Location-Based Services & GML

Laying the Geo-spatial Web Foundations

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1. Introduction

The world of the wireless Internet is almost upon us. This past year saw the number of Imode users in Japan pass 12 million. While numbers are smaller in other parts of the world it is clear that wireless Internet is here to stay.

One of the key requirements of any mobile wireless user is to know what is going on around them. Questions such as "Where am I?" "What is near by?" have special meaning to a moving user often navigating in a unfamiliar environment.

I arrive late at night in a strange city, rent a car and head for my hotel 50 miles out of town. En route I realize that the highway ahead requires local currency, and in my haste to make the plane I did not arrange to change any money. I could go back to the ATM's in the airport, but that means finding a parking space and navigating the airport. In addition why lose the time of going in the opposite direction. I need to locate the closest ATM before I reach one of those toll booths.

Note that the answer to my question could be phrased in the form of a map, however, that is only one of many possibilities. It could be a voice message ("the closest ATM is located at … "). It could be a route displayed on a map on my in-car computer, or on my cell phone or PDA. It could be driving directions sent to my in-car navigation system. The key thing to understand here is that it may be any or all of these different possibilities and more besides. Furthermore we can expect different types of communication modalities to be available at different points in time and for different purposes. In every case, however, the information supplied rests on a geographic model of the world around us. Unlike the traditional desk-bound surfer that navigates a virtual world in cyberspace, the wireless user navigates the real world through the lens of the geo-spatial world model.

Building this geo-spatial world model is the key subject of this paper.

The wireless world is of course different in other ways from its desktop cousin. Wireless users usually have less bandwidth available to them although this is changing rapidly. Wireless users work with display devices offering limited spatial and colour resolution. More importantly wireless users are doing something else (e.g. driving a car, talking on the telephone) and hence have limited attention space for visual information display. or for devices that require their hands for interaction such as a pen or track ball.

The consequence of these wireless constraints is that information presentation must be tailored to both the user's device and to the user's task. Furthermore, both of these may change in a dynamic fashion as the user moves from one place to another. The presentation of the geo-spatial world model must be conditioned by the user's activities and by the state of the world around them. The key driver however is not the bandwidth, nor the display restrictions of the wireless user, but rather the more fundamental fact that he or she is doing something other than being connected to the Internet. The wireless Internet user is busy.

Our picture of the future of location-based services is thus one of users interacting with a model of the world, and one in which information about that world model is dynamically presented to different users in different ways and at different times.

When we say model of the world do we mean one model only? Surely there are different models for the casual tourist than for the ambulance driver? Surely the model for the exploration geophysicist is not the same as that of the New York cab driver or the Tokyo policeman? When we say the wireless user interacts with a model of the world we recognize that there can be many such models.

Even in this context of multiple geo-spatial models it is clear that different users have different views of the world. Each does not exist in a separate and isolated world. Wireless users interact with one another and within the things in the real world around them. Each user interacting with a particular model of the world has their own view of that world containing the types of objects and object relationships which are of interest to them and to the role they are playing at a particular time. Wireless users interact with views of a model of the world. The user's view changes as their role and context change.

There are thus several levels in our hierarchy as shown in Figure 1.

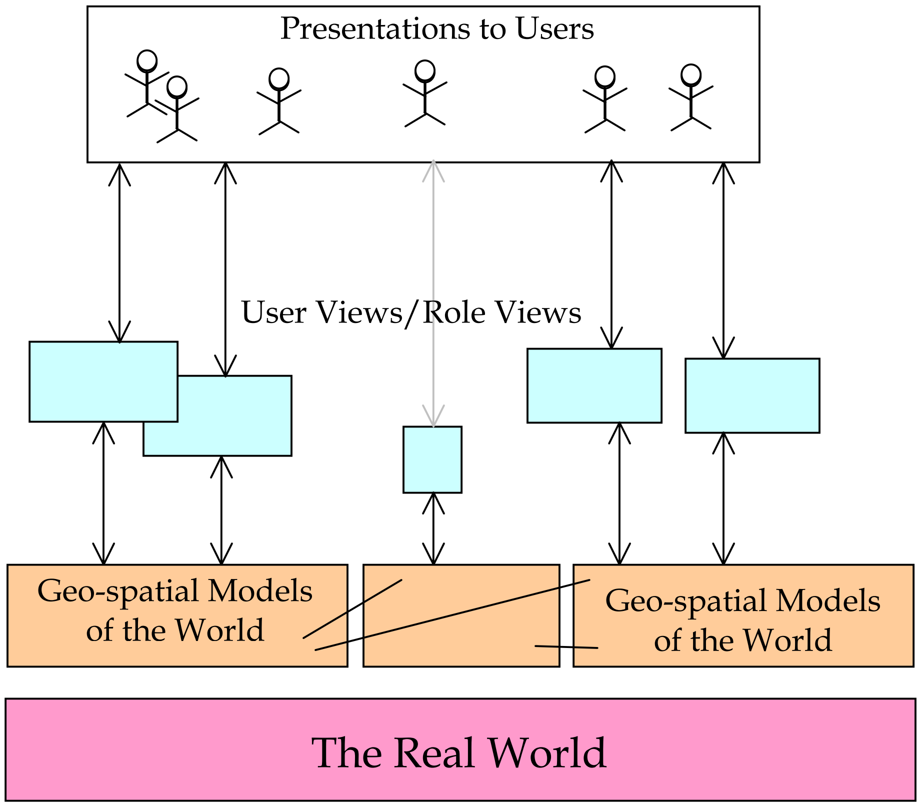

Figure 1. A Hierarchy of Models, Views and Presentation

A moment's reflection indicates that the picture is really somewhat more complex than that shown in Figure 1. Not only do we have interconnected views of the geo-spatial models by different users and user roles, we also have relationships and dependencies between the different geo-spatial world models. The roads and streets, the buildings and coastal boundaries, and other feature types are shared by many geo-spatial models. The geo-spatial model is thus in reality a network of interconnected models rather than a simple hierarchy.

The simple hierarchical picture from conventional cartography (e.g. base data and overlaying layers) must be replaced by the more complex notion of a network of models as we enter the world of location-based services. This is a complex concept and rests on building an equally complex and highly distributed dataset. Is such a thing possible?

It should be obvious that such a complex and far-reaching structure cannot be built by a single organization, or even by any single group of organizations. Furthermore it is clear that such a complex structure requires a degree of organic development. Sound familiar? The Internet itself offers the outstanding model for such an information structure.

2. GML AND THE GEO-SPATIAL WEB

The premise of this article is that the successful deployment of location-based services depends on the evolution of a geo-spatial information infrastructure, a linked and integrated set of models of the world that capture information about the world around us.

At Galdos Systems, we further believe that Geography Markup Language (GML) is critical to the evolution of this geo-spatial infrastructure, just as HTML was to the development of the conventional Internet. Why might this be so?

In the simplest terms, GML is nothing more than a means of encoding geo-spatial information using XML or eXtensible Markup Language, the emerging "lingua franca" for data description. Using GML, one can encode a description of the location or spatial extent of a building, a roadway or a lake. Such encodings can readily capture not only the geometry of the building or roadway, but also any of its other properties such as the number of lanes or the number of floors.

GML can go further of course and capture information about more abstract spatial entities like voting districts or county boundaries. None of this is in itself new, however, as GIS (Geographic Information System) technologies by vendors like ESRI or Intergraph have been doing this for years. One of the key things about GML, and one of things essential to its role in the emerging world of location-based services is that it is open and non-proprietary. No single vendor controls it. This means that many vendors can build components and software to capture, share and transform GML data. This is essential in the global world of the Internet.

GML goes still further by embracing a means of representing spatial relationships. When you look out into the world you do not see isolated geographic features. The roads are not in one place and the rivers in another. You perceive the world as an interconnected and inter-related set of entities each distributed in space and time. GML allows some of those relationships to be effectively captured, something that has long been a goal of the geo-spatial industry. GML not only enables the representation of such spatial relationships, it does so in a distributed fashion. Data elements in one part of the country can be dynamically related to data elements in another, in much the same manner as the real world entities that they represent.

Land parcel datasets can share political boundaries. Utility corridors can share parcel boundaries. Coastal boundary and terrain data can be owned by a land-based mapping agency and shared with the related hydrographic institute.

GML opens to us the possibility of building interconnected spatial models in much the same way as we routinely link web pages. Create a web page. Open other web pages on the Internet and link them to your newly created page. Suddenly your new web page is an organizer, a centre of information, and a set of relationships between hitherto unrelated islands of information. So too, will GML drive the world of the Geo-spatial Web.

GML achieves the capabilities by building on emerging XML technologies for linking and pointing. Linking and pointing, the twin cousins underlying the hypertext revolution that spawned the Internet, emerge in the world of XML as vastly more powerful and subtle than their HTML ancestors. Linking is no longer restricted to simple one-way associations bound to web page display. Links can now represent associations between multiple resources having nothing to do with data visualization. Pointing in HTML meant access only to a point in another web page. In XML pointing provides a means of making fine-grained references to XML elements, trees of elements or even fragments of element content. In GML these XML capabilities translate into powerful spatial and non-spatial relationships between spatial features, their geometric components and non-spatial properties.

3. Towards a User Centric Geo-Web

Most of the wired Internet today is what one might term "site centric". We "go to" or "visit" a site. With the exception of the occasionally useful site map, or clever presentations of our visit history, the cyber-visitor has little insight as to where he or she is located or what is around them. This is acceptable more or less in wired world because we mostly navigate a virtual reality. The target of our journey is of greater importance than who we are or how we get there. While we would value services that tailored the world to our particular tastes this is a nicety rather than a necessity. Not so for the wireless location-based services user.

The wireless user must navigate in the real world. Cyberspace only serves to make that navigation easier and more profitable. It can only do so by taking the character of the user into account. The world of location-based services is of necessity user centric.

To the mobile user what matters most of the time is that fragment of the world in his or her immediate vicinity. In fact this is a useful term to denote those objects of interest that are "nearby" a particular user, at a particular location and at a particular moment in time. A user's vicinity is the perceived bundle of objects that are reachable in a "reasonable time" from their current position. It depends on who they are and the role they are playing. The vicinity of an on-duty paramedic racing to an accident scene is very different from that of the same individual stopping at the store for milk and a loaf of bread while en route to his home. It depends too on the modality of transport that the individual is using. As I move down the Beltway or the Peripherique, I pass thousands and thousands of shops and services. Many of these are very close to me. Only a few would I think of as close in the sense of being easily accessed from the highway. A totally different sense of "vicinity" applies if I am at leisure and walking through a park.

A user's vicinity must select the objects of interest to that user and to that user's role. It must also select the relationships between those objects that are of interest to that user and in that role.

Effective delivery of location-based services will depend on being able to deliver information in the context of the user's vicinity, thus mapping the user's view of the world to the information sources and services that they draw upon.

GML is focused on the expression of geo-spatial content. As in XMI in general, GML strictly separates presentation and content. GML can construct different models of our vicinity for different people, different roles and for different times of day.

GML provides the mechanisms to represent relationships between geo-spatial objects and to do so in a manner that varies from one geo-spatial model to another or from one user's view to another.

4. THE END OF GIS?

Location-based Services, in spite of the current hype are unlikely to represent a homogeneous category of applications. It is unlikely that we will see a huge vertical market of location-based services.

A more likely scenario is that location capability will be increasingly integrated into existing software for everything from transportation and logistics, to municipal services registration, facilities design and construction. Companies whose software already dominates these vertical domains are likely to continue to dominate but using new location aware or location-enabled versions of their products. This is not to say that new companies and services will not arise, but simply that we can expect location-based services to evolve in large measure from the existing software entities.

Where does this leave traditional GIS? At its origins, GIS was a more or less vertical market, devoted initially to the production of digital maps, and subsequently to geo-spatial data analysis such as overlays and network route computations. Much of the value of GIS technology lay in the spatial data structures themselves, the software to manipulate them, and the software for drawing graphical maps.

GML may change all of this. With GML, the structures to represent spatial data become open and accessible to any developer and any data provider. Many tools for data manipulation can be drawn from the large and evolving corpus of tools for treating any kind of XML data. Integrating GML into an application is much easier than with conventional GIS products. Graphics drawing, once the cornerstone of any GIS vendor is rapidly becoming an almost free commodity, built into standard browsers and Internet appliances.

The world of location-based services demands standardization and openness just as for the Internet on which it will build. Analytical tools and applications will remain important, and software vendors with specialist application understanding in fields such as local government, disaster management, forest harvest planning, and facilities design will continue to prosper. Proprietary data models and data encodings, and the ability to transform these into graphical maps will, however, no longer constitute a serious business case.

5. Evolution of the Geo-Web

For the past decade, governments throughout the world have dreamed and worked toward national spatial data infrastructures. Every developed country in the world has such a project or program, including the NSDI (U.S.), NALIS (Malaysia), CGDI (Canada), and NSDIPA (Japan). There is even the concept of a Global Spatial Infrastructure or Digital Earth. Numerous other infrastructures exist or purport to exist at the provincial or state level in almost every developed country. The dream varies from one place to another. In some countries it is an open market in geo-spatial services. In another it is the sale of the national governments data holdings. In still another it is an engine for economic development and improved government decision making. In all cases it depends on the ability to share and integrate spatial information over a broad collection of agencies and over wide reaches of geography.

While many governments have sought to plan the development of such infrastructures, groups of spatial and other IT vendors have organized to facilitate the interoperability of spatial information systems. The largest and most successful of these is the OpenGIS Consortium with some 200+ members from the ranks of academia, government agencies and commercial IT vendors. The OGC has not thus far focused on any explicit notion of a national geo-spatial infrastructure. It has concentrated on more local approaches, by developing the interfaces and encodings that facilitate the exchange of information and services between different agencies and vendors via the Internet. This has led in particular to the Geography Markup Language (GML) specification, and to following specifications for Web Feature Services, Web Coverage Services and Geo-Coding. Increasingly these look like the standards and technology required to build the long sought after national geo-spatial infrastructures.

To carry this success to the next level requires that we begin to think in terms of a national and even international geo-spatial infrastructure. It does not require a single locus of design, but it does require that we work together in a standards based fashion every bit as do the developers of other national and international infrastructures for telephony and data communications. It requires that data holding agencies in both the private and public sectors understand their role in the construction of this infrastructure. It requires that they be active participants in the standards process and in the process of infrastructure deployment.

The fusion of the world of national geo-spatial infra-structures, driven largely by data holders, and the world of geo-spatial standards, driven largely by vendors, is key to the evolution of geo-spatial web, and the world of location-based services on which it depends. Geography Markup Language (GML) is emerging as a key element in the fusion process.