Article for January, 2001 GEOWorld

Title: A Hitch-Hiker's Guide to the New Web Mapping Technologies

Author: Ron Lake, President and CEO, Galdos Systems Inc., Vancouver, BC.
(rlake@galdosinc.com)

The World Wide Web is, above all else, easy to use. Stick out your thumb, climb aboard, and away you go. Web mapping, too, is all about ease of use. If it's working right, the user needs no understanding of the underlying technologies.

This article is a look-ahead for people who will use web mapping as most of us use the web itself, and as most of us use automobiles and telephones -- blithely, without preparation, study, or deep technical understanding of how it works. We include a technical summary of web mapping developments for those who need to know "what's under the hood." But you can skip that part of the article if you are likely to be a user only, and not a provider of web mapping capabilities.

Where is Web Mapping Headed?

In general, Web mapping is headed in the same direction as the rest of the web: toward increasingly frequent use by a rapidly expanding population of people using all kinds of wired and wireless Internet-connected devices for all kinds of purposes. More specifically, we can expect:

Greater reliance on Web-resident geodata and geoprocessing resources.

For a long while, we have all been using the Web to download data, which we often process using software applications on our PCs. In the last year or so, a new approach has emerged. This is called the Application Service Provider (ASP) model. This allows users to not only access data over the Web, but to also run applications, also over the Web, in order to process data. ASPs are beginning to appear in the geospatial realm. They provide common geospatial data sets, as well software tools to display and manipulate the data, and integrate it with local data sets. The point to note is that the software is provided over the Web from a remote server; the user does not have to download it and install it on his or her PC.

There are economy-of-scale benefits to this model. The user has access to potentially very sophisticated geospatial analysis tools on a pay-per-use basis, thus avoiding the cost of buying, installing and maintaining the software locally. Users also benefit from having ready access to up-to-date geospatial data, without the worry of storing it, backing it up, and maintaining its currency.

In the future, it is likely that custodians of geospatial data, especially in the public sector, will adopt an ASP model for providing access to both their data and the applications necessary for using it to best effect. Providing applications services in this manner increases that value of the data.

Automatic linking to spatial data and spatial processing resources.

The Web model provides powerful capabilities for linking together resources without regard to physical location or types of technologies used. Web users can hop from one Web resource to another simply with the click of the mouse. This ease of navigation provides substantial benefits to users and paves the way for greater interoperability between service providers. The OpenGIS Consortium (OGC) is working hard to make interoperability easier and more powerful by defining standards for storing, delivering and processing geospatial data.

Location Services. In the wireless world, cell phones, PDAs, laptops and car computers will soon be "wireless, position-aware Internet devices." They will be position-aware through calculations of signal power from multiple nearby cellular communications transmitting antennas in some cases, and through built-in GPS or other location-determining technologies in other cases. By October, 2001, U.S. phone carriers will be required by law to be able to identify the location of cell phone callers. Similar initiatives are under way in Europe and elsewhere. Location services using web mapping will contribute significantly to public safety and disaster management, as well as commerce involving people on the move. OGC's October 30 Request for Technology, which is soliciting participation by technology providers in a testbed to develop open interfaces and standard protocols for Location Services, listed these Location Services examples:

- Traffic Information, e.g., "You are about to join a ten kilometer traffic queue, so turn right on the A3 ahead."
- Emergency Services, e.g., "Help, I'm having a heart attack!"
- Roadside Emergency, e.g., "Help, my car has broken down!"
- Law Enforcement, e.g., "What is the speed limit on this road where I am now?"
- Firefighting (e.g., "Where should I shovel snow to find the hydrant?" and "Are there flammables/explosives nearby?"
- Classified Advertising, e.g., "Is there a job nearby?" and "Where are nearby yard-sales featuring antiques?"
- Boundary visualization, e.g., "Where is my parcel boundary?"
- Underground Object Visualization, e.g., "Where is the water main?"
- Public Safety Vehicle Management, e.g., "Who is closest to that emergency?"
- Location-Based Billing, e.g., Free calls on your mobile phone, while you are in a particular location

- Wireless PABX, e.g., Using mobiles as internal phones while on your company campus
- Residential Cordless, e.g., Use your mobile as your home phone
- Leisure Information, e.g., "We want to go to Ronnie Scott's Jazz Club tonight; how do we get there from here?"
- Mobile Service Information, e.g., "I need to upgrade my mobile terminal, where is the nearest phone shop?"
- Road Service Information, e.g., "Where is the nearest gas station?"
- Directions, e.g., "I'm lost, where is the nearest Metro station?"
- Fleet Tracking, e.g., "Why does it always take twice as long to deliver to that customer?"
- Package Tracking, e.g., "Where is the package with those new SIMM cards?"
- Asset Tracking, e.g., "I'm sure I left my PDA on the train, but where is it now?"
- Vehicle Navigation, e.g., "How do I get back to the Interstate from here?"
- Public Transport Tracking, e.g., "I need to display train arrival times at un-staffed stations."
- Vehicle Theft Detection and Recovery, e.g., "My car has been stolen, where is it?"
- Child Tracking, e.g., "Tell me if my child strays beyond the neighborhood."
- Animal Tracking, e.g., "Where has Tibbles gone this time?"

Compared to traditional applications of GIS, Remote Sensing, and Facilities Management, most of these Location Services applications don't require the user to understand or use very much data. Most Location Services will depend on specialized online servers to handle almost all of the processing, and only small amounts of data will be delivered to the mobile devices, where users will merely receive the information, or interact in limited ways. (Note that GML, described in the technical part of this article, will play a major role in providing Location Services.)

Good-bye primitive GIF/JPEG; hello sophisticated services. A number of recent advances in technology and standards (particularly GML) work together to enable:

More interactive Web Maps. The pictures -- and maps -- we are accustomed to seeing on web sites are GIF and JPEG images. They are "dumb" images, not "smart" data. A geographic feature such as a road or lake cannot be selected to query it for information, move it, edit it, change its styling (such as color of interstate highways), or zoom in on it to see more detail. In some vendors' web-based GIS systems, these things are possible, but the methods and data formats are proprietary. GML and its supporting standards provide a standard, vendor-neutral way of encoding 1) virtually any kind of geospatial data and 2) virtually any method for processing and displaying such data. It makes it possible for geodata providers to become geospatial service providers, delivering real GIS, facilities management, and remote sensing services over the web for use by anyone with a recent version (XML-capable) web browser.

Non-map spatial information presentation. Some studies have shown that as many as 60% of people cannot read maps. Also, you don't need studies to know that a 3cm x 4cm monocolor display on a cell phone is too small for almost all map applications. So how will wireless Web Mapping work on small devices and voice–based car computers? Good news. Each device that receives GML-encoded geodata can process it in its own special way. So, for example, GML-encoded data could be expressed as verbal driving instructions or displayed as an interactive map. The means of presentation is dictated by the capabilities of the receiving device, not by the sender and not by the contents of the GML data. This capability requires only that the receiving device be XML capable.

Geospatial Fusion. When we think of spatial data we usually think of maps, but many kinds of place-related information not thought of as spatial – videotapes, photographs, and text documents, for example – could conceivably be stored and indexed in ways that would enable people to discover this information in spatial searches. "Fusing" such disparate kinds of data into one spatial framework has huge commercial potential and social value. GML, because it is XML-based, provides a straightforward way to integrate spatial data with other XML information types. Also, the data content is freed from the need to be displayed in a particular way.

Many applications for these capabilities are expected, including:

– Municipal governments acting as application services providers
– Spatially-enabled land title and permitting systems
– Wireless Services for mobile users
– Logistical systems –providing services such as routing analysis

Beyond HTML: Technologies of Web Mapping

To get a clear picture of web mapping technology trends, we need to understand something about the future of the Web itself. Today's Web is based on HTML (Hypertext Mark-up Language). In *hypertext*, selected words form links to other files: text, images, or any digital file. Hypertext's great power was unleashed when standards were established to enable links to files on remote Internet-networked computers. A *mark-up language* is a system of codes embedded in text data that specify how the data is to be presented. When you look at a web page's "source" you see the embedded HTML codes. HTML gave us the Web as we first knew it in the early 90s, an Internet-delivered cornucopia of flexibly formatted text, simple images, browsers, search engines and easy-to-create web pages. HTML primarily addresses formatting on a page, but now "mark-up" refers also to codes for handling voice and other media that are not page based.

Since the early days of the web, technologists have been working to extend the web's range of capabilities. Extended capabilities enable, among other things, easy conveyance of voice, music, video, 3D graphics, software, and, of particular interest to us, geospatial information. Inventing the web technologies that enable these capabilities is less difficult than reaching consensus on web technology standards. But standards are necessary when the goal is communication and interoperability among multiple, often dissimilar systems. Web standards are common protocols, interfaces, and mark-up schemes that enable information sent by one system to be interpreted by thousands of other systems.

The standards that are of particular importance in Web mapping are listed below, with brief descriptions.

- XML (Xtensible Mark-up Language) has been adopted by the Worldwide Web Consortium (W3C) as the path that takes the web beyond the limitations of HTML. Unlike HTML, XML explicitly separates information content from how it is presented. XML is a simple and powerful way of describing arbitrary information by means of mark-up schemes. The means of presentation of XML files is left to the client device. If the client device is a web browser, then it will know how to display document-type XML files. Indeed, most users couldn't tell a web page produced from an XML file from one produced from an HTML file. However, unlike HTML, XML files can be received and easily interpreted by non-browser devices, such as client software applications and XML-enabled PDAs, cell phones and car navigation systems.

- GML (Geography Mark-up Language) takes advantage of XML's flexibility. GML is simply a standard way of encoding geospatial data in XML, based on the OpenGIS standards for representation of geospatial features. Ironically, OGC's approach historically has been to develop software interface standards, as opposed to "yet another data standard," and yet GML is a data standard that is likely to be used widely as a general export format for GISs. Its advantages over previous data formats are (a) it is extensible, (b) it can easily be linked to any kind of non-spatial XML data and (c) it can be displayed as a map on a Web browser with negligible effort.

  Galdos Systems and other companies now provide software that leverages the power of GML. Using such software, data providers and users can much more easily exchange, display and manipulate geospatial data. Data providers can also collaborate and build business relationships that exploit the power of the web, crossing national boundaries to bring powerful new geospatial services to users, wherever they may be. And users no longer have to install expensive proprietary software on their desktops in order to view and analyze data. Most users' needs for feature-based map display, querying and analysis can be met simply using the XML-processing capabilities of today's web browsers.

  Galdos, for example, is currently executing a contract to provide the US Census Bureau's Tiger/line files in GML, and at least one European national mapping agency is considering using GML as its standard data delivery format. In addition, the UK Government in October adopted GML as its national standard for geospatial data exchange.

This however is only the beginning. Within the OGC, GML has played a critical role in the development of many new standards, some of which can be expected to appear in the public arena within the next 6 to 10 months.

Several other standards relevant to web mapping will be implemented in ways that involve GML:

- Two important developments in web-based computing are Sun's Java and Jini. Java is an open object-oriented language that can be used to deliver client- and server-side Web applications. Jini is a scheme for indexing and identifying the capabilities of any kind of device on the web. "Geojava" is a Java implementation of OpenGIS Specifications. Geojava provides an effective way to deliver geoprocessing capabilities that operate on GML-encoded data. This allows for client- and server-side geoprocessing, or a combination of both. Virtually every Java-enabled mobile Internet device could use this technology to efficiently deliver geospatial services to users. Jini will be used to tailor services to the capabilities of the client device.

- SVG, VML, and X3D. Several XML-based specifications for describing vector graphic elements have been developed, including Scalable Vector Graphics (SVG), Vector Markup Language (VML), and X3D, the XML incarnation of the syntax and behavior of VRML (Virtual Reality Markup Language). The purpose of these specifications is to define how graphical elements (such as points, lines, polygons and arcs) are presented. They cover properties such position, color, line weight, transparency, and size. These standards arose from the Web publishing domain and have nothing to do with geospatial data. Their job is simply to draw collections of graphical elements (which happen, in our case, to represent maps). To view an SVG, VML or X3D data file, it is necessary to have a suitable graphical data viewer. In the case of VML this is built into IE 5.0. In the case of SVG, Adobe has developed a Web browser plug-in, while IBM and several other companies have developed SVG viewers and supporting graphics libraries. Several Java SVG viewers are also available. To draw an SVG, VML or X3D map from GML data you need to transform the GML into one of these graphical vector data formats. This is done by associating a graphical "style" (e.g., symbol, color, size) to each feature in a GML file. When the styles are painted on the screen, you end up with a map that represents the GML features. Voila.

[Sidebar] OpenGIS Specifications:

The OpenGIS Specifications provide a common software syntax and semantics for requests in distributed geospatial computing environments. Some of the completed specifications and specification topics are listed below:

The **OpenGIS Simple Features Specification** describes "vector" geodata (e.g., streets, land use zones, property lines, watersheds, etc.) as points, lines, arcs and polygons.

The **OpenGIS Grid Coverages Specification** addresses satellite images, aerial photos, digital elevation data, and other kinds of “gridded” data.

The **OpenGIS Catalog Services Specification** describes the services of “clearinghouses,” providing a common architecture for online automated directories of web-based geospatial data and geoprocessing services, rather like “spatial search engines.”

The **OpenGIS Web Map Server Specification** specifies the request and response protocols for open web-based client/mapserver interaction. It addresses basic web-based image and vector data access, display, and manipulation capabilities.

****
About the Author

Ron Lake is president and CEO of Galdos Systems Inc., Vancouver, BC. Prior to founding Galdos, Mr. Lake was Vice President of Engineering for Laser Measurement International, following a decade as Principal Engineer at MacDonald Dettwiler & Associates Ltd. In the OGC, Galdos has played a lead role in the definition and adoption of the GML standard, working with Oracle Corporation, MapInfo, CubeWerx, NTT Data, Compusult Ltd. and other companies. Galdos builds software to facilitate the integration of geography and e-business through the delivery of geospatial data and services over the Web, and helping service providers deliver better data and services to their customers and users. See http://www.galdosinc.com.

****

-- end --