Technical Trends in the Geospatial Industry

Jonathan W. Lowe

Expanding on the Market Map — Lowe speaks with spatial specialists about technology trends now driving the industry.

Care to speculate on where the spatial industry is heading in 2003? Or how the trends you observe will change our spatial datasets, software applications, and business practices? To answer these questions, the experts featured in this column (See "Says Who?" sidebar) drew from their many years of hands-on experience using and building geospatial tools. Though diverse in spatial sub-specialty, many predicted the same common themes for the year ahead.

Decoupled architectures

By far the most mentioned theme was decoupling — reliance on standards and elimination of unnecessary software, format, and delivery dependencies. Down at the programmer's level, decoupling translates into the combined use of XML/SOAP, WMS, WFS, and various other protocols and data standards. For instance, most participants had already implemented some form of XML and Internet-based spatial data exchange into their own products or their customers' workflows.

Holmes (on decoupling with XML and Web services): The use of geospatial data is moving from the mapping department in the back office to the existing business practices of the enterprise, most notably with Web implementations. One of the technologies that will help this area is the .NET game with XML Web services. Web services provides a more industry-standard consistent set of interfaces for businesses to work together or for services to be provided to businesses. It's going to make the ability for Web systems to talk to other Web applications much easier (which is not unique to the geospatial world). It's also going to offer the ability to write a piece of code and offer that across the Web, plus make it just as easy for a desktop application to get to that code as a Web browser application.

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Says Who?

The following ten participants shared their observations of spatial industry trends:

Dean Angelides, vice-president of Vestra Resources, Inc. (vestra.com), in Redding, California, has 20 years of experience implementing GIS within organizations to improve their decision making and operations.

Clay Collier, president of Kivera, Inc. (www.kivera.com), in Oakland, California, and **Mark Strassman**, Kivera's vice-president of marketing, produce a real-time, LBS platform that improves the accuracy of in-car navigation systems by decoupling the street network data from its algorithmic analysis.

David Holmes, director of worldwide product strategy for Intergraph Mapping and Geospatial Solutions (www.Intergraph.com/imgs), guides the Intergraph product line to leverage ongoing trends such as decoupling and expert-system integration.

David Maguire, general manager of ESRI (www.esri.com), influences a large existing customer base by aligning ESRI's product line with peer-to-peer computing and IT industry standards.

Paul Ramsey, president of Refractions Research, Inc. (www.refractions.net), in Victoria, Canada, a developer of spatial software and applications including PostGIS, the spatial extension to the open-source database, PostgreSQL.

Clive Reece, GIS products manager for Meteorlogix, LLC (www.meteorlogix.com), in Minneapolis, Minnesota, a provider of industry-specific weather management capabilities.

Rob Shanks, president of GlobeXplorer, LLC (www.globexplorer.com) in Walnut Creek, California, delivers dynamic online aerial and satellite imagery to customers including MapQuest and Claritas.

Dennis Wuthrich, CEO of Farallon Geographics, Inc. (www.fargeo.com), in San Francisco, California, a spatial data management and system integration consultancy serving governments, utilities, and Earth resources clients.

Andre Zirkler, vice-president of program management for Viecore Federal Systems Division (www.viecorefsd.com), builds military battlefield simulation software that relies on spatial data to model potential outcomes.

Pervasive Peer-to-Peer Computing

David Maguire

Decoupled architectures support communications autonomy at all levels, commonly known as peer-to-peer computing, and is often characterized as the ability of any application to "talk" to any other application.

Maguire (on the evolution of GIS on the Web in context of ESRI software's progressive shift towards a peer-to-peer architecture): ArcIMS is really a first generation software solution. You have a browser that can talk to one Web server at a time. Any Web server — you just type a URL and talk to a Web server. Last year's work on data fusion was the second generation. We first experimented with client-side fusion, so we taught an intelligent client (ArcMap) how to talk to multiple (ArcIMS) Internet servers, and how to fuse the data together on the client.

Also last year, we worked on server-side fusion, the third generation. We extended ArcIMS, through the means of the Geography Network, to allow people to chain services together. That meant that a very thin browser-based application could, for example, combine data from multiple services, such as geocoding on one service and mapping on another.

Today, ESRI is investigating industry standard Web services technology as a mechanism for delivering on the promise of the distributed GIS vision and making real a spatial data infrastructure. We're looking now at moving from the client–server paradigm to the peer-to-peer paradigm where any machine or system on the network can talk to any other machine or system on the network. What this means for users is any GIS could potentially be both a client and a server. It has a GUI that people are familiar with, but also a Web services interface, which allows it to talk to other machines on the network. That is what I see as the fourth generation in the evolution of GIS on the Web.

With a geocoding Web service, for instance, users don't have to worry about formats or compatibility between the service and any particular application. This decoupling should improve access for the user.

Shanks (on how a decoupled Web services architecture simultaneously increases his company's efficiency and expands its reach): Technically, the real development that has a chance to affect broader markets is Web services. People are used to typing URLs — everyone knows how to do that. They can sit back and let the service take care of the technical details. Web services really enhance our business model. We don't have to develop intricate extensions; we just develop within the much simpler framework of Web services. You're not upgrading operating systems and dealing with, say, Windows 98 versus Windows XP. We're decoupled from that really complex programming environment, and on the server side we're listening for requests and saying, 'Hey, we understand XML, SOAP, etcetera.' This reduces our engineering time and overhead and expands our ability to get into [any application framework] quickly. If we're running within the .NET framework, for instance, then when you're asking for a street map from MapPoint .NET, you can also get an accompanying aerial image from GlobeXplorer. In the near future, imagine typing "Paris, France" into an article in Word, a little information button comes up asking "Would you like more information on Paris, France?" and it offers a picture, an encyclopedia entry, etcetera. If you choose "picture" then Word automatically calls out to GlobeXplorer and, boom!, back comes an image of the Eiffel tower. All GlobeXplorer had to build to make this possible was a reusable Web service.

Rob Shanks

Collier (on how the advantages of a decoupled architecture are already the basis of their business model): There are a few different fundamental data vendors in North America. None of them has identical coverage; none of them has the same format; none of them has the same quality or connectivity in the database; so when you have to merge them or switch from one source to another (because of either coverage, cost, quality or content), then a stacked, coupled architecture to that format, that cost, that license, or those limitations will cause you extreme pain.

Clay Collier

Kivera is data neutral [that is, decoupled] and can enhance data in unique fashions: algorithmic merges, toggling datasets, enhancing accuracy of data — whatever it takes to be able to have interchangeable data supplies and give a better offering to the marketplace.

Maguire (on the role of standards in a decoupled architecture): In addition to technology, vision, and cooperation, we need standards. My own view is that the standards that will ultimately win out will be industry de facto standards, not necessarily parochial GIS standards. These industry standards include Web services standards like XML and SOAP, the network standards TCP/IP and HTTP, metadata standards like ISO-19115 and also content data models.

Glossary

DBMS: Database management system

EMS: Emergency medical services

GUI: Graphical user interface

HTTP: Hypertext transfer protocol

ISO: International Standardization Organization

IT: Information technology

LBS: Location-based services

OGC: Open GIS Consortium

ROI: Return on investment

SOAP: Simple Object Access Protocol

TCP/IP: Transmission Control Protocol/Internet Protocol

WFS: Web Features Service

WMS: Work management system

URL: Uniform resource locator

XML: Extensible markup language

Proliferation of spatial technology

Decoupled peer-to-peer spatial environments are removing old barriers that used to exclude nontechnical users. Furthermore, spatial data and functionality are proliferating to other IT environments. And new technologies like GPS-enabled cell phones are changing the requirements of formerly planning-oriented data and software.

Angelides (on use of spatial technology by nontechnical users): Because the tools are becoming more available and pervasive, we're seeing the technology applied in new areas like health and human services, where the technology makes imbalances and inequities much more visible and understandable. As a result, we're seeing new methods of dealing with problems begin to be crafted. Rather than working in the backroom, the GIS guy can go in the field and jointly solve the problem with stakeholders. In Sonoma County, for instance, health-care providers for community clinics are participating in the designation of study areas that will result in the allocation of tens of millions of funding dollars. Involving those most in need in the allocation process gets the money to the right regions, a great advance for everybody involved.

Dean Angelides

Shanks (on new market penetration): I think making it easy for users to find, search, and access geographic content in real time has the potential to increase not only the scope of the problems geospatial content can address but also can increase the adoption of geospatial content into a broader market. By that I mean seeing it used more in real estate, finance, and sales planning — areas that are outside of the typical GIS and mapping realm of engineering, transportation, and land-planning applications. For instance, a real estate professional can just type a URL, user name, and password, and they're accessing the picture of the property that they need incredibly easily. They get in, get out, and go on with the business that they're accustomed to. We've added geospatial imagery to their traditional business workflow in a very seamless fashion.

Holmes (on systems integration): Another trend that we see is to tightly integrate more geospatial information with other expert systems, such as with Hansen's enterprise systems. Anybody doing operational work (with, say, utility assets or permits or pavement management systems) needs to be able to have a geospatial component immediately available. The people running these systems don't necessarily know or want to know about GIS. They don't have to understand coordinate systems, projections, or even buffer zones, because the capability is offered within the context of the system with which they're already familiar.

David Holmes

Collier (on new device proliferation): The trend in proliferation of cell phones and cell-phone functionality is driving up application performance requirements. For instance, some of Kivera's customers now demand hundreds of reverse geocodes per second.

Widening the audience

Some trends don't seem to merit much comment until the implementers share the ripples of consequences they've observed. Migrating file-based spatial data into a relational database is just such a trend. As with decoupling, spatial database migration widens the audience and access to spatial data.

Ramsey (on decentralization of responsibility due to spatial database migration): Over the next 12 months in the province [of British Columbia], we'll flip-flop from having the majority of spatial data on a file system to having the majority of the spatial data in the database. That's step one to organizations that are pushing their data out. Once they're in databases, they can be edited through Web interfaces. Arguments for decentralizing the responsibility for spatial data begin to make sense at that point. To the extent that organizations are committing to spatial databases, it's a lock-step process with committing to decentralizing responsibility for their spatial data — turning the GIS shop from a bunch of operators to a smaller bunch of experts. Spatial databases take away the requirement that the data be manipulated and processed by any particular front end or tool. We spend a lot of our effort as GIS guys doing stuff which doesn't require our expertise; we do it because

Automation and Commoditization

Clive Reece

A small but growing group of experts offer real-time spatial data services, including the mapping of changing weather conditions. Just seeing companies like Meteorlogix on the market is a trend, but so is the need for automation and messaging that their real-time services encourage.

Reece: (on automated decisions) There's a big opportunity in automation, especially with GIS becoming more seamlessly integrated with DBMSs. The industry has traditionally focused on desktop GIS with analysts using the technology in the back room. I see the market expanding outward from that center, both up and down: upward in terms of fewer but larger and more complex problem-solving aids that provide automated decision support. Downward in terms of commoditized information generated by decision-support systems going to the masses.

With a time window for a decision, there's more need for making automated decisions. For instance, imagine the Doppler weather radar identifying a tornado. The tornado is located at a specific geographic point, but it also has direction and speed of travel. An automated system can project that tornado forward over its area of influence 30 to 60 minutes into the future. Rather than have an emergency manager sit and watch the weather system, an automated system can proactively alert him that something's headed towards his community's hospitals, schools, or vehicles, so he can either take immediate action or dig down a little deeper and look at what's going on.

the only way to get access to the data and manipulate it is through our GIS tools. People can now use the data through simplified (Web) user interfaces instead. You don't have to go get the GIS specialist to pop open ArcInfo to change the name of a road network — that's unnecessary! Just open up the Web interface, click on the road, and change the name yourself.

Holmes (on widening the user base through spatial database migration): One of the trends we've seen is moving the geospatial data from the file system world into standard databases. It's not a new trend; it started about 1994 when Oracle Spatial came on the scene. But it's a trend that people are beginning to adopt as they recognize that the best way for geospatial data use to increase is to adopt more IT infrastructure standards, such as databases. A key advantage to this strategy is to centralize data management operations and realize the productivity benefits — but still provide for departmental controls and responsibilities. The adoption is relatively slow because it requires cooperation and communication within an enterprise.

Taking action on fidelity, resolution

Compared with traditional planning-oriented spatial applications, real-time spatial decision support applications are action-oriented and place new demands on spatial data's resolution and fidelity.

Collier (on LBS data granularity): Customer satisfaction requirements are high for the luxury car market; mobile device users have more stringent data quality requirements. They're "in" the data and it's a different kind of experience than analyzing GIS data at the desktop. So, LBS users are pushing a trend toward increasingly accurate and rich data.

Zirkler (on safety and security data needs): The need for increased resolution and fidelity of data is going to continue in decision-support applications for less traditional warfare environments such as urban areas. If you want to look at how you're going to solve a problem in time and space and want it to be accurate with respect to the outcome, the resources required, the duration, and the sustainment requirements, you need more and more data and at as high a resolution as you can get. So, for example, we have a homeland defense prototype, and when we look at doing some kind of evacuation of an area by the EMS or fire department, we need data on traffic patterns by time of day. That kind of detail has a huge impact on how you move through that kind of space. If you've ever been in New York relatively late in the evening, traffic can be light unless you're in the theater district and all the shows are letting out around 11:00 p.m. or 11:30 p.m. It's absolute hell — you can't move."

Bidirectional flow

Mix decoupled systems, proliferation of devices, expansion of the user base, and a struggling economy together and the result just might be bidirectional data flow (though some participants contend that this trend may be two to five years ahead). Bidirectional data flow means that users not only pull mapping data and applications from providers, but also return their own edits and updates. Often, the users are the closest to the point of data collection and have the biggest stake in the data's accuracy.

Ramsey (on the impetus behind user-maintained, but centrally managed datasets): As the big money for centralized data-gathering processes withers away (such as in British Columbia), organizations have to get

Awareness of ROI Drives Cooperation

Speaking of security, everyone noticed the downward trend in the world economy and the upswing in concern for safety and security. Unpleasant though these factors are, they have helped drive better business practices and cross-departmental cooperation. The experts interviewed for this column encouraged more of the same.

Maguire (on the nontechnical challenge of enterprise GIS): To make GIS on the Web really work, we need not just technology, but also a vision for what it really means to build an enterprise, integrated, peer-to-peer GIS system. And we need cooperation. We need all the people in the planning department to talk to the public works department. We need the counties to talk to each other; we need the federal agencies to be willing to talk to each other. That's a huge challenge. But, no question in my mind, the technology and the way that spatial software and applications are evolving, many more people will be connected together, and sharing and cooperation will become an everyday part of our lexicon, not just something that is written about in the pages of magazines.

Wuthrich (on a trend he hopes will disappear): Businesses still need better cross-departmental communication about the value of spatial technology. I try to drive discussion between, say, a CIO and a GIS manager. Because most of the technology already exists, line-of-business operations could be improved by using the resources already in house. For example, one of my utilities clients manages pipelines that parallel rail lines. Cross referencing rail postmiles to a pipeline's linear reference system is a basic business need and a simple technical problem. But because the GIS department didn't understand this business need, the utility was using a cumbersome manual process to locate pipe leaks caused by train wrecks — even though they had an in-house GIS shop that could have done it automatically.

Holmes (echoing Wuthrich's feelings): I hope that this article could motivate [GIS users] to meet with some of their colleagues and ask questions such as, "Are we doing what we do in the most efficient manner? Could we share our geospatial data with other people in the enterprise and realize more value from that geospatial data? Could we offer geospatial data to our field workers in a form that they can use more efficiently, and improve the roundtrip of field updates back to the enterprise data model?"

Collier (on the deflated LBS industry): Awareness of return-on-investment is rising. We have found success with solid growth industries of in-dash car navigation systems, wireless directory assistance, value-added travel on the Web, travel-related services with a brand (like AAA). There was an overhype, but some of the compelling wins we're seeing are market corrections.

their clients to gather data for them. Organizations have been asking: "How do we expose our databases to our clients so that (1) they can see what we have, and (2) they can start giving us updates?" Question one was answered last year by the big standards story — WMS. The discovery of the WMS standard has driven organizations to understand not just how they can publish their data with a Web interface, but how they can publish their data so that other organizations can make use of it. The story for next year that answers question two is going to be the blazing discovery of WFS, a mechanism allowing people outside the organization to update their data, not just view it. The OGC is rolling out testbeds and an open-source reference implementation of WFS written in Java and based on the existing open-source library called GeoTools (www.geotools.org).


Paul Ramsey

Strassman (envisioning a future where vehicles don't just acquire GPS positional data; they also broadcast their locations back, bidirectionally, to a central source): If you start seeing users moving out there, you can start building content out of that; all of a sudden you're tracking where everyone's stopping — you know there's traffic or an intersection there. You see cars only going one way down a street; you know it's a one-way street. You start actually building and enhancing datasets based on that information.


Mark Strassman

Now what?

Will any of these trends change your spatial datasets, software applications, and business practices? For some of us, probably not. As David Maguire noted, "At one level nothing changes. Everything that everyone's been doing in the past still works." Maguire went on to stress, however, that as technical barriers continue to drop, true collaboration is sure to follow. To participate in and benefit from the trends of decoupling, proliferation, real-time automation, commoditization, increased data resolution, and bidirectional flow, our first challenge is understanding them. Thanks very much to these 10 experts who helped us do just that by sharing their experience and observations! Best of luck in the year ahead.