to create a "map configuration file" in ArcXML format. ▪ Administrator - creates a "map service". ▪ Information sent to clients in one of two modes: o HTML view - viewing and querying only. Clients are sent image files in GIF or JPEG format. o Java view - a Java plug-in is required, but this allows user interaction, analysis, and vector features. ▪ Designer - used to specify what is actually displayed in the map.
4.2 Vertical Applications	▪	▪ The WebMap Professional program adds some features not available on the standard WebMap application. The introduction of network objects in this application allow for route analysis, proximity analysis, area allocation, analyzing data with dynamic segmentation and writing to the database from remote locations. o Route analysis helps with the determination of the best routes to follow to increase efficiency. o Proximity analysis helps people locate businesses within a certain distance from their current	▪	▪ Vertical applications available in ArcIMS are the ArcIMS Route Server and secure access to map services through HTTPS.

Criteria	Autodesk MapGuide	Intergraph GeoMedia WebMap	UMN / Open Source MapServer	ESRI ArcIMS
		location. o Site selection helps the user determine number of items matching prescribed criteria in a certain area. o Dynamic Segmentation is for analyzing tabular data referenced to linear features on a map for applications such as type of pavement and daily traffic statistics. ▪ LocationServer is a vertical application for WebMap that provides routing capabilities (as well as map publishing capabilities for mobile devices) ▪ GeoMedia WebMap Professional also provides the dynamic segmentation function.		
4.3 Supported Development Environments	▪ Develop map-based applications using standard technologies such as HTML, XML, JavaScript, and COM. ▪ Author and save your applications in either Map Window File (MWF) or Map Window XML (MWX) format ▪ Dynamic Authoring Toolkit is implemented as a COM object and can be used in any development environment that supports COM automation. ▪ The SDF Component Toolkit is a set of COM interfaces for reading and writing the SDF format used with Autodesk MapGuide software. You can access SDF Component Toolkit objects in COM-aware development environments such as Microsoft® Visual Basic®, Macromedia® ColdFusion®, ASP, and C++. ▪ Core components work together with utilities and toolkits such as Symbol Manager, Dynamic Authoring Toolkit, Raster Workshop, SDF Loader, and more for a comprehensive client/server development and interactive access environment. ▪ However, Autodesk MapGuide provides two powerful development tools: the Dynamic Authoring Toolkit and the SDF COM Toolkit. The Dynamic Authoring Toolkit provides access to all the properties of the MWF file.	▪ GeoMedia's extensive object model is accessible for customization through familiar industry-standard programming languages such as PowerBuilder, Delphi, and any of the Microsoft® Visual Studio languages including .NET.	▪ PHP, Python, Perl, Ruby, Java, and C# ▪ One can use DHTML, Java, and Flash on the client side to improve the interface ▪ Template File - controls how the maps and legends output by MapServer will appear in the browser. By referencing MapServer CGI variables in the template html, you allow MapServer to populate them with values related to the current state of your application (e.g. map image name, reference image name, map extent, etc.) as it creates the html page for the browser to read. The template also determines how the user can interact with the MapServer application (browse, zoom, pan, query).	▪ Web application development framework for .NET(windows platform only), ASP, and Java ISP. ▪ Customization is in VB, ASP, C++, etc. ▪ ArcIMS Data Delivery extension enables users to easily select, export, and deliver vector data in a variety of formats and projections from a centralized Internet map server: o Simple client interface—Just add a button to the ArcIMS toolbar. o Interface is fully customizable HTML and JavaScript code. ▪ The JavaVM, which provides the basic application programming interface (API) for customizing these applications. ▪ A servlet engine is an extension to the JavaVM and provides support for servlets through a servlet API.
4.4 Ease	▪ Requires development skills to implement anything but the most basic application.	▪ Development objects for the desktop are the same objects used for the Web. This means that developers have to learn only one set of objects for desktop and Web applications. ▪ Open architecture maximizes configuration flexibility – both out of the box and in custom applications. ▪ Typical installation of WebMap Publisher: ▪ The definition of the GeoMedia WebMap Publisher site is held within an MS Access or Oracle database,, and is usually stored on the GeoMedia WebMap or GeoMedia WebMap Professional server ▪ In version 6.0, the Publisher metadatabase can also be stored in SQL Server.	▪ Needs strong in-house skills or access to skilled consultants. ▪ Need to be able to create or at least modify HTML pages and understand how HTML forms work. Since the primary purpose of a MapServer application is to create maps, you will also need to understand the basics of geographic data and likely, map projections. As your applications get more complex, skills in SQL, DHTML/JavaScript, Java, databases, and scripting may be very useful. ▪ MapServer interface is customizable in HTML	▪ ArcXML also offers an easy way to customize ArcIMS applications. ▪ Requires development skills to implement anything but the most basic application ▪ Standard template and functionality provided will likely not meet the needs of an organization. ▪ A developer must be available to customize the reports, interface, and functionality ▪ Application development and customization of ArcIMS is done through ArcXML or by translating from another language to ArcXML ▪ Although different connectors allows for a diverse customization environment, each connector has different restrictions on what the developer can do

Criteria	Autodesk MapGuide	Intergraph GeoMedia WebMap	UMN / Open Source MapServer	ESRI ArcIMS
5.0 COMPATIBILITY	**This section discusses support for Web Map Services and Web Feature Services, as specified by the Open Geospatial Consortium (OGC).**			
5.1 Open GIS support	▪	▪ All of the WebMap applications are consistent with the Open GIS Consortium, meaning that the applications are interchangeable with one another. The applications allow users to access data in its native format and perform queries on live data. Unlike some other GIS software vendors, the Intergraph applications do not use proprietary software languages. ▪ Vector data can actually be supplied as SVG, which is a W3C recommendation as an open source vector graphics format ▪ Supports WMS and WFS ▪ To maximize flexibility in building and using Web applications within a broader set of business and IT environments, Intergraph has added interoperability standards – Simple Object Access Protocol (SOAP) / Web Service Definition Language (WSDL) interfaces – to its existing OGC-compliant Web Services.	▪ Cross-platform support ▪ Linux, Windows, Mac OS X, Solaris, and more ▪ Need a working and properly configured HTTP (Web) server, such as Apache or Microsoft Internet Information Server, on the machine on which you are installing MapServer	▪ Web Map Services and Web Feature Services connectors are included and adhere to Open Geospatial Consortium, Inc. (OGC) specifications. ▪ In addition, AXL image and feature services are also available
6.0 COSTS	**This section provides Public Sector prices for acquiring and using the software and for maintaining a support agreement with the vendor. Of course, the ultimate cost is relative to resources (person/hours for setup) and usefulness (functionality/benefit of the final product).**			
6.1 LICENCING	▪ There are two pricing models for AutoDesk MapGuide: private sector and government. The price includes all components. Unless the web GIS implementation is restricted to a small number of internal users, it is less expensive to purchase by processor than by named “seats:” Here are sample prices (2003): o 10 named seats – Public $4,600 Private $9,320 o unlimited internal seats plus unlimited internet: ▪ 1 processor – Public $8,625, Private N/A ▪ 2 processors - Public $16,500, Private $30,000	▪ Intergraph’s GeoMedia WebMap o $10,000 for two concurrent transactions over unlimited CPUs o Includes 2 GeoMedia WebMap Licenses – one for production and one for development o Includes a copy of GeoMedia for authoring purposes. ▪ Intergraph’s GeoMedia Web Professional o $24,000 for two concurrent transactions over unlimited CPUs o Includes 2 GeoMedia WebMap Licenses – one for production and one for development o Includes a copy of GeoMedia for authoring purposes.	▪ Free to use. Cost is in terms of development time and resources, etc. ▪ “Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions: ▪ The above copyright notice and this permission notice shall be included in all copies of this Software or works derived from this Software.”	▪ $7,500 for the first CPU and $5,000 for each additional CPU. (2003, USD) ▪ 1st Year Maintenance Fee Included ▪ Annual Maintenance Subscription Available
6.2 MAINTENANCE	$5,519 per annum per licence (i.e. licenses for internal and external users and require separate maintenance agreements)	$2,892 per annum (covers both internal and external users)	▪	▪
7.0 SUMMARY				
7.1 Strengths	▪	▪ More flexible from a data usage standpoint, therefore, if multiple data types will be utilized, WebMap is a reasonable choice ▪ has the advantage of not having a native data type – reducing conversion costs. ▪ GeoMedia WebMap Publisher provides web application generation and maintenance without the need for programming	▪	▪
7.2 Weaknesses	▪ Downloading and installing a plug-in may be a problem for networked users that do not have administrative rights on their computer. ▪ 3 MB size can be an issue for dial-up users ▪ The ActiveX Plug-in for Internet Explorer is over	▪ CGM plug-in is a major component of WebMap, however, Intergraph does not own it ▪ CGM plug-in must be downloaded and installed on client machine ▪ Plug-in is limited to a Windows OS platform and	▪	▪ Inability to use non-ESRI data sources without conversion without ArcServer ▪ For system requirements and platforms see: http://support.esri.com/index.cfm?fa=knowledgebase.systemRequirements.matrix&pName=ArcIMS&Prod

Criteria	Autodesk MapGuide	Intergraph GeoMedia WebMap	UMN / Open Source MapServer	ESRI ArcIMS
	3MB, and thus an inconvenience for dial-up users. Plus downloading and installing a plug-in may be a problem for networked users that do not have administrative rights on their computer or are less experienced computer users ▪ Downloaded plug-in viewers handle live vector data combined with raster data and much greater functionality, including multiple modes of selection, buffering, queries, access to layers, control over print output, and measuring. ▪ Based on preliminary reports from a reseller and a reputable consultant, the newest version of MapGuide (version 7.0?) will not be compatible with older versions of ColdFusion. Apparently, ASP.NET and PHP are the preferred web-database development environments, with compatibility possible through a special functionality of the latest ColdFusion environment.	must use Internet Explorer or Netscape. ▪ However, the Java applet viewer allows the user to view the CGM data using a viewer owned, developed, and maintained by Intergraph. The Java Applet viewer is not platform dependent and doesn't have to be pre-installed by the user.		uctID=16&pvName=9.0&PID=16&versionID=38&PVID=150
7.3 Published Opinions	▪	▪	▪	▪ Federal Computer Week (April 15, 2002): "ArcIMS is complex and takes time to employ, but it is also more flexible and powerful than the other solutions we tested" and is " . . . much easier to use than other enterprise-level solutions, including Intergraph Corp.'s GeoMedia."

FUNCTIONAL COMPARISON

Based on the tools that area available “out-of-the-box” (i.e. without programming), organized around the Viewer (with or without a plug-in), Author, and Server components. See notes below the table for a brief description of each tool.

Table 3.1: Viewer Built-in Tools – with Plug-in or Applet

Viewer Functionality (with plug-in)	**MapGuide**	**GeoMedia**	**MapServer**	**ArcIMS**
Download required	Y	Y		Y
Support for Netscape	Y	Y		HVO
Navigation				
Zoom In, Zoom Out	Y	Y		Y
Zoom Area	Y	Y		
Pan	Y	Y		Y
Pan One Direction				Y
Zoom Full Extents	Y	Y		Y
Zoom Layer Extents		Y		Y
Zoom Width	Y	Y		Y
Zoom Scale	Y	Y		Y
Zoom X,Y		Y		
Zoom Selected	Y	Y		Y
Zoom Previous	Y	Y		Y
Zoom Next				JVO
Bookmarks	Y	Y		
Overview Map - reference		Y		
Overview Map - control		Y		
Data				
Add Local Layer				Y
Add Remote Layer		Y		Y
Refresh		Y		
Reload		Y		
Stop/Interrupt	Y	Y		Y
Selection				
Select by Point		Y		
Select by Line		Y		
Select by Rectangle		Y		
Select by Polygon	Y	Y		Y
Select by Radius/Circle	Y	Y		
Select by Feature	Y	Y		Y
Select by Properties	Y	Y		Y
Select Nearest		Y		
Select Multiple on Various Layers	Y	Y		
Clear Selection		Y		Y
Set Selection Mode	Y	Y		
Measuring				
Measure Distance	Y	Y		Y
Measure Rectangle		Y		
Measure Area		Y		
Bearing & Distance		Y		
Coordinate Display	Y	Y		
Set Measure Units	Y	Y		
Set Display Units	Y	Y		Y
Buffering				
Create Buffer	Y	Y		Y
Buffer Layer	Y	Y		
Select Within Buffer	Y	Y		Y
Querying				
View Attributes	Y	Y		Y
Find Address	Y	Y		Y
Find Feature	Y	Y		Y
Locate Feature by Query		Y		Y
Create Custom Query		Y		
Presentation				
MapTips	Y	Y		JVO
Layer Resymbolize		Y		Y
Redlining		Y		JVO
Copy Map Image	Y	Y		Y
Save Map Image		Y		Y
Print	Y	Y		Y
Miscellaneous				
Save Settings		Y		Y
Load Settings		Y		Y
Set Preferences	Y	Y		
Help	Y	Y		Y

Codes:
- Y = available as a built-in tool
- (Y) = function available but must be incorporated in code or using free templates provided elsewhere (e.g. Chameleon from DM Solutions)
- HVO = Tool available on HTML Viewer only (other tools available in both Java and HTML Viewers)
- JVO = Tool available on Java Viewer only (other tools available in both Java and HTML Viewers)

Tool Definitions: generic names have been given to each of the tools in the table above, the actual tool name in the respective software is often different from the one listed, but the functionality of each tool is more or less the same, and is listed below:

Navigation
- Zoom In - Zooms in to a specified center point by a magnification factor of two.
- Zoom Out - Zooms out by a magnification factor of two and centers the view at the specified point.
- Zoom Area - Zooms in to a specified rectangular area of the map.
- Pan - Moves the map around map window to display areas that are outside of the current view without changing magnification by dragging or by specifying a new center point for the view.
- Pan One Direction - Pans the map in one direction—north, south, east, or west.
- Zoom Full Extents - Redraws so the full extents of the map are displayed in the current window.
- Zoom Layer Extents - Redraws the map so that the full extents of the active layer are displayed.
- Zoom Width - Zooms to a specified width on the center of the current view.
- Zoom Scale - Zooms in or out to a specified scale, retaining the current center of the map.
- Zoom X,Y - Zooms to a point for which the coordinates are specified by the user.
- Zoom Selected - Zooms to an area just large enough to enclose the selected map features.
- Zoom Previous - Returns to the previous zoom magnification and location.
- Zoom Next – Goes back to the original view after the Zoom Previous tool was invoked.
- Bookmarks - Add a bookmark to save the current view magnification and extents (so the user can quickly access this same view again); also select a bookmark, or delete an existing bookmark.
- Overview Map, reference – an overview map depicts the current extents of the view
- Overview Map, control – the current extents of the view can be manipulated using the overview map

Data
- Add Local Layer – add a new layer to the map from the local machine or network.
- Add Remote Layer – add a new layer to the map from a remote source over the Internet.
- Refresh – redraw current map view
- Reload – redraw default map, initial view
- Stop/Interrupt – cancel the current data load or drawing operation.

Selection
- Select by Point - select map features identified with a click
- Select by Line - select map features that overlap a line drawn by the user
- Select by Rectangle - select map features within (or touching) a rectangle drawn by the user
- Select by Polygon - select map features within (or touching) a polygon drawn by the user
- Select by Radius/Circle - select map features within (or touching) a circle drawn by the user
- Select by Feature - select map features within (or touching) a feature identified by the user
- Select by Properties - select map features based on their display properties
- Select Nearest - select map feature closest to a specified point
- Select Multiple on Various Layers - select map features on different layers at the same time
- Clear Selection – deselect all currently selected features
- Set Selection Mode – specify criteria for selecting features within a buffer (e.g. Centroid or Intersection)

Measuring
- Measure Distance – measure polyline (segments and total distance) drawn by the user
- Measure Rectangle – measure area of a rectangle drawn by the user
- Measure Area – measure polygon drawn by the user
- Bearing & Distance – measure distance and angle of a polyline drawn by the user
- Coordinate Display – display X,Y coordinates of a specified point or points
- Set Measure Units – specify units for displaying results of the measure tools
- Set Display Units – specify units for displaying screen cursor position (e.g. Lat/Long or Projected)

Buffering
- Create Buffer – generate a buffer zone around a feature or features
- Buffer Layer – save buffer zone as a new layer
- Select Within Buffer – select features within the buffer zone

Querying
- View Attributes – display attribute data (from database) for a selected feature.
- Find Address - Zooms to a location based on street address matching.
- Find Feature - Zooms to a feature with a database attribute value matching a user-specified value.
- Locate Feature by Query - Zooms to a feature with a database attributes matching a predefined query.
- Create Custom Query - builds database query to find features matching user-specified criteria.

Presentation
- MapTips - displays certain attributes of a feature when the screen cursor hovers over it.
- Layer Resymbolize - change the way a layer is displayed.
- Redlining - annotate the map with text and graphics for display or to submit revisions
- Copy Map Image - copy the current map view to the Clipboard (as an image or EMF).
- Save Map Image - save the current map extent as an image file on the user's computer.
- Print - Prints the current map view with various options to a connected printer.

Miscellaneous
- Save Settings - Saves the project to the user's computer.
- Load Settings - Opens an existing configuration file.
- Set Preferences – set various options related to the use of the viewer.
- Help - open the Help window to get information about working with the viewer.

Table 3.2: Viewer Built-in Tools – without Plug-in or Applet

Viewer Functionality (no plug-in)	**MapGuide**	**GeoMedia**	**MapServer**	**ArcIMS**
Output image format	PNG	JPEG,GIF, PNG	JPEG,GIF, PNG,WBMP, GTIFF, SWF	JPEG,GIF, PNG
Navigation				
Zoom In, Zoom Out	Y	Y	(Y)	Y
Zoom Area			(Y)	
Pan	Y	Y	(Y)	Y
Pan One Direction			(Y)	
Zoom Full Extents	Y	Y	(Y)	Y
Zoom Layer Extents			(Y)	
Zoom Width			(Y)	
Zoom Scale			(Y)	
Zoom X,Y			(Y)	
Zoom Selected			(Y)	
Zoom Previous			(Y)	
Zoom Next				
Bookmarks			(Y)	
Overview Map - reference			(Y)	
Overview Map - control			(Y)	
Data				
Add Local Layer			(Y)	
Add Remote Layer			(Y)	
Refresh			(Y)	
Reload			(Y)	
Stop/Interrupt				
Selection				
Select by Point			(Y)	
Select by Line			(Y)	
Select by Rectangle			(Y)	
Select by Polygon			(Y)	
Select by Radius/Circle			(Y)	
Select by Feature			(Y)	
Select by Properties			(Y)	
Select Nearest				
Select Multiple on Various Layers				
Clear Selection			(Y)	
Set Selection Mode				
Measuring				
Measure Distance		Y	(Y)	Y
Measure Rectangle			(Y)	
Measure Area			(Y)	
Bearing & Distance				
Coordinate Display			(Y)	
Set Measure Units			(Y)	
Set Display Units			(Y)	
Buffering				
Create Buffer		Y	(Y)	Y
Buffer Layer				
Select Within Buffer		Y	(Y)	Y
Querying				
View Attributes	Y	Y	(Y)	Y
Find Address			(Y)	

Find Feature			(Y)	
Locate Feature by Query			(Y)	
Create Custom Query			(Y)	
Presentation				
MapTips				
Layer Resymbolize			(Y)	
Redlining			(Y)	
Copy Map Image			(Y)	
Save Map Image			(Y)	
Print			(Y)	
Miscellaneous				
Save Settings			(Y)	
Load Settings			(Y)	
Set Preferences			(Y)	
Help				

Table 4: Author Built-in Tools

Author Functionality	**MapGuide 6**	**GeoMedia**	**MapServer**	**ArcIMS**
Open map file…	*.mwf, .mwx*	.mdb		(*.xml, .axl, .mxd, .pmf*)
Save as…	*.mwf, .mwx*	Y		*.axl*
Save individual layer	Y	Y		
Copy map as…	*.emf*, URL	Y		*.jpeg*
Open file from HTTP location	Y	Y		
Authoring				
Link map features to URL	Y	Y		Customize in viewer
Open multiple maps at once	Y	Y		
MapTips	Y	Y		One layer only
Add scale bar		Y		Y
Labeling	Y	Y		Y
Map preview	Y	Y		
Change coordinate system	Y	Y		
Create queries/stored queries	Y	Y		Y
Thematic mapping based on OLE DB data source	Y	Y		
Graduated symbols		Y		Y
Security				
Map password protected setting	Y	Y		
Track map usage	Y	Y		

Table 5: Server Built-in Tools

Server Functionality	**MapGuide 6**	**GeoMedia**	**MapServer**	**ArcIMS 4**
Security—restrict access to resources	Y	Y		
Open data sources from remote web server	Y	Y		
Load balancing	Y	Y		Y
Direct connection to OLE DB/ODBC	Y	Y		
Native Database Connectivity				
Oracle	Y	Y		
SQL Server	Y	Y		
Sybase	Y			
Spatial Data Support—Vector				
ESRI SHP	Y	Y		Y
DWG	Y	Y		convert to Shapefile
ESRI ARC/INFO coverages	convert to SDF	Y		through ArcSDE
MapInfo MID/MIF	convert to SDF	Y		convert to Shapefile
Intergraph DGN	convert to SDF	Y		convert to Shapefile
Atlas BNA	convert to SDF			convert to Shapefile
ASCII comma-delimited CSV	convert to SDF	Y		
Spatial Data Support—Raster				
BMP	Y	Y		Y
CALS	Y			
ECW	Y			
GeoSPOT	Y			Y
JPEG	Y	Y		Y
MrSID	Y	Y		Y
PNG	Y	Y		Y
TGA	Y			
TIFF	Y	Y		Y
Spatial Data Support—World Files/Georeference				
ESRI world files	Y	Y		Y
MapInfo tab files	Y	Y		
Geo TIFF files	Y	Y		Y
GeoSPOT BIL Header Files	Y	Y		Y

HEAD-TO-HEAD

Advantages of one web GIS software application in comparison to one other application:

Table 6: One-to-One Comparison

ArcIMS vs. MapServer	
• Better support for storing spatial data in RDBMS through SDE • You don't have to try to sell a relatively unknown product (MapServer) and philosophy (Open Source) • has out of the box capabilities for simple designs and functions • well integrated with existing ArcGIS installations	• Speed - MapServer is much faster, even running as regular cgi it requires much less resources • Can use other OS besides Windows (Linux) • Cost – all the software components are free! • Generally reported that Mapserver's support (via the user community) and documentation is much more useful than ArcIMS • MapServer alone is only analogous to ArcIMS Spatial Server, but the other features can be added using other tools. Other than being able to use fewer data formats, MapServer is a better spatial server than ArcIMS's. By using an existing web application server you can get the additional functionality with a minimal amount of work.
ArcIMS vs. MapGuide	
• well integrated with ESRI SHP files • buffering and measuring already included but must be added to the LiteView with customization to make it equivalent in features to ArcIMS HTML view.	• uses SDF (spatial data file) to deliver data to the end user, which allows for faster delivery • supports many formats without data conversion • simpler server/author/publishing configuration • does not require middleware for ODBC sources • can easily access multiple databases residing on different servers • well integrated with Autodesk CAD files • authoring environment has advantages: it is truly WYSIWYG, with more features than ArcIMS
ArcIMS vs. GeoMedia	
•	• greatest number or data and file types supported • not having a native data type – no conversions are required as all transformations are done on-the-fly, potentially saving costs and implementation labor

Performance Comparison

- based on same Windows 2000 OS, same , with same ArcXML interface, and same 200MB shapefiles
- MapServer is wrapped in a C# .NET web service
- six simultaneous clients requested 500 maps each for a total of 3000 maps
- from johan.e.hallgren@wmdata.se

Table 7. Performance of ArcIMS vs MapServer

Map Request Response Time	MapServer	ArcIMS
Total Map Retrieval Time (minutes)	7.47	12.08
Seconds per Map	0.1566	0.2426
Maps Per Minute	385	247
Max Delay for a map (seconds)	2.93	3.94
Min Delay for a map (seconds)	0.14	0.12
Average time map (seconds) for 6 simultaneous clients	0.96	1.49

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