

INTELLIGENT GEO-WEB SERVICES BASED ON HYBRID-MASHUP USING OPEN SOURCE GEO-SPATIAL SOFTWARE

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ABSTRACT:

In these days, geo-spatial technologies, as components in geo-web, according to extension of web 2.0 or more paradigms are diversified and emerged: software as a service, asynchronous particle update, mashup, open sources, rich user experiences, collaborate tagging, and structured information. These are closely related and linked to each other, so as to design and implementation stages for a given target application to meet users' needs. In the mean time, many types of applications using some of them have been developed and implemented. The main theme in this study is a sort of hybrid-mashup. This term is distinguished from data-centric mashup, a typical mashup. As well, it focuses on open sources in geo-spatial communities, open APIs provided by web portal or commercial vendors, geo-standards in OGC and ISO and freely-accessed geo-based data. This can be regarded as technological bases towards more intelligent geo-web to fulfil more complex users' demands beyond data level. In this study, some cases are presented; for examples, mashup using Google maps API, smart 3D applications on mobile devices, or data interoperable application using middle ware of open sources. Architecture with layered structure for hybrid-mashup in geo-web is proposed with an example case. Open sources widely used in geo-spatial domain such as Geoserver or Deegree are utilized, and other open sources are also used in design process: PostgreSQL/PostGIS as open DBMS and spatial engine, and OpenLayers or Google maps API as client modules. The beneficial points of hybrid-mashup in the view from intelligent geo-web implementation are system adaptability and portability, and extensibility for user-sided application purposes.

1. INTRODUCTION

Recently, geo-spatial technologies related to geo-web, are diversified and emerged according to extension of web 2.0 or more paradigms: software as a service, asynchronous particle update, mashup, open sources, rich user experiences, collaborate tagging, and structured information. These are closely related and linked to each other, so as to design and implementation stages for a given target application to meet users' needs. Web service with the basis of Web 2.0 needs a strategic design process for good performance of better data building or contents creation. Some core aspects for this consist in content accessibility, easy-of-use, collaboration with data provider, content authoring tools, open API, rapid implementation of light applications, and feedback on user need.

The main theme in this study covers a sort of hybrid-mashup. This term is distinguished from data-centric mashup, a typical mashup. As well, it focuses on open sources in geo-spatial communities, open APIs provided by web portal or commercial vendors, geo-standards in OGC and ISO and freely-accessed geo-based data. This can be regarded as technological bases towards more intelligent geo-web to fulfil more complex users' demands beyond data level.

Based on the general term, a mashup means a web page or application that combines data or functionality from two or more external sources to create a new service. Intrinsicly, it implies easy and fast integration, using open APIs and data sources to produce results that were not the original reason for producing the raw source data. In this study, some cases are firstly presented in this term; for examples, mashup using Google maps API (Purvis *et al.*, 2006), smart 3D applications

on mobile devices, or data interoperable application using middle ware of open sources. From these experiences, it is recognized that architecture with layered structure applied for mashup implementation is also applicable to intelligent geo-web. In this approach, two terms are introduced: hybrid-mashup and intelligent geo-web. Hybrid-mashup is a kind of mashup which is capable of executing more analytical and functional resources, originated from other existing services or sources. It can be distinguished from general mashup, limited for data-centric services using open APIs, in some extents. At the next, intelligent geo-web can be understood as semantic geo-web in the wide scope. However, component building within intelligent geo-web are less strict than semantic geo-web, composing ontology components such as RDF, RDF schema, OWL and so forth (Allemang and Hendler, 2007), I mean. Of course, these terminologies are on the conceptualization stage. This work composes of some parts with general overview or previous works: open source geo-spatial software, geo-spatial web, hybrid mashup, and intelligent geo-web services.

2. OPEN SOURCE GEO-SPATIAL SOFTWARE

Over the last few years, it has been reported that users' or developers' communities of free and open source geo-spatial software has progressively advanced such as FOSS4G, FreeGIS.org or OSGeo foundation (Ramsey, 2006; Bruce, 2007; Sherman, 2008). Open source software for geo-spatial information manipulation and processing is categorized in many types: desktop viewer, web client and server, middleware, database management, file converter and so forth (Torre, 2005).

Web paradigm shift from passive web to intelligent web influences web services and their contents, to fit user demand and industry needs. This should be considered to implement web mapping or web map service associated with portal search engines. However, currently most search engines do not reach to intelligent geo-spatial web. However, SaaS(Software as a Services) and mashup focused on technological aspects, among factors for intelligent geo web, are closely related to open sources and geo-based standards. Table 1 shows types of open source software for geo-processing, supporting some OGC standards for resources interoperability, which classify into open standard specifications and their users. Recently, these geospatial open sources listed are widely used for parts or whole of a given target system.

Table 1. Types of geo-processing open sources software supporting OGC standards

Standards	Supporting Open Source	
WMS	Provider	Deegree, Geoserver, Mapserver
	Consumer	GeoTools, gvSIG, Ka-Map, MapBlender, OpenLayers, OpenJump, uDig, iGeoPortal
WFS	Server	Deegree, Geoserver
	Client	GeoTools, gvSIG, Ka-Map, MapBlender, OpenLayers, OpenJump, uDig, iGeoPortal, OneMap
WCS	Deegree	
WTS/WPS	Deegree	

3. GEO-SPATIAL WEB

The web paradigm pursuing openness, sharing, and participation is the mainstream in comprehensive information technology communities, besides in the geospatial domain with the viewpoint of standardization and industrial needs.

Geospatial web or geo-web implies the merging of geographical information with the abstract information that currently dominates the Internet. As well, it is extended that the geospatial web has a profound impact on managing knowledge, structuring workflows within and across organizations, and communicating with like-minded individuals in virtual communities, being characterized by the self synchronization of network addressing, time and location. It is conceived that the geo-web is regarded as a visual medium and geospatial platform for data self-organization, discovery and use. The geo-browsers which revolutionize the production and consumption of media products are the important and enabling technologies for the geo-web (Scharl and Tochtermann, 2007). Among several definitions or concepts for the geo-web as a platform, these sentences are rationalized (Maguire, 2006; Homes, 2007): 'spatially enabled and access over the internet', 'complete integration and use of location at all levels of the internet and the web' and 'internet technologies to get and share geospatial information'. Compared to conventional web services handling geo-data and web mapping, geo-web emphasizes on dynamic, participation-oriented, user-centric, distributed, loosely-coupled services. Furthermore, in other aspects for geo-web as data presentation platform, it is important that new types of geo-based data can be exchanged transferred, and published through geo-web.

There are a few mashup applications for geo-spatial feature generation, being implemented using Google maps APIs. By using this system, both public users and GIS experts on web client can create their own geo-spatial data sets in the form of vector typed feature, without help of any GIS tools or accessible account to proprietary databases. The extracted or

derived feature data sets also can be used for other web mapping applications. In the next stage of this study, the following functions or applications will be implemented: linkage with server-sided GIS development APIs, transformation general GIS file structure into KML and GeoJSON (Fig. 1), direct geo-coded overlay of user's geo-spatial data sets on Google map. In this case, user interface of web-based mashup in client-side using open API can be used as an alternative for geo-browsing system or portable feature generation system. Figures 2, 3, and 4 represent geo-web components, previously implemented (Park and Lee, 2008a; Park and Lee, 2008b; Park and Lee, 2009; Han and Lee, 2010).

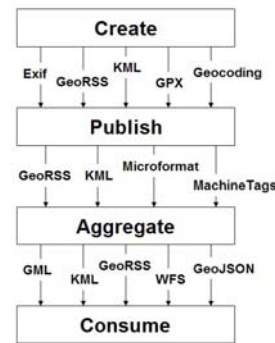


Figure 1. Standards for geo-web including OGC and non-OGC standards (Turner, 2008).

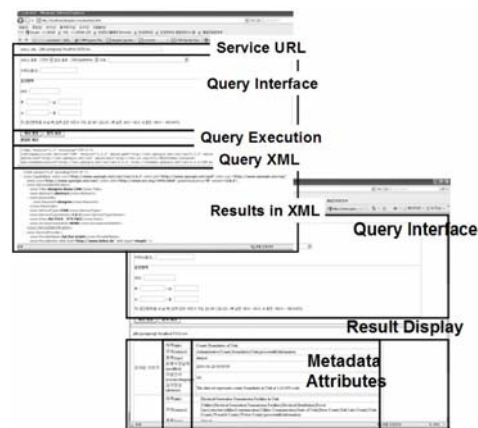


Figure 2. Query processor on CSW(Catalogue Service on Web).

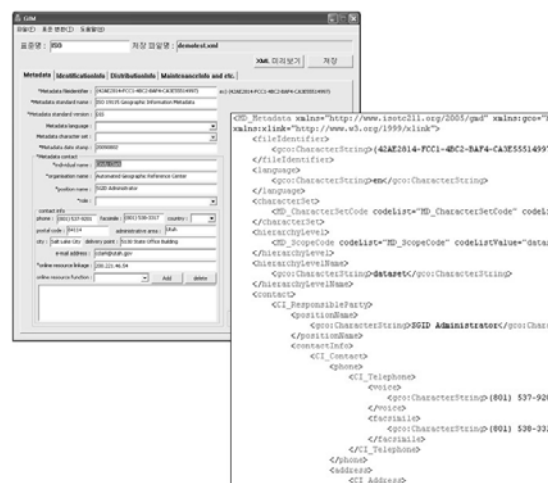


Figure 3. Metadata editor and the followed XML-DB.

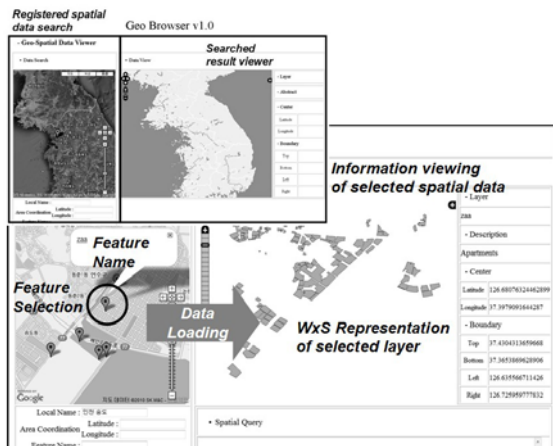


Figure 4. Mashup supporting OGC WxS standards.

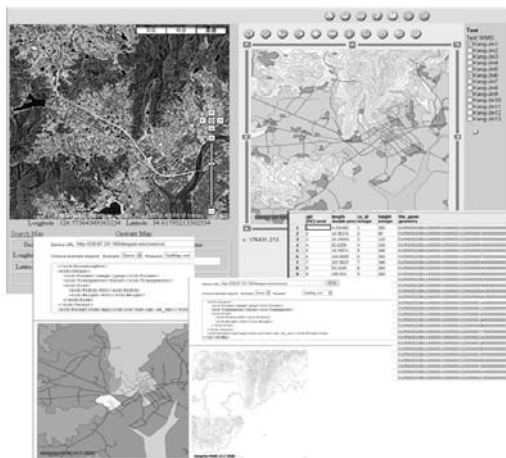


Figure 5. Web GIS application using Google maps API and PostGIS.

4. HYBRID MASHUP CONCEPTUALIZATION

Mashup, what Wikipedia formerly defined as a web application that combines data from more than one source into a single integrated tool, is a kind of realization of web 2.0. This trend and advancement of web technology cause GIS communities and markets to flourish web mapping based on mashup. Now that mashup using open map APIs is one of the popular and affordable ways to web mapping or web map service based on Web 2.0, there are the various types of mashup applications (Manso, 2005; Lowe, 2008). Mashup application using AJAX computing of open API is presented as web mapping service based on web 2.0 paradigms and computing schemes. Development of web GIS technologies and applications is actually long-standing issues, in the viewpoint of 'GIS for web' and 'web for GIS'. For this problem, Google map composed of open API for mashup and huge map resources covering all over the world is an important milestone for web GIS, though Google is not a GIS company. For public uses, the number of web sites for web mapping or mapping mashup is gradually increased. But most mashup applications are limited to geo-spatial data browsing or viewing, in some extents. Moreover, this mashup application used to be regarded a part of geo-portal (Kalberer, 2007).

Web mapping mashup cases using open API are inclined to web applications for the purpose of geo-data searching and viewing, showing products which are mixed with other data resources. For instances, there are several types of mashup: mashup between heterogeneous data, mashup using different

open APIs, and so on; however, there are a few cases aimed to implement mashup application for direct feature generation on web browser by users. Furthermore, geo-portals or geo web portal with web mapping have also established with their unique functions: map viewer, channel editor, harvest tool, and many kinds of extensions for OGC WMS and catalogue services (Nogueras Iso *et al.*, 2005; Bai *et al.*, 2007; Pascual *et al.*, 2009).

The hybrid mashup suggested in this work is towards more intelligent web services handling geo-based resources. In general, content provider provides data, and may be the authority in these data. API provider provides API to access and modify the data, and may be the same organization that publishes the data. API is usually open-based. Client web browser displays mashup pages to the user, and may perform mashup logic, being implemented using JavaScript or ActiveX. It may license the use of data or API from the content provider or the API provider. In cases of Google map uses, it plays a role as API provider for mashup site development and content provider for map resources in the form of maps, satellite images or hybrid map. Whereas Web 1.0 is on provider-centric and server-oriented service, Web 2.0 paradigm pursues users' participation, information sharing, and interface openness. In fact, Web 2.0 can be realized in the form in combination with several web computing technologies such as AJAX, Open API, REST, XHTML/CSS, RSS and so forth.

For this conceptualization, several concerned figures are presented in the consideration to ontology. Figure 6 shows general architecture for geo-portal and its relation to ontological elements. Figure 7 and figure 8 are for WWW to semantic web taken into account of geo-ontology and mashup using AJAX components with ontology data stack, respectively.

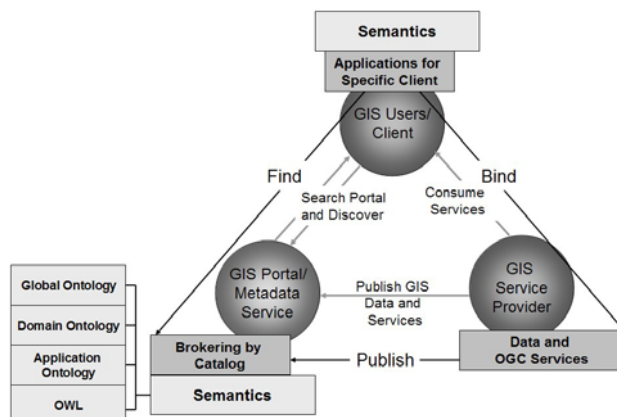


Figure 6. General architecture for geo-portal (Rose, 2004) and its relation to ontological elements.

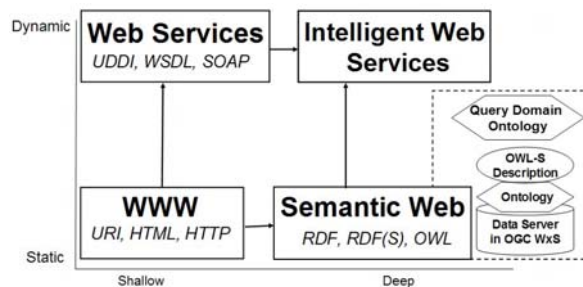


Figure 7. WWW to semantic web taken into account of geo-ontology, modified from Francisco *et al.*(2009).

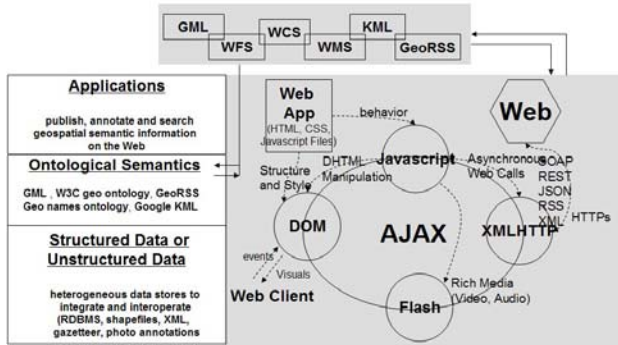


Figure 8. Mashup using AJAX components with ontology data stack, modified from Sayar(2006).

As for ontology, it can be useful methodology in the cases of sharing common understanding of the structure of information among people or software agents, enabling reuse of domain knowledge, making domain assumptions explicit, separating domain knowledge from the operational knowledge, or analyzing domain knowledge (Lemmens *et al.*, 2006; Kavouras and Kokla, 2008). These causes from the several reasons as follows: ontology consists of vocabulary to describe some domain, an explicit specification intended meaning of the vocabulary, concept classifications, and constraints capturing additional knowledge about the domain. Furthermore, beneficiary points of ontology are evoked on dealing with large amounts of data, data available on the web, data acquired or generated by new techniques, complex data structures with inheritance, containment and hierarchies, data by many relationships and diverse sources, many legacy systems, sources on the web using different formats, requirement for formal proofs, and contracts and policy enforcement.

5. INTELLIGENT GEO-WEB WITH HYBRID MASHUP

The ontology application system could be developed to collect, manage and compare ontological information for integrating data. Data sharing and data service such as support of metadata deign, structuring of data contents, support of text mining are applied for better use of data as data interoperability. Semantic network dictionary and gazetteers are constructed. Ontological information is added to the system by digitalizing text based dictionaries, extracting semantic relations from authoritative documents with natural language processing technique. However, ontology building and its applications are somewhat not established yet with the following reasons. On constructing ontology, there is no one correct way to model a domain so that viable alternatives always exist. Further, best solution depends on target applications and extensions. Therefore, initial models and iterative processes to refine that are essential.

Figure 9 is a kind of comprehensively hybrid mashup architecture based on data servers with ontology, open sources, and middleware. Figure 10 is a case of geo web services model based on hybrid mashup architecture with ontology and open sources geo-spatial software, updated from Han and Lee (2010).

represents a case of mobile 3D application based on hybrid mashup architecture with ontology.

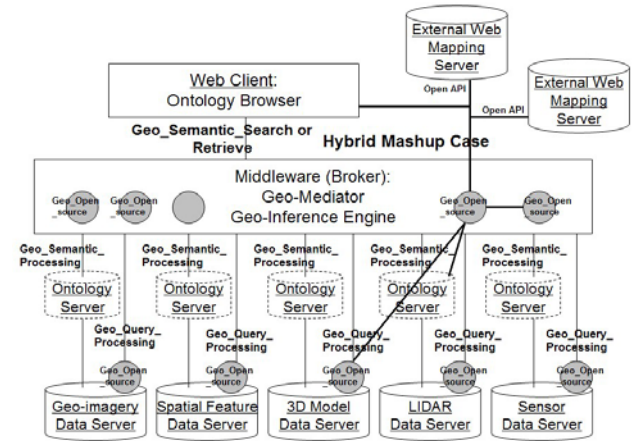


Figure 9. Hybrid mashup architecture based on data servers with ontology, open sources, and middleware.

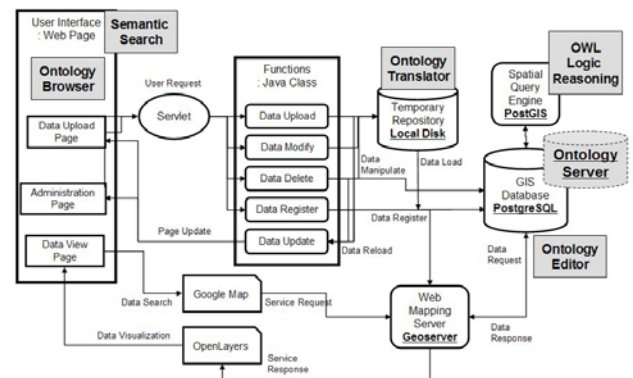


Figure 10. Geo web services model based on hybrid mashup architecture with ontology and open sources geo-spatial software, updated from Han and Lee (2010).

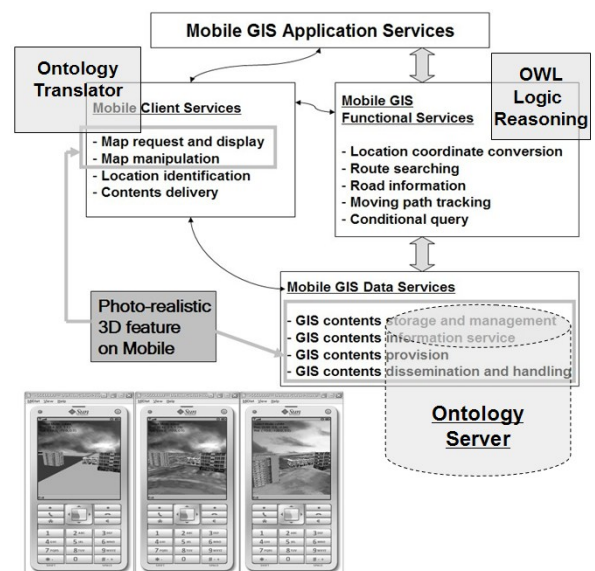


Figure 11. Mobile 3D application based on hybrid mashup architecture with ontology, updated from Lee and Dong (2008).

6. CONCLUDING REMARKS

In geo-based application domain, emerging technologies or methodologies are on the adopted and adapted stage in various fields. This work deals with many aspects concerning these trends. Among them, open source geo-spatial software, ontology and mashup are the main themes, and these are central in the intelligent geo web services. Mapping mashup continues to mature in terms of sophistication and functionality, providing end users with an ever-expanding set of tools and applications. As a result, the intersection between traditional geospatial data and these new map mashup requires well defined ways to create, publish, aggregate, transfer, distribute, and consume geospatial data in a web-friendly way.

As for ontology, it is regarded as a sort of very complicated methodology, but ontological concepts, though it is not full ontological approach, are often utilized. In this work, ontological concepts are applied to mashup in the term of hybrid mashup in associated with open source geo-spatial software. This is eventually intelligent geo-web services. Furthermore, it is on the conceptualization stage, not on realization.

For this work, some previous results and component products are demonstrated as the evidences for integrated and advanced works for intelligent geo-web: web mapping formats transferring being aware in geo-web including OGC geo standards, metadata XML-database building and its related catalogue services, mashup with Google map APIs and PostGIS/PostgreSQL databases or web mapping client interfaces and middleware using open source geo software.

As an initial and comprehensive model, hybrid mashup architecture based on data servers with ontology, open sources, and middleware is presented. According to this model, practical application models for example case are shown: geo-web services model based on hybrid mashup architecture and mobile 3D application based on hybrid mashup architecture with ontology. Current, these are on the prototyping with test databases. For the further work, actual applications regarding these two case studies will be presented.

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