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"The Spatial Web Wants to be World Wide"

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People working in the "geotech" industry know that spatial technologies are potentially useful to almost everyone. With the explosion of the World Wide Web, there's now a medium with the potential to distribute spatial technology benefits to all users of the world's digital information network. The burgeoning growth of Web-centered geospatial systems, services and information provides an unprecedented market opportunity for technology and service providers, and there have been notable successes.

For example, GEOWorld's GEOPlace.com Web site lists hundreds of Web mapping sites around the world at http://www.geoplace.com/gw/1999/1199/webmapsites.asp . In the US, TerraServer (http://www.terraserver.com) gets three million hits a day (700,000 page views in 35,000 visitor sessions). National Geographic's MapMachine site (http://www.mapmachine.com/) claims 10 million requests per month. And Mapquest.com (http://www.mapquest.com) claims 8 million visitors per month.

Established and start-up software vendors (see "Web-Based Mapping Vendors Worldwide," page XX) are making GIS, geoengineering and imaging capabilities accessible via the Web.

But despite proliferation of web mapping sites and a bankable boost for most companies in our industry, the "World Wide Spatial Web" hasn't yet caught hold like the wildly successful non-spatial World Wide Web. In the worst case scenario, it will never catch up. Viewed from outside the geospatial industry, just as in pre-Web days, geoprocessing still is mostly a "back-office specialty," providing pretty maps that can, with a little work, be pasted into documents. Web mapping can potentially provide much more.

Impressive web-based geoprocessing power can be demonstrated, certainly, via an intranet in which a single vendor solution can give enterprise users Web access to almost anything in the GIS arsenal. But that's via an "intranet" and not the "Internet." GIS fulfills its potential when users can portray, overlay, compare and combine geodata from many different sources. Those sources will be Web servers, but they won't all be from a single vendor.

We have a reasonable hope that in the World Wide Spatial Web of tomorrow, hundreds of thousands of geodata sources will be just as discoverable and accessible as text-and-JPEG web sites are today. And as so many have pointed out in past issues of this magazine, we are aiming beyond GIS to the ubiquitous presence of spatial information in our Information Infrastructure. But we are not there yet.

The World Wide Web (like our telephones and faxes) is successful because of universal acceptance of a handful of technical interoperability standards (e.g., TCP/IP, HTML, CCITT Group 4, etc.). Note that in Metcalfe's Law, which states, "The value of a network grows by the square of the size of the network," the word "network" implies interoperable nodes. The Web's technical standards are responsible for the economic explosion in e-business, digital communication devices and bandwidth "build-out." Key specifications for the World Wide Spatial Web's technical interface standards are complete, but vendors, with a few exceptions, haven't released OpenGIS-conformant client and server products, so interoperability is unavailable to users. The "network effect" isn't in effect.

THE BIG RISK

Consider what a loss it would be if the largest Internet portal companies and/or service providers could build impermeable fences around their user communities, so no user of their service could access the World Wide Web, but only the "Companywide Web." Or consider what it would be like if telephone companies' networks didn't interoperate. This would be Metcalfe's Law in reverse: Those companies responsible for such barriers would dramatically decrease the value of the network (for everyone, even their officers and shareholders). This dismal vision describes the current state of the Spatial Web.

The biggest risk to the World Wide Spatial Web is that we remain stuck in the current disaster. For example, users can get wonderful map images from TerraServer, MapMachine, MapQuest or hundreds of other Web map sites, but they can't use them together in a GIS to solve a problem. Users can't even overlay them in a Web browser. Unless they're working within a single vendor's Web client/Web server/data format system, users can't do much besides paste a JPEG map image into a document. (There are exceptions, work-arounds, plug-ins, downloads, conversions, batch transfers, etc., but that's the ugly past that we're trying to avoid repeating.)

IS THAT A SINKING FEELING, OR JUST BUTTERFLIES?

World Wide or not, the Spatial Web is already big business. Who would have predicted two or three years ago that an almost unknown web map server company (MapQuest) would soon be bought by AOL at a price greater than the annual software revenues of all the world's GIS software vendors? But it's not bad news for the vendors, because most of them continue to show increasing revenues. Why? The bigger and more visible the Spatial Web gets, the more valuable its pieces become. As more and more people discover the value of free or cheap access to online geospatial information, the more value there is in such information, so the market for digital geospatial products of all kinds expands. Because spatial information is so important, growth is happening even though the market is not yet embracing the standards that would make the Spatial Web World Wide, and exponentially more valuable than it is today.

More and more people are being exposed to GIS and remote sensing, but the exposure comes indirectly, through "information products" produced using those technologies, or through functionality that is provided as part of another product. It is much like the advance of computer graphics: Fifteen years ago there was intense competition between vendors of graphics boards and graphics subroutine libraries. Now graphics is part of almost everything we do with computers, yet few people give any thought to graphics hardware and software. As with computer graphics, our geoprocessing industry is stronger than ever, even as our technologies become more "underlying" and invisible.

Web-based information access and delivery scenarios are relevant to the emergence of all the industry advances described by Fred Limp in GEOWorld's's [month] [year] issue (see "…," page …):

-- Enterprise solutions: "gIS" now is the spatial aspect of a database that e-enterprise workers and consumers access via the Web.

-- Geoprocessing software components: Workers and consumers are also beginning to access applets that run on their browsers, providing just enough geoprocessing to let them do what they need. This is the future: query-discovered applets operating on query-selected bits of Extensible Markup Language (XML)-encoded data gathered from multiple sites. XML is the "next thing" after HyperText Markup Language (HTML) and the key technical underpinning of business-to-business e-commerce. XML-encoded geodata will be called Geography Markup Language (GML) if Open GIS Consortium (OGC) members finish—and deploy in products—a standard for XML encoding of spatial data.

-- Consumer solutions and "wireless field systems": Much of the technology in wireless field systems is being miniaturized in "position-aware Internet devices" -- next generation cell phones, car computers, and PDAs for the masses.

-- New imagery sources and microsize data distribution: On the Web, users can buy a specific rectangle of imagery they need, unlike the old days when they had to buy a whole scene that was sometimes hundreds of square kilometers. (They would have to buy two scenes if the area of interest crossed a scene boundary.)

Do users of these merging technologies need to know about components, applets, XML or scene boundaries? No, those are part of the underlying, invisible technology.

WHERE'S THE ANSWER TO "WHERE"?

How will people find spatial data and services on the Web? In some scenarios, searches won't be necessary: commonly used spatial data will be provided via a hard link—a "view" into a dataset kept current, accurate, safe and online by the agency responsible for it. In other scenarios, spatial data searches will work like Web browser text searches, but better, because spatial search engines will potentially have a richer metadata index from which to work.

If all online digital geodata were indexed by standards-conformant metadata, catalogs conformant with the OpenGIS Catalog Services Specification could process queries to find datasets and map layers as well as geospatial features and collections of features of specified types. Catalogs likewise will enable Web discovery of online processing resources and the automated linking of process parameters. "Discovered" software will then immediately do the needed processing. Users won't need to buy, install, configure and maintain a full-featured GIS.

WHAT'S NEAR AND WHAT'S NEXT?

"Location services" refer to information services provided to users of (typically mobile) position-aware Internet devices. Global Positioning System (GPS) subsystems, cellular technologies and other methods can determine a device's location. The device then can report the location to a server, and the server can run user queries against a database of "things nearby" or "things ahead on the road," such as restaurants, stores, hotels and automobile services. The technology is "thin" compared to traditional GIS, geoengineering and remote sensing, but the market is several orders of magnitude larger. The potential safety, convenience and commerce benefits are enormous.

However, as in the broader geospatial domain, location services need standard geospatial protocols if they're to be available and consistent across national regions, technology platforms, application domains and product classes. Traditional GIS application domains that have begun to use "wireless field systems" will benefit immensely from the "commoditization" of mobile devices, but only if location services' interoperability standards are consistent with the interoperability standards for "thicker" geoprocessing technologies. Imagine the importance of consistent standards for disaster managers, for example, who may rely on people with position-aware cell phones to provide information that updates in real time one data layer of a complex decision support model.

SOME LITTLE RISKS

Change brings risk. Here we look at a few of the risks faced by people looking to do their jobs in the world of the Spatial Web:

-- The GIS software vendor may discover that former customers are renting time on web sites that package tailored applications (delivered by an Application Service Provider, or "ASP") with built-in web links to critical geodata servers. Such a website is a desktop that also includes email lists and video conference windows connecting the user to colleagues in other departments and to the appropriate network of data coordination folks developing consistent geographic feature type descriptions, feature relationship descriptions, and metadata. Such a site might have a "web cam" window showing a real-time view of a job-related construction site, traffic jam, or crowd. Who should the vendor partner with to be a part of this solution? Whoever helps them serve the customer.

-- A government worker may discover that certain spatial data he or she is supposed to put online is derived partly from purchased data that is not to be redistributed. There is a risk here for the government worker and for the private data supplier. The geodata-on-the-web industry is a young industry and many of the rules have yet to be written. One solution for data providers is to provide views of data but not the data, so the data can't be altered or downloaded. Also, the data provider can reduce risk by developing a "brand," or a reputation for excellence. If you (and your value-added product) are the best (in coverage, resolution, timeliness, quality, etc.) you will probably succeed with your geospatial products even if there are no non-redistribution clauses protecting you. The web rewards "syndication" of content -- that is, you publish to multiple customers something (their requested area of a data layer, for example, or a multilayer data model) that is current and of high value. Those who would pirate your work can't provide a product that is as current or as certifiable as yours.

-- The city manager or legislator may discover that some of the public money being spent locally on infrastructure projects is mandated to be spent on spatial data, but the data will be useless after the construction phase because it doesn't conform to feature schema or metadata standards. The web increases the risk that such waste will be discovered, because web publishing of geodata exposes more and more people to the semantic interoperability issue. And governments are indeed being asked to provide all sorts of information on-line, much of it spatial. Solution: Build the spatial data with standards-conformant schemas and metadata, so it can become part of an online repository of data serving efficient management of physical infrastructure for years to come. Or go a step further, and help start a local spatial data consortium of public and private data providers and users who create a web-accessible data warehouse and a network of agreements to manage metadata, privacy, intellectual property issues, freedom of information law compliance, etc.

STANDARDS COORDINATION

Fortunately, geoprocessing technology providers and users have been working together to create the standards necessary to make the Spatial Web spread worldwide. There's now active communication among the spatial standards organizations, who understand that a platform of complementary, noncompeting standards is essential to enable the market benefits and human-benefit potentials of the World Wide Spatial Web.

In May 2000, a Joint Steering Group on Spatial Standardization and Related Interoperability formed, and they will meet again in September 2000 to "deconflict" the many International Standards Organization (ISO), JTC1 and other "de jure" and "de facto" spatial standards. ISO/TC 211, for example, asked OGC to implement its metadata and portrayal standards, and those standards are now being tested in OGC testbeds. OpenGIS Catalogs in OGC's Web Mapping Testbed Phase 2 (WMT2) are being labeled with TC 211 metadata tags, and portrayal tags in WMT2 are intended to be conformant with the TC 211 draft international standards. The new Internet Engineering Task Force Spatial Location Protocol Working Group is communicating with OGC. And OGC has established channels of communication with the Wireless Application Protocol Forum, ITS America and ISO/TC 204 (for intelligent transportation systems).

INNOVATIVE, "FAST-TRACK" STANDARDS PROCESS

Much inter-organization cooperation likely will happen in testbeds. All the groups mentioned in the previous paragraph have expressed interest in OGC's "rapid prototyping" approach to standards development. OGC's 1999 Web Mapping Testbed, sponsored by U.S. and Australian federal agencies, brought together key Web mapping technology providers in a program to create the OpenGIS Web Map Server Specification, which enables automatic overlay of map images (usually JPEG or GIF images) accessed from diverse servers fitted with software interfaces that conform to the specification. (See http://www.opengis.org and also "Demo" at http://www.ionicsoft.com.) This successful testbed led to other OGC Interoperability Initiatives, including the following:

• Upper Susquehanna and Lackawanna Pilot Project, completed in June 2000, which introduced open Web mapping into a multiagency flood-management scenario.

• WMT2, which runs from June 2000 to November 2000, extending OpenGIS Web mapping to enable a client program to discover and access individual geospatial features and coverages (like images, thematic raster data, etc.) held on heterogeneous servers. A server can provide feature schema value types as well as parameters that distinguish particular values. The new specification will solidify the GML specification and provide standard ways to communicate user permissions with respect to geodata access.

• Geospatial Fusion Services Testbed, running in parallel with WMT2, is developing rigorous industry-standard interfaces for services involving gazetteers, geoparsing services (i.e., looking at text and extracting geonames) and georeferencing.

Other interoperability initiatives are in the works. Candidate technical areas include: extension of interfaces and encodings into three and four dimensions, interfaces for the integration of advanced services (such as services to provide interoperability between diverse models used in decision support), and interfaces to address intra- and inter-community semantics. New government and private sector sponsors from around the world are sought to help fund and shape this 2001 program of activity. Sponsors of an initiative provide requirements and incentives for the technology providers, who "rapid prototype" draft specifications for open standard interfaces and protocols. Sponsors benefit immediately from specific inter-vendor interoperability results, but unlike most integration efforts, these results are part of a broader, coordinated, world-wide effort to "spatially enable" the Worldwide Web through consensus standards.

Demand Standards!

Geoprocessing software vendors face some risk in being early providers of products that are fully standard conformant, because interoperable products might make it easier for competitors to do business with existing customers. At the same time, from a strategic point of view, it makes sense for vendors to invest leadership in various standards organizations, and most of them do. Users need to pull the vendors into offering standards-conformant products by making standards conformance a requirement in procurements.

Some user organizations are moving rapidly in this direction. As Jim Jancaitis, Senior Program Advisor in the US Geological Survey for Map Data Collection and Integration reports, "The USGS is continuing to pursue common standards as the means to facilitate widespread access to the nation's geoprocessing resources and information for the common good. Toward this goal, the USGS is committed to the activities of the FGDC, ANSI, ISO and the OpenGIS Consortium, and our procurement documents will reflect this commitment."

USGS has been working with other US federal agencies in developing procurement language that requires standards in areas where the standards are already well developed. In areas where the standards are not yet well developed, staged procurements can be structured to require vendors to commit to future delivery of releases that will be conformant with future standards. Federal agencies are big customers, so their leadership can have a significant effect on the market. But widespread demand in all market sectors is what will ultimately bring "critical mass," widespread adoption of the standards, and a truly World Wide Spatial Web.

Many things should be easy that are difficult today: It should be easy to find on the web a specific data layer for a specific region. It should be easy to gain access to particular geoprocessing functionality. It should be easy to overlay maps and images from different web sites. It should be easy to learn who and what is nearby, or along the road ahead. It should be easy to learn and verify the source or sources of web-resident geodata. It should be easy to find text and video related to a place, through a simple query on that place. It should be easy to make geodata accessible to everyone, or to only those with permission. It should be easy to exchange a small amount of e-cash for a small amount of geospatial information. Many things should be easy, given today's sophisticated technologies, but they are difficult because of our industry's legacy of non-interoperability. The best path forward is widespread adoption of geoprocessing standards. There is no other way to achieve a truly World Wide Spatial Web.

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