

Web 2.0 Applications of Geographic and Geospatial Information

by Alan Oxley

This paper covers the topic of Web 2.0, focusing on the use of geospatial and geographic data. Web 2.0 has not arisen due to a major change in technology. The label *Web 2.0* applies to recently developed types of web applications and ways of using the web; however, advances in technology, such as the extensive use of XML, have enabled them.

The type of web applications that are available – and which ones dominate – has been transformed as have the ways that people use the web. For example, Web 2.0 allows users to keep track of items of interest. For years users have noted their favorite web pages. Now they can give tags to their favorite pages, photos, videos or other items as part of an interactive, social network. More formally and more pertinently to our topic, items can be geotagged, giving their physical location. Individuals can also make maps for their own use. Finally, the ease with which programmers can access information from websites using “services” has also led to the development of mash-ups. A mash-up is a web application created by mixing the information from two or more sources. Many existing data mash-ups involve data available from map sites.

In this paper we will look at both the Web 2.0 technologies and applications in somewhat more detail. We will also consider the critical area of geographic data standards and the availability of public-sector geographic data, particularly in the United Kingdom. Finally, we conclude with some developments that are likely in the near future.

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Technologies that Support Web 2.0 Geographic and Geospatial Applications

While Web 2.0 may not be only about technology, hardware and software changes have nevertheless facilitated it. In their recent book (*Unleashing Web 2.0* [1]), Vossen and Hagemann call these changes the technology stream of development. Specifically, they include the development of Ajax, PHP, Flash, XML web services and web procedure calls and syndication, among others. We will briefly describe these technologies.

Static web pages have given way to dynamic ones. For instance, Ajax enables just a portion of a web page to be downloaded from a server. Formerly, if anything changed on a page, the whole page had to be downloaded.

Another factor in the development of dynamic web pages has been the development of the scripting language PHP, while Flash is an animation technology that takes up relatively little bandwidth and also makes page content dynamic.

In addition, data can be shared between websites by putting it into a format such as XML (Extensible Markup Language). XML files look like well-annotated databases. They are easy to look at and understand. Freedman [2] gives an example of storing the details of music albums.

FIGURE 1. XML code (from Freedman [2])

```
<Albums>
  <Album>
    <Title>Abbey Road</Title>
    <Artist>The Beatles</Artist>
    <Total_Tracks>17</Total_Tracks>
  </Album>
  <Album>
    <Title>The Fall</Title>
    <Artist>On The Surface</Artist>
    <Total_Tracks>12</Total_Tracks>
  </Album>
</Albums>
```

Returning to Vossen and Hagemann, the *application stream* of development is the name they give to changes in the types of web applications and services that are available and to changes in which web applications dominate – as opposed to the *technology stream* mentioned above. A range of services has been developed for use over the web and that allow one computer to access information on another one. These web services transfer information in XML format. There are three parties involved in the utilization of web services as illustrated in Figure 2.

1. The service providers make their web services known to a registry. Typically the standard for exchanging this information is the Universal Description, Discovery and Integration Standard (UDDI).
2. The client looks for a service in the registry (using UDDI).
3. The client pulls a description of the service from the provider. Typically the standard for exchanging this information is the Web Service Definition Language (WSDL).
4. The client requests information, and the provider supplies it. Typically the standard for exchanging this information is the Simple Object Access Protocol (SOAP).

Sometimes the above model is not adhered to when transferring information from the provider to the client. For example, a provider may not advertise the service in a registry. In these cases we do not use the term *web service*; instead we call them *web procedure calls*. The increased availability of free APIs has led to the development of mash-ups, a new type of web application created by mixing the information from two or more sources. Mash-ups can be created relatively quickly by interacting with APIs via procedure calls.

Finally, syndication is an example of another key feature of

Web 2.0 contributing to the improved functionality of web applications. Using syndication, content such as news headlines or information from retailers can be inserted onto many websites. These are called *RSS feeds*. (There is more than one interpretation of what “RSS” stands for. One interpretation is “really simple syndication.”) When information to be sent over an RSS feed is converted to RSS format, it looks much like XML. A similar phenomenon is podcasting where a user subscribes to a service that provides audio or video files to a portable device or a PC.

Types of Geographic and Geospatial Applications in Web 2.0

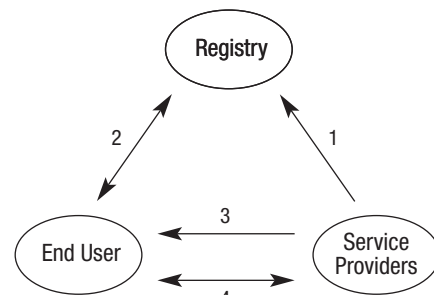
Vossen and Hagemann refer to changes in how people use the web as the “user participation and contribution stream” of development. Users now no longer simply receive information – they create it. A main feature of Web 2.0 is the social interaction that is taking place. This includes the use of wikis (created by users collaboratively) and blogs, the sharing of videos and the use of websites based around individuals giving their comments. Another feature of Web 2.0 is tagging.

Geotagging. Tagging is a widely used social feature of the web. Web users can rank content, as is done in a number of websites. On the Digg website [3], for example, users submit content and other users say if they “dig it” (like it). An overall ranking is thus formed. Indeed, a major feature of Web 2.0 is the power afforded to ordinary users when they act collaboratively.

If users engage in assigning tags to resources, they are said to be creating a “folksonomy.” Any website will have numerous tags associated with it that have been assigned by the different users. It is possible to have a pictorial representation showing the frequency with which tags are used for a particular website. Such a display is referred to as a “tag cloud.” An example can be found at www.flickr.com/photos/tags

In addition to the free use of tags by general users, items can be tagged by more formal means, by adhering to a standard. The Geotagging format is one such standard. It is used to specify the geographic location (latitude and longitude) of an item. Example websites where user information is geotagged include Flickr [4] (photos), Wikipedia [5] (articles and their photos), Upcoming.org (events and things to do), Weather, the U.S. site Traffic and

FIGURE 2. Steps involved in making web services available from a provider to a client



Yahoo's Local Search site. Some websites such as Flickr have a built-in map display, such as Flickr [6].

Mapping. Using Web 2.0 features, some individuals make maps for their own use (neography). On the social networking site MySpace [6] it is possible to map the location of one's friends (see ProfileMaps.info [7]). In another application, a group of friends can see where each other is located by displaying a map with markers, on their mobile phones (see plazes.com).

This activity is facilitated by the availability of hardware and software, some of which is low-cost, including high-speed digital cameras, handheld GPS location equipment, vehicular SatNav and digital compasses. As far as handheld location equipment is concerned, there are low-cost Bluetooth GPS receivers that can transmit to a PDA, mobile phone or laptop PC. Some PDAs and mobile phones have GPS built into them. A full 3D orientation of a mobile user can be created from the combination of a GPS receiver, a compass and tilt sensors (or gyroscope). A geo-wand is a device that uses 3D information to identify geographic objects by pointing at them. Knowing the location and orientation of the user, a database is consulted in order to identify the object. Simon and Fröhlich [8] developed a system comprising a sensor-equipped mobile phone, a geo-wand and software, which they used to identify buildings they pointed to in a city center.

A large amount of software exists, including Google Maps, Yahoo! Maps, Windows LiveSearch Maps [9], Google Earth, NASA World Wind, Open Street Map, Ask Maps, Map24 and MapQuest [10].

Mash-ups. A mash-up is a new type of web application created by mixing the information from two or more sources. For example, traffic data from one site could be acquired while mapping data could be retrieved from a second site. The resultant site could give some pictorial representation of traffic congestion. There are several collections of existing mash-ups such as at gallery.yahoo.com and www.programmableweb.com

Many existing data mash-ups involve data available from the search engine providers Google and Yahoo! In order to affect a mash-up a programmer needs to write code. For the information contained in a website to be accessible to a programmer, the website must have the necessary

interface to make procedure calls, an applications programming interface (API). Freedman [2] gives an example of retrieving data using the Yahoo! Maps API. This can be illustrated by entering the following URL [11] into a browser.

<http://api.local.yahoo.com/LocalSearchService/V3/localSearch?appid=WroxYahooMaps&query=pizza&zip=60609&results=1>

The first part of this URL gives the location of the API. In this case we are requesting from the server the details of pizza cafes in U.S. zipcode 60609. The server extracts this information from its database. It also converts the zipcode into latitude and longitude or "geo-codes" it. The information is then written in XML code and sent to the client. The client's browser displays the XML code. In practice the URL will be called from within the web page code and the returned XML code would be processed to, say, place a marker on a map. Details of the Google Maps API can be found at [12]. Before making use of it one must sign up for a key.

There are other examples. GeoURL [13], for instance, is a website that lets you see other websites that are close to a given location by assigning geotags. (It is possible for software to automatically assign a geotag to an item by, for example, reading the text and looking for a place name). Trippermap.com, Stamen Design's website [14], and [Fotoland](http://Fotoland.com) [15] are also mash-ups, in this case, of Flickr and Google Maps. They can plot a map showing the location of photos provided that each photo is tagged with a place name.

Standards and Policies Regarding Geographic and Geospatial Data

The traditional providers of geographical information systems have standards. Those investigating issues related to digital data include a collection of user organizations, the Open Geospatial Consortium (OGC), the International Standards Organization (ISO) and various government bodies. The relevant ones in the United States are the Federal Geographic Data Committee (FGDC) and the National Spatial Data Infrastructure (NSDI) program.

The OGC comprises hundreds of organizations from both the public and private sectors. One of its achievements is the definition of the Geography Markup Language (GML), for specifying how geographic objects should be defined in website programming code. A group that works closely with the OGC is ISO TC/211, a standard technical committee within the ISO for digital geographical information. The standards produced by OGC are often identical or very similar to those produced by the ISO TC/211. The standards used for geospatial web services are quite different than those for non-geospatial web services. Zhao, Yu, and Di [16] review the standards for geospatial web services.

Discussions have taken place between Google, the Ordnance Survey (United Kingdom) and others, into possible standards for use with new technology. (The Ordnance Survey is the United Kingdom government body responsible for mapping.) The IT community and users need to know what standards can be applied to open data, mash-ups and user-created content. The community will attempt to suggest how an institution can decide which geo-data services to use based on compliance with standards. The British government's Information Fair Trader Scheme, of which the Ordnance Survey is a member, sets standards for the reuse of information in the public sector.

The topics that must be considered in setting geographic and geo-spatial data policy include trust, provenance, access to data, longevity, IP rights and data accuracy. There is also the potential problem of changes to software. The question of how continuity of access to data can be maintained in the face of software revisions needs to be addressed. Potentially, networking problems could occur if mash-ups are prevalent.

Availability of Government-Produced Geographic Information with Reference to the United Kingdom

Due to technological advances, tools have now become available for individuals and small organizations to reuse public sector information. The British government is interested in maximizing the value of online information to citizens and government departments. In theory it wishes to collaborate with the contributors to user-generated sites, work out how

public information can best be supplied and protect the general public. One way it intends to help user-generated sites is to look at the licensing of information to ensure that it encourages innovation, especially when information usage is not for profit.

Let us consider the role of the Ordnance Survey (OS). In today's society it is essential to have high-quality maps, including a clear definition of the area covering each postcode and a clear definition of who owns what land. Key activities that depend on the reliability of this information include the delivery of products to a property and the rental or transfer of ownership of a property. The Ordnance Survey's OpenSpace project, created in 2006, is an example activity by the government in its efforts to supply public information. It is intended as an experimental service in open data formats for non-commercial use, but it has not been launched.

There would be benefits to releasing OS data to individuals and small organizations for free. Firstly, there would be increased usage of the data. The South African Mapping Agency had a 500% increase in the usage of its data when it stopped charging for it. The extensive use of Google Maps in data mash-ups is, no doubt, due to the fact that developers can use it freely for non-commercial purposes. Secondly, non-commercial use encourages innovation. Thirdly, if launched soon, the OpenSpace project could serve as a pilot project for future non-commercial licensing of government data.

In practice, the government normally charges very little for providing public sector data that others wish to reuse. There are exceptions though, and these are termed *trading funds*. The OS, which costs approximately £60 million a year to run, is a trading fund. It is the largest trading fund by revenue. It funds almost all of its operations from commercial revenue, although half of this revenue comes from use by different parts of government. The question that is being asked is "Who should foot the bill?" The OS's OXERA study claimed that the OS's activities underpin £100 billion per year of U.K. economic activity. There is a huge difference then between the running costs and the claimed economic benefits. If the current way of charging for OS data is inhibiting economic activity, then activity would only have to increase by a tiny amount for it to offset the £60 million costs. This and other arguments given by Mayo and Steinberg [17] suggest

that consideration should be given to removing its status as a trading fund. If this were done the taxpayer would foot the bill. Mapping agencies in the United States, South Africa and Canada, for example, make their data available to commercial and non-commercial users free of charge. In the light of this and the other reasons discussed above, they recommend that the OS should launch the OpenSpace project.

The Future

Examples of technological developments that are likely to affect the web within the next five to 10 years include the following:

- *GeoTracker* [18], a mash-up between an RSS publisher such as Yahoo! News or Google Video and Google Maps. The user is presented with a map having pins on it corresponding to where events are taking place. The user can hover his/her mouse above the pin to get a brief description or click on the pin to get detailed news in the form of text and, sometimes, video. With GeoTracker it is possible to look at a period of time – a day or a week, say – and move a sliding bar from the start of the period to the end. The user will be able to see the pins appearing as the news was reported and, in the case of multiple reports from the same location, the pins are color-coded to indicate the frequency of the reports.
- Microsoft Research's project *Composable Virtual Earth*, which is looking into the inter-operability of map mash-ups
- *Geo*, a draft standard for specifying latitude and longitude of a web page in HTML code. Other websites can read this information and process it by, for example, displaying a map of the location. There is another draft standard called *GeoRSS* for embedding the latitude and longitude into the code of an RSS feed. A browser displaying the feed can read the information and display an appropriate map.
- Developments in open source geospatial applications
- Sensor-based geographic information systems
- Virtual reality mirror worlds.

Also important is the continued development of software engineering

(SE). Broadly speaking, SE has evolved from structured programming to object-oriented programming to component-based SE to service-oriented architecture (SOA). With each change there has been a higher level of abstraction. The potential of SOA is yet to be realized. It promises to dramatically affect how the web is used. The aim of SOA is to make it possible to create a website that makes use of the services offered by two or more existing websites. For example, one could develop a holiday planning website to organize an array of details and constraints specified by the holidaymaker such as the following:

- Departure and arrival dates
- Grade of hotel
- Size of car to be hired
- List of excursions
- List of plays, cinema viewings

The holiday planning website would make use of existing websites that focus on each aspect of the trip: air travel, hotels, car rental, public transport and so forth. Such planning websites already exist; however, the various constituent websites were designed to interact with one another. With SOA the intention is to make it possible to develop a value-added website from constituent websites that have been developed independently. Mash-ups can be regarded as the forerunners of website combination before more formal SOA frameworks have been established.

Conclusion

Many Web 2.0 applications are incorporating geographic and geospatial features creating tagged data and also mash-ups, which involve combining data from more than one source using APIs. This rapidly evolving area poses both hardware and software challenges. However, the major challenges are institutional, for example in standards development and data policy. Web 2.0 geographic and geospatial applications will also affect not only how individuals operate, but also many institutions and the agendas and methodologies of research in the hard and social sciences. We look forward to rapid and significant evolution in this area. ■

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