

To improve a public participation decision support system based on web2.0 technology

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Abstract

Despite the importance of the public participation, there are limited methods to support the participation in decision making processes. Web-based technologies have been developed to overcome above the obstacles. Web 2.0 resolves the problems, which allows people to share their opinions through the Internet. Although the Web 2.0 technology allows users to participate in the planning process easily, the web-based Public Participation GIS (PPGIS) requires another tool to collect and manage user's opinions. The opinions would be submitted in different formats. For example, it is reported by using images and movies or text formats. However, the PPGIS should produce collective and overall summarized information from the public input data in order to support decision makers. Therefore, the purposes of this research are to develop 1) a spatial data warehouse using ArcServer based on .NET Framework, 2) diverse webservices through using OpenAPI that is served by Portal Site and Software Company, 3) Easy-to-use Web environment using AJAX, and 4) Polygon-based data structure to organize and reclassify various formatted opinions in order to efficiently analyze the data.

1. Introduction

Web 2.0 has been developed to use the concept of User Generated Content (UGC) that user (client) directly generates contents and shares them with other user. This means that the one way distribution is changed to the two way process as 'Conversational Application'. This change in the web environment can apply to the Geographic Information System (GIS). GIS data is accessible on the Internet. And the spatial data for using in the GIS is made by GIS user on the Internet as the UGC concept. It is the concept of Public Participation GIS (PPGIS). As well as participating as UGC, the development environment is changed by OpenAPI. The OpenAPI is served by portal site and software-company. It provides simple interfaces and methods to users (or developers). In case of using map API (Google map API, Virtual Earth API and so on), users (or developers) can add several types of map to their web application and can use tools. By using satellite maps and street maps, users can more easily make GIS services on Internet. And the strong point of openAPI is possible to make customized services through mixing these openAPIs. This concept is called Mashup. For example, user can make a web application by using google API, Microsoft API and Yahoo API. These APIs have a merit of easily providing map services through the web, but they have apparently a limitation about GIS analysis tools. However ArcServer released by ESRI allows supplement. ArcServer could provide a variety of maps as well as necessary GIS analysis

tools. And these are provided on Web. PPGIS applications are served to users in this environment but problems for GIS analysis remain. For example, users simply create a location data as a point type and participate in PPGIS. But data have a weak relationship each other. So it is difficult to understand for analysis. Therefore, the purposes of this research are to develop 1) a spatial data warehouse using ArcServer based on .NET Framework, 2) diverse webservices through using OpenAPI that is served by Portal Site and Software Company, 3) Easy-to-use Web environment using AJAX, and 4) Polygon-based data structure to organize and reclassify various formatted opinions in order to efficiently analyze the data.

2. Review of current communication technologies

2.1. PPGIS

The phrase "public participation GIS" comes to the GIS community from the planning profession (Obermeyer 1998). In the mid-1990s, Harlan Onsrud, Paul Schroeder and Xavier Lopez of the University of Maine met to plan a workshop on the subject of how to improve access to GIS among non-governmental organizations and individuals, especially those who have been historically under-represented in public policy making. Mr. Lopez suggested using the phrase "public participation" in the workshop title because of its use and familiarity among planners, who also have a long and close affiliation with GIS technology. As a result, the phrase has since been used to describe a variety of approaches to making GIS and other spatial decision-making tools available and accessible to all those with a stake in official decisions (Schroeder 1997).

However differences have existed between the PPGIS and the GIS, Carver (2001) has explained its relationship by using SWOT (Strengths, Weakness, Opportunities and Threats) analysis. He said that the most benefit of PPGIS is a part of decision making as a public participation. And if user is able to access the Web based GIS, it provides the environment of participation. When GIS service is provided on the web, user can easily obtain information about policy and GIS data. The relationship between PPGIS and Web based GIS is interoperability.

For example, the city of Seoul provides GI (Geographic Information) about Seoul to user on the internet. Nation Map, in USA, aims to update data at real time through web and improves a quality of data as participating by government, federal and public. The EGIS of HUD (Housing and Urban Development) also provides online information about HUD and EPA (Environmental Protection Agency) by local communities and user could search data about their local communities.

Recently, the most applications provide that user can customize their maps. Now users participate in PPGIS by taking GIS data as well as share a GIS service that is made by OpenAPI among users. They are provided as various types (i.e. Mashup). For example, user can create and share maps based an album application that is made of Google Map API, Microsoft Map API and Flickr API. And users can create another type of applications that show static value about county by using map API and static data. PPGIS has been extending that users can participate in them by using GIS data as well as directly created GIS services. But this process has problems. Above all it is hard to gather GIS data. Because now participating type is very difference and they need a relationship among them for analysis. And data type is mostly specific location that is point type, so it has a limitation in the analysis of used relationship with distance. And PPGIS needs management or maintenance systems for a diversity data.

2.2. Web based GIS

The Web base GIS provides GIS Services to user via the Internet. User can obtain information from the Web based GIS. It means only using the GIS services via web but doesn't assure to be able to participate in the Web based GIS.

The Web base GIS consists of several web components including Database, GIS Service, Web application and Browser. The role of GIS Database is management, maintenance, security and query about GIS data. To update data is important in database and to keep accuracy is too. And the map service belongs to GIS Services. The map services provide spatial data coverage around the globe. The spatial data include the map data (e.g. road network, hydrographic features, political boundaries) and image (e.g. satellite photo, aerial photo) (Chow 2008). And the Web Application is hosted in server. It responds to users' request as HTML, graphics (e.g. JPEG, GIF, PNG) and so on. It connects to GIS Server via script language (e.g. javascript). Thus, the web application accesses to GIS Services.

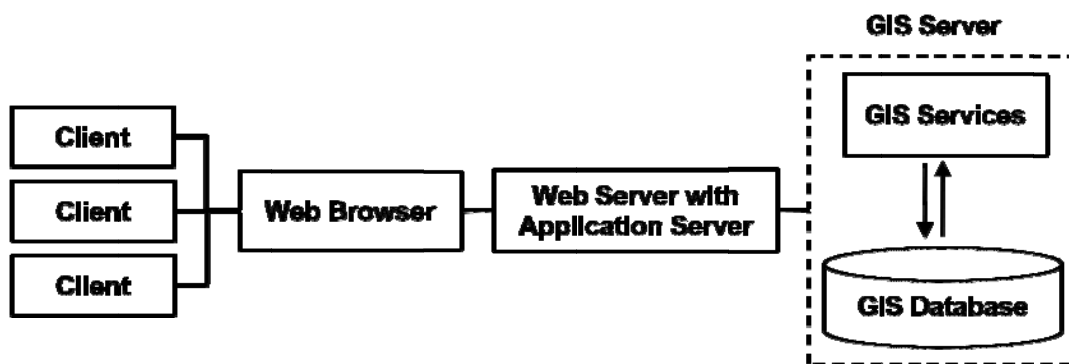


Figure 1 Simple Architecture of Web based GIS

The structure of GIS Services is shown by figure 2. The concepts of component, interface, and service are based on ISO TC 211 document *Geographic Information – Services*, as follow. (ISO19119)

- Component – “a physical, replaceable part of a system that packages implementation and conforms to and provides the realization of a set of interfaces”
- Interface – “ a named set of operations that characterize the behavior of an element”
- Service – “ a capability which a service provider entity makes available to a service user entity through a set of interfaces that define a behavior, such as a use case”

The architecture of GIS Services is described by using UML in Figure3. UML notation use diamond shape to represent the aggregation. The line between classes represents the association relationship between them. The texts next to line are association names. Based on UML notation (figure 3) identifies the architecture of GIS Services. There are four types of associations. The class User has the class User Scenarios. The class User Scenarios constructs the class GIS Services Architecture. The class GIS Services Architecture provides the class GIS Services. The class GIS Services fulfills the class Users needs.

And the aggregation relationship (in Figure2) also consist of four types aggregation relationships. The class User Scenarios is composed of the class GIS tasks, Client Machine, and Network Performance. The class GIS Services Architecture is constructed by the class Geodata Objects and GIS Componets. The GIS Services is provided to user by these relationships.

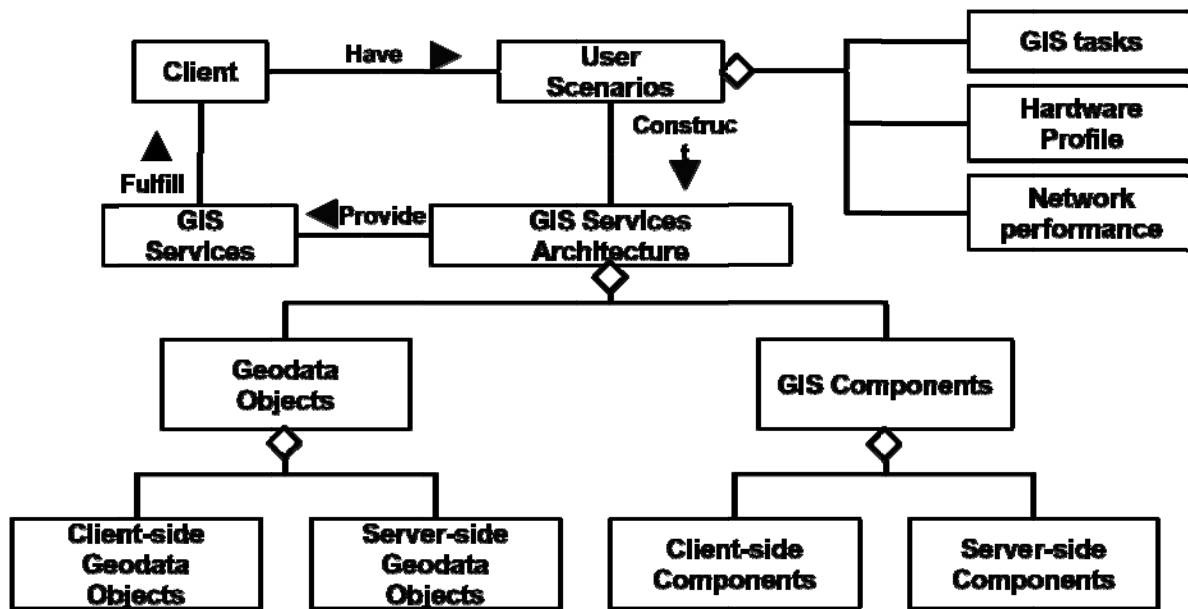


Figure 2 The Architecture of GIS Services (Peng and Tsou 2003)

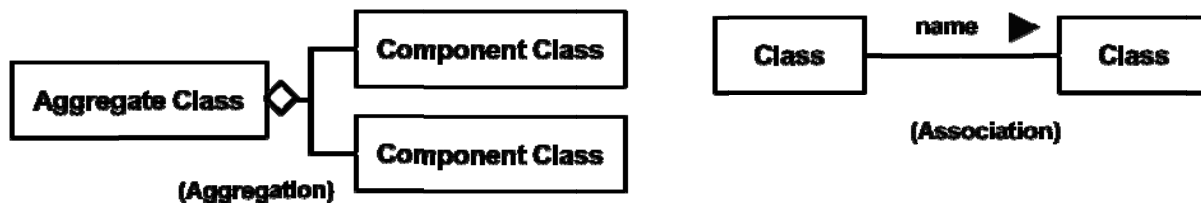


Figure 3 UML Notation

2.3 The Concept of Web 2.0

The concept of web 2.0 proposed by Tim O'Reilly in O'Reilly Media, is improved from early internet that is to obtain and to distribute information simply. According to the summary of its content, the Web 2.0 could be the recreated space of the wisdom of crowds that is divided by participating, opening, sharing the distributed information (O'Reilly 2005).

Web 1.0		Web 2.0
DoubleClick	-->	Google AdSense
Ofoto	-->	Flickr
Akamai	-->	BitTorrent
mp3.com	-->	Napster
Britannica Online	-->	Wikipedia
personal websites	-->	blogging
evite	-->	upcoming.org and EVDB
domain name speculation	-->	search engine optimization
page views	-->	cost per click
screen scraping	-->	web services
publishing	-->	participation
content management systems	-->	wikis
directories (taxonomy)	-->	tagging ("folksonomy")
stickiness	-->	syndication

Table 1 O'Reillys' initial brainstorm, he formulated our sense of Web 2.0 by example

Web 2.0 based on participating, opening, and sharing is developed and is being utilized via the portal service (e.g. Wikipedia, Flickr, Youtube). Users voluntarily supply their information and share it via the web site. If the more people participate, open and share their information, web site is more and more accumulated by those. Finally, it forms the rich wisdom of crowds.

3. Development of Web based PPGIS

3.1. Limitation of Legacy System

The method of participation in the legacy PPGIS is formed by adding, editing and updating information. But portal sites and software companies open their API (e.g. map, tools) to user, so users can easily customize GIS services themselves. Thus, users participate in PPGIS with the GIS data and the GIS services those are made by themselves. But the GIS services via this process are almost visualizing them in parts. When each user is participating same object in this process, the legacy PPGIS is differently representing them. So it needs to aggregate the participation data. The each participation data is representing same data via other way, and systems have only the objects' IDs relating with each data. So it could not have the strong relationship of data. It is the limitation of aggregation in the current systems. To improve this limitation, the participation data is stored as aggregated type (e.g. polygon) in Figure4, so it is efficiently for managing, manipulating and analyzing.

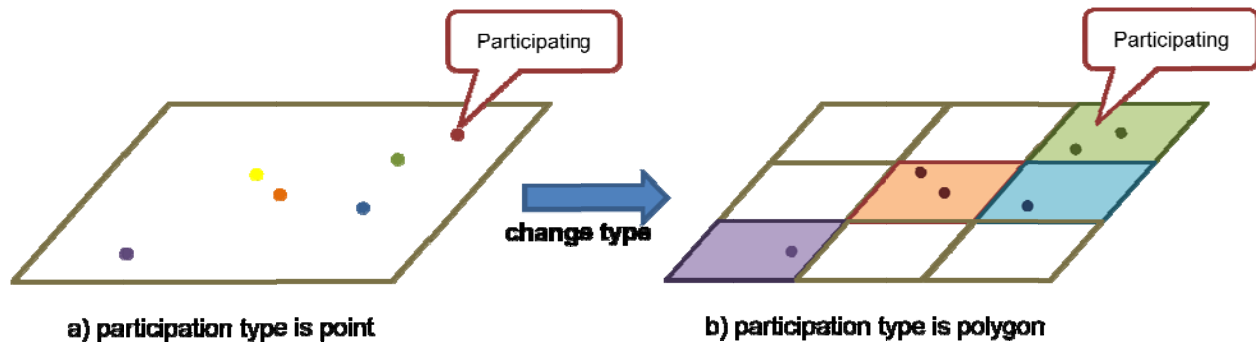


Figure 4 the change of relationship structure

3.2. Architecture of Web based PPGIS

In figure 5, the GIS Services consist of ESRI API and OpenAPI (Google, Microsoft) and are mixed via the Mashup concept. And web application is hosted by web server. When user requests the GIS service via browser, the Web application find appropriate GIS services, and request it to server and respond to a users' request. Review components of architecture, in detail, ArcGIS Server is a comprehensive web-based GIS that provides a range of out-of-the-box end user applications and services for mapping, analysis, data collection, editing, and management of spatial information. ArcGIS Server provides a server-based platform (Map, Geocode, Geoprocessing, Geodata, Globe). ArcGIS Server supports access using a range of desktop, custom, mobile, and browser-based clients. ArcGIS Server also includes the ArcSDE data management technology for managing multi-user, transactional

geodatabases using a number of relational DBMS's. (ESRI Online help document 2008). And the OpenAPI is technologies that enable websites to interact with each other by using SOAP, Javascript etc. While its possibilities aren't limited to web-based applications, it's becoming an increasing trend in so-called Web 2.0 applications. (Wikipedia)

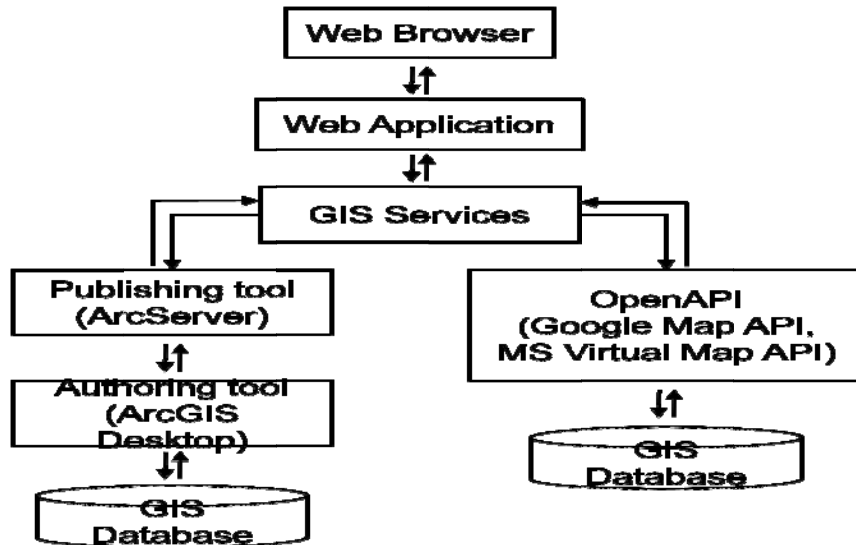


Figure 5 Architecture of Web based PPGIS via OpenAPI and ESRI API

4. Implementation to a Public Participation Decision Support System

4.1. Implementation

The implemented Public Participation Decision Support System is divided to the parts of a user interface, an administration database and organization of GIS Services. The development platform is the .NET Framework and primary language is C#, ASP.NET, Javascript and HTML. The most important part of implementation is to organize a map service in the GIS service. It consists of basic map (e.g. street map, satellite map, terrain map) that is implemented by using Google map API. If an application need to visualize 3D model, implemented by using the Virtual Earth API of Microsoft. Map interface is also implemented by the openAPI. The part of transforming participation data (point) into polygon type is implemented by the ArcServer. And ArcServer (ArcSDE) stores and manages the GIS data via participating. And the Geoprocessing Service is too.

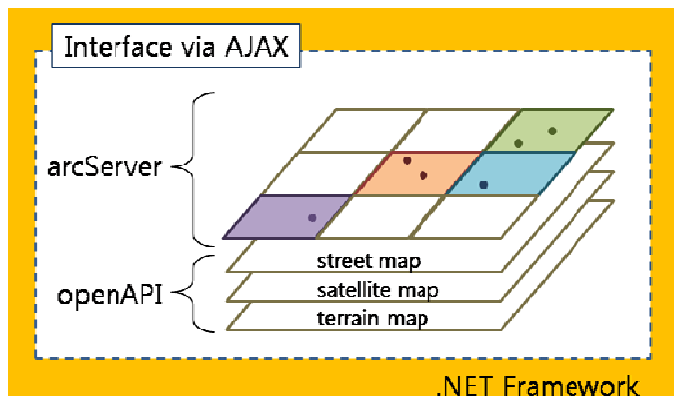


Figure 6 the Conceptual Implementation Model

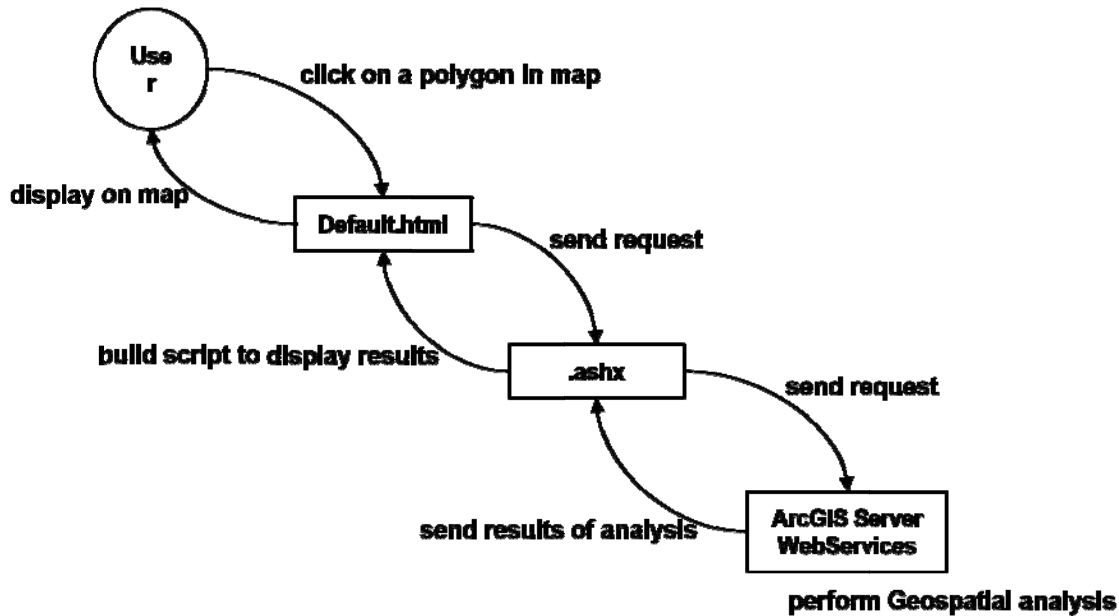


Figure 7 A principal of web application operation

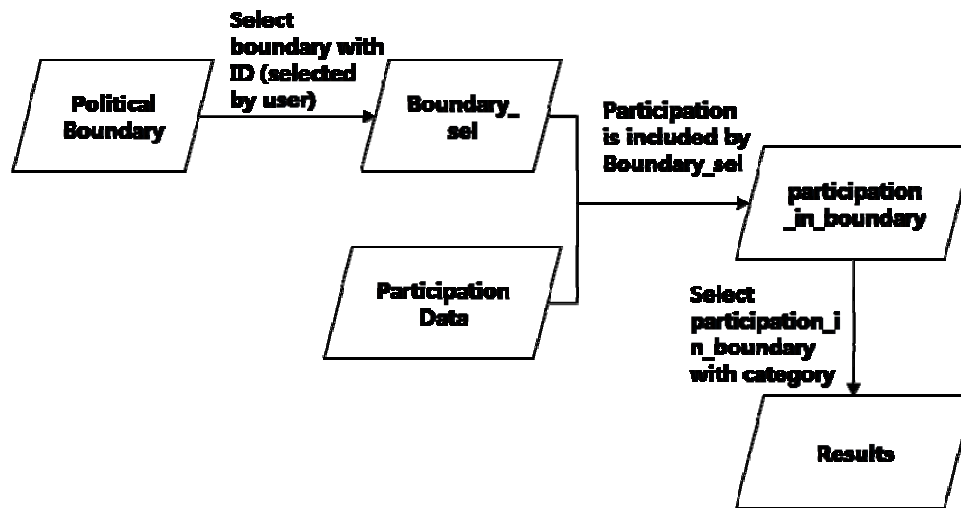


Figure 8 Data Flow Diagram of GIS Services

If users click a polygon in map, then HTML page sends request to web-method, and then web-method sends request (parcel info) to the ArcGIS Server Web Services (Figure 9,10). After the ArcGIS Server Web Services performs Geospatial Analysis (Figure 8), send result of analysis back to web-method. The web-method builds script to display results those are created by previous step (Figure 11) and send script to HTML page. The HTML page display results on web page. For example, an architect wants to search the demand of remodeling in one district. He connects this web application, and selects a wanted district (polygon). So web application displays the data of district (e.g. law, census data) and demands that is participated by another person who want to remodel his house in selected district. And an

architect easily gains this data by simply clicking polygon.

The goal of this system is to aid decision making for zones analyzing by gathering and managing the GIS data. And so the polygon type of participation changed in this article serve as one of methodology that provides rapid analysis process, efficient storing GIS data, and simple web interface.

```
//Get Parcel Info
ISpatialFilter sf = (ISpatialFilter)context.CreateObject("esriGeodatabase.SpatialFilter");
sf.Geometry = pt;
sf.SpatialRel = esriSpatialRelEnum.esriSpatialRelIntersects;

IFeatureCursor featCursor = parcelFeatureClass.Search(sf, false);

String html = "";
IFields flds = (IFields)parcelFeatureClass.Fields;
IField fld = null;
IFeature feat = (IFeature)featCursor.NextFeature();
if (feat != null)
{
    html = "<table>";
    for (Int32 i = 3; i < flds.FieldCount; i++) //skip OBJECTID, etc.
    {
        fld = (IField)flds.get_Field(i);
        if (fld.Name.ToUpper().IndexOf("SHAPE") == -1) //skip shape fields
        {
            html += "<tr><td><b>" + fld.AliasName + "</b></td><td>" + feat.get_Value(i) +
"</td></tr>";
        }
    }
    html += "</table>";
}

if (html == "")
{
    return "Try again.";
}
```

Figure 9 Get a Parcel Information (John Waterman 2008)

```
//call ArcGIS Server web service
string serviceResponse = gisService.getParcelInfo(x, y);
if (serviceResponse.ToUpper().IndexOf("TRY AGAIN") != -1)
{
    context.Response.Write(header["cmd"] + "|" + serviceResponse);
    return;
}

string[] splitResponse = serviceResponse.Split("{".ToCharArray());
string attributeInfo = splitResponse[0];
```

Figure 10 Call the ArcGIS Sever Web Service (John Waterman 2008)

```
//Build Google polygon graphics
string googlePolygons = "";
string[] splitPolygons = splitResponse[1].Split("?".ToCharArray());
for (Int32 i = 0; i < splitPolygons.Length; i++)
{
    googlePolygons += "var polygon = new GPolygon([";
    string[] splitPoints = splitPolygons[i].Split("|".ToCharArray());
    for (Int32 iPointCount = 1; iPointCount < splitPoints.Length; iPointCount++)
    {
        string[] splitPoint = splitPoints[iPointCount].Split(",".ToCharArray());
```



```

        string lng = splitPoint[0].ToString();
        string lat = splitPoint[1].ToString();
        googlePolygons += "new GLatLng(" + lat + ", " + lng + ")";
        if (iPointCount != splitPoints.Length - 1) googlePolygons += ",";
    }
    if (i == 0) //first point is buffer polygon; specify different color
    {
        googlePolygons += "], '#FFFFFF', 5, 0.8, '#0000FF', 0.4);_map.addOverlay(polygon)";
    }
    else
    {
        googlePolygons += "], '#f33f00', 3, 1, '#ff0000', 0.2);_map.addOverlay(polygon)";
    }
}

```

Figure 11 Build the Google polygon (John Waterman 2008)

5. Conclusion

The key point of PPGIS application is decision making by public participation so that the PPGIS application should basically provide comfortable and easy interface to user. And the current OpenAPIs those are served by Portal Site (e.g. Google API, Microsoft API) help to visualize the GIS data and to customize the GIS services but they has apparently limitation about analysis tools. Developers need to implement with ArcServer or another GIS analysis tools via the Mashup concept. And it needs to develop an efficient application for user and to deploy the suitable GIS services. In addition, the participated GIS data that is aggregated is needed to store, manage, and manipulate for efficient analysis. For example, when analyzing a demand in political boundary, if the participation is aggregated as polygon, is more effective during analyzing.

6. Acknowledge

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