Advanced GIS

http://publish.mersin.edu.tr/index.php/agis/index

e-ISSN:2822-7026

WebGIS technology and architectures

Mehmet Alper Şahin[*1], **Murat Yakar** [2]

[1]Mersin University, Faculty of Engineering, Remote Sensing and Geographic Information Systems, Mersin, Turkey
[2]Mersin University Engineering, Faculty, Surveying Engineering Department, Mersin, Turkey

Keywords
WebGIS Architectures
Server-Client Architecture
Service Oriented Architecture
Cross-Platform
Information Technologies

ABSTRACT

WebGIS allows everybody to reach geo-spatial data. It creates a rapid and advanced environment without place, time and the limitations of high processing power and high client computer. WebGIS, reshapes and makes use of all computer functions including gathering attribute data, storing, acquiring, analyzing and visualizing. WebGIS was employing the internet based maps and client-server architecture in order to provide these facilities to all. This architecture, however, has been switched to service oriented architecture, not being able to meet cope with, increasing data volume and number of access requests. Service oriented architecture, provides a service system, dynamic, elastic and re-contractible where meeting with different users. Also this improves the decision making progresses by spreading spatial information. This article analyzes WebGIS architectures and Technologies by emphasizing architecture.

Research Article
Received: 10.08/2021
Revised: 30/08/2021
Accepted: 15/09/2021
Published: 30/09/2021

1. Introduction

Desktop GIS software has enabled users to view spatial data and text-based information associated with that data in an appropriate format (Güleç Korumaz et al., 2011; Çoruhlu & Çelik, 2017; Çelik & Çoruhlu, 2021). As a result, spatial data has become easier to interpret and increasingly simple to understand. Unfortunately, everyone has access to desktop GIS and application development; This is not possible due to license fees, client-side system costs, and lack of time to use it efficiently (Çoruhlu et al., 2017). WebGIS is an inexpensive and easy way to disseminate geospatial data and processing tools. Many organizations, companies and research institutes are interested in distributing maps and rendering tools to users without the constraints of time and space (Alesheikh et al., 2002; Taşdemir et al., 2008; Yakar et al., 2010; Yakar & Doğan, 2016). These organizations have a lot of experience in software development. Different industries and sectors have had plenty of practice and experience. Numerous WebGIS solutions have emerged over the past two decades. The development of WebGIS software has reinvigorated the global software industry and system manufacturers and has set a challenge for the industry to come up with new standards and technologies. The full use of WebGIS, information technology and resources have a catalytic effect on the development of geographic information systems (Shouqun, 2015). To develop a successful WebGIS application, it is necessary to treat the application as a process rather than a step. The implementation should also fit the existing technology and system requirements (Alesheikh et al., 2002). This paper provides an overview of current Web GIS technologies and architectures.

2. WEBGIS technologies

The development and dissemination of the Internet provides two main possibilities that can greatly assist GIS users. First, the internet allows visual interaction with data. Clients can generate maps by installing a Web Server. As maps and related attribute data are published on the Internet, other users can see these updates and speed up their evaluation and decision-making processes. Second, geospatial data is widely accessible because the internet is available from almost anywhere. Users can work on GIS data from virtually anywhere and from any platform. Both of these features will reshape the way GIS users do their jobs in the very near future.

* **Corresponding Author**

*(mehmetalpersahin@engineer.com) ORCID ID 0000-0003-0133-5278
(myakar@mersin.edu.tr) ORCID ID 0000-0002-2664-6251

Cite this article

Şahin, M. A., & Yakar, M. (2021). WebGIS technology and architectures. *Advanced GIS*, 1(1), 22-26.

The ease of access to data and the synthesis of its visual presentation make it easier for them to evaluate and perform geoscience analyzes (Gillavry, 2000).

WebGIS is not faultless. The primary issue is speed; GIS relies on extensive use of graphics. Connection speeds over the Internet can make heavy use of graphics unbearably slow for users. In the near future, special GIS programs such as "ArcView & ArcInfo" or "MapInfo" will not be the optimal solution due to the complexity, system requirements they require, license costs and rapid access to data in bulk. On the other hand, WebGIS does not need the same resources as these programs. For a large-scale GIS solution, WebGIS does not require client-side powerful computers, extensive training, and expensive site licenses (Strand, 1998).

2.1. Data formats

A decisive factor for using GIS on the Internet is which data type format (vector or raster) will be used to transfer the data to the client. In order for the client to view the data on their device, it is necessary to convert the map to raster or vector format by the server (Gillavry, 2000).

Then, the data converted to the desired format needs to be processed through tile (breakdown of all data into small data) and cache (map server caching the data that goes through the tile process) for speed of data access and fulfillment of requirements.

Raster data is the expression of spatial data as cellular frames. Represents a real state in cells (raster cell) with equally sized rows and columns. Each cell takes different color values depending on the geographic area and defines the geographic area it represents. The size of raster cells refers to the resolution of the dataset and the detail of the specified area. Satellite photos, scanned plans, orthophotos and any image work in raster format (KBS, 2021) (Figure 1).

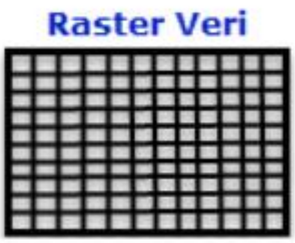

Figure 1. Raster data

Vector data is a data type that expresses spatial objects (point, line, closed area) on the earth and whose coordinate information is known. Complex shapes of space can be drawn using points, lines and closed areas. Each vector data type is held and organized in separate layers.

Point object is data represented by x, y coordinate pair (such as electric poles, wells).

The line object is represented by a set of x, y coordinates with a start and an end point (such as streams, roads).

The area object is represented by a sequence of x, y coordinates with the same start and end point. (such as building, parcel, vegetation)

In three-dimensional data sets, in addition to the x, y coordinate pair, the height information of the object or fracture is represented by the z coordinate (KBS, 2021) (Figure 2).

Figure 2. Vector data

The amount of vector data sent over the web can be three to four times less than the amount of raster data required for equivalent resolution, resulting in faster response time and productivity (Nayak, 2000). The choice of format (vector or raster) of the data to be transferred varies depending on the applications and existing infrastructures. Software products that optionally offer vector or raster data transfer may be advantageous (Leukert and Reinhardt, 2000).

Different consortia are developing different standards for data transfer over the internet. For example, the Open GIS consortium offers Geographical Markup Language (GML). GML will enable the transport and storage of geographic information in eXtensible Markup Language (XML). Geographic information includes both features and geometry of geographic data (OPENGIS, 2021). The W3C (The World Wide Web Consortium) offers Scalable Vector Graphics (SVG), a language that defines two-dimensional vector and mixed vector/raster graphics in XML (W3C, 2021).

2.2. The map types

We can collect the maps published on the Internet under three main headings.

Static (Stable) maps are maps that use known digital mapping techniques and bases.

Dynamic maps are maps that show traffic, migration, military advance, withdrawal and the related history, geography, state of engineering projects, two or more of these with special lines and arrows in a time unit.

Interactive (Interactive) maps are maps where users can make all kinds of interactions (add data, delete data, make measurements, broadcast, etc.) and the changes are published instantly. It is the most challenging map type in terms of WebGIS.

The Special Interest Group (SIG) within the OpenGIS Consortium is working on the problems of interactive maps in WebGIS. This group has recently developed a workflow model for interactive maps in a basic WebGIS (Figure 3).

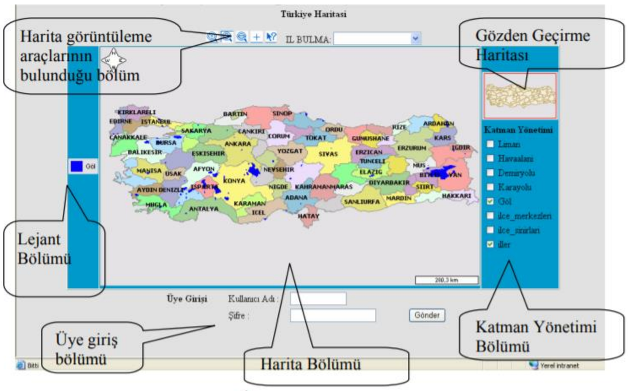

Figure 3. Interactive map home page (HARITA, 2021)

This model has four layers:

• The selection process retrieves data from a geospatial data source according to query constraints such as search area or thematic selections.

• The Image Element Generator process transforms selected geospatial data into a series of image elements. Adds styles such as symbols, line styles, fill styles to spatial properties, creates comments from alphanumeric attributes, sorts image elements in a specific order, and performs other graphical operations.

• Render takes display elements and creates a rendered map. Examples of generated maps are in-memory display lists, GIF files, or postscript files.

• View makes the created map visible to the user on a suitable display device.

Between these four layers, there are three different types of data:

Features and scopes from the selection process (e.g. scan data)

Display elements created from Display Element Builder

Render-generated images

2.3. WebGIS engine

The WebGIS engine is the hub of geographic information systems. A good map engine is essential to improve the responsiveness of WebGIS. Online maps communicate over the Internet, which is inevitably affected by the network transmission speed. Meanwhile, large amounts of data in GIS often cause display lag on the client page. Real-time data display is one of the most important factors in WebGIS (Zhihong, 2011).

2.4. Internet map server

Internet Map Server makes maps and spatial data accessible to end-users via a web browser. Publications can be provided within the institution/organization (intranet) as well as to the whole world (internet) (Alesheikh et al., 2002; Brandon, 1997).In order to prepare a map requested by the user in the map server, it is necessary to go through a number of stages. These stages from data source to map presentation are shown in Fig. 1 (ISO/TC211, 2000).

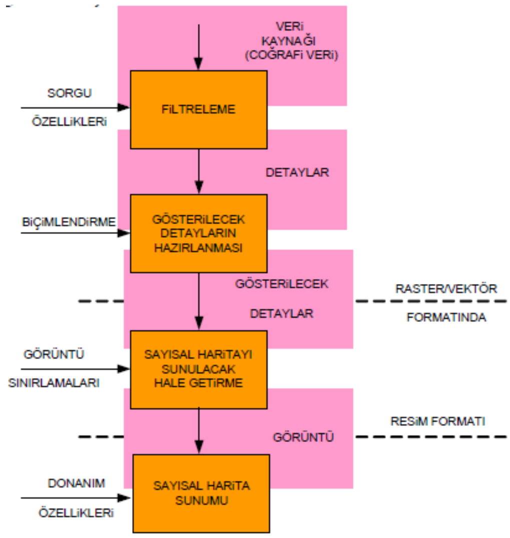

Figure 4. Process steps from the preparation of the image to its presentation (Erbaş & Taştan, N.D.)

3. WEBGIS architectures

We will examine two of the main architectures used to transmit geographic information to users via the Internet.

3.1. Server-client architecture

The main idea that creates the Client/Server models is to collect and combine various data and software on a computer accessible to users (Erbaş & Taştan, n.d.).

3.1.1. Server method

If users make requests from the server, the server evaluates these requests and transfers the desired image in HTML format. Internet-based GIS applications have spatial and attribute data on the server-side (Esri, 2021). The fact that the GIS application and spatial data are on the server side allows the applications to be easier (Erbaş & Taştan, n.d.).

3.1.2. Client method

In client applications, operations are performed on the client computer. The client must support GIS applications. The client makes a request from the server and displays the results on its own computer (Erbaş & Taştan, n.d.).

The biggest problem in server/client architecture is interoperability. Interoperability can be expressed as the ability of a unit to communicate with other units, transfer data and run applications without knowing the defining characteristics of other units. One of the most suitable methods to provide interoperability infrastructure is to use Service Oriented Architecture (SOA) based Web service applications (Gümüşay, 2019).

3.2. Service oriented architecture

Service-Oriented Architecture (SOA) provides the opportunity to create a distributed, dynamic, flexible, and reconfigurable service system that will meet the needs of different users. DEM basically consists of services that communicate with each other through defined interfaces. SYM creates an infrastructure that allows the data and functions of the service to be used by other services or users. With the DEM approach, it is possible to create flexible, easy-to-maintain, and consistent systems that can easily adapt to changing needs and technologies. The basic principles of DEM, which is an important guide in the design and development of service and service interfaces, are as follows (Gümüşay, 2019).

3.2.1. Loose commitment

Like loose fit, interoperability is important in realizing successful DEM. Interoperability removes the impact of technological features and limitations that would prevent or limit interoperability in DEM. Interoperability allows services and users to exchange information and work together using different technologies. The basic principle of SYM is that services and users work together regardless of the platform they are developed on. Like this; A service developed using Java and Oracle database on the Linux operating system can also be easily used by a client developed using Visual C++ on the Windows platform. Messaging plays an important role in supporting interoperability and loose cohesion through interfaces developed in accordance with certain standards (Gümüşay, 2019).

3.2.2. Reusability

Reusability optimizes design and development processes, minimizing new system development costs. The principle of reusability is to design and develop applications with an emphasis on reducing costs. It is possible to reuse a service designed and developed to support loose compliance and interoperability principles. So much so that all kinds of users can benefit from a common service that meets their needs without needing a specific service (Gümüşay, 2019).

3.2.3. Availability

Usability supports reusability and requires services to be published in an easy-to-find way. In order for a service to be preferred by different users, the service must exist. No matter how extensive a service is, it will have no effect if the service cannot be found for later use. The way to find a service is to use the catalog service. The catalog service stores information about services and provides facilities to find this information. Thus, those who design and implement new systems can find existing services that they can use through catalog services (Gümüşay, 2019).

3.2.4. SYM Find-Connect-Run

In this model, service providers register their services in service registers. The service records made are used by the clients to find the services that match the features they want. If the service requested by the client is available in the service records, the registrar sends the address and information of the service to the client (Gümüşay, 2019).

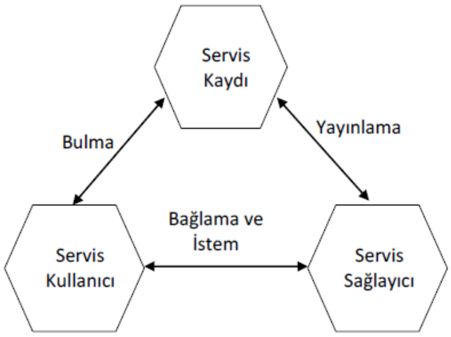

Figure 5. DEM find-connect-run (Gümüşay, 2019)

Acknowledgement

I would like to thank Mersin University Department of Geomatics Engineering for their support and contributions to this study, and my friend Tuğçe KUŞ, a Turkish teacher who contributed to the revision of the text.

Author Contributions

The contributions of the Authors of this article is equal.

Statement of Conflicts of Interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

References

Alesheikh, A., Helali, H., & Behroz, H. (2002). Web GIS: Technologies and its applications. *Symposium on Geospatial Theory Processing and Applications*, 18(1), 81–95.

Brandon, P. (1997). *GIS online information retrieval, mapping and the internet.* OnWord Press.

Çelik, M. Ö., & Çoruhlu, Y. E. (2021). Land Management within This Framework of Sustainable Protected Areas in Turkey. *Turkish Journal of Land Management*, 3(1), 40-52.

Çoruhlu, Y. E., & Çelik, M. Ö. (2017). Protected areas in land management in our country. *2nd International Conference on Advanced Engineering Technologies*, Bayburt, 21-23 September 2017.

Çoruhlu, Y. E., Çelik, M. Ö., Demir, O., & Yıldız, O. (2017). GIS applications in land management of protected areas. *Proceedings Book of DOKAP Region*

International Tourism Symposium, Trabzon, Türkiye, 295-308.

Erbaş, M., & Taştan, H. (N.D.). Serving and Using Digital Maps On Internet-Intranet Environment. *Journal of Geomatics,*32–49.

Esri. (2021). Retrieved June 07, 2021 from https://www.esri.com/library/userconf/proc00/professional/p

Gillavry, E. M. (2000) Cartographic aspects of Web GIS-software [Doctoral Thesis, Utrecht University]. Utrecht.

Güleç Korumaz, A., Dülgerler, O. N., & Yakar, M. (2011). Digital techniques in cultural heritage documentation. *Selçuk University Journal of Engineering, Science and Technology*, 26(3), 67-83.

Gümüşay, Ü. (2019). Web based geographic information systems. *AKU J. Sci. Eng*., 17(2017), 215-222.

HARITA. (2021). *HARITA*. Retrieved June 07, 2021 from http://www.harita.gov.tr/

ISO/TC211. (2000). *New York Item Proposal: Geographic Information-Web Map Server Interface*. ISO.

KBS. (2021). *KBS.* Retrieved June 07, 2021 from http://www.bulut-kbs.gov.tr/

Leukert, K., & Reinhardt, W. (2000). GIS-internet architecture. *International Archives of Photogrammetry and Remote Sensing. Vol. XXXIII,* Part B4, Amsterdam 2000.

Nayak, S. (2000). *GIS data dissemination: A new approach through WEB technology*. Rolta India.

OPENGIS. (2021). *OPENGIS.* Retrieved June 07, 2021 from http://www.opengis.org/

Shouqun, L. (2015). Rise of open source. *Office Informatization,* 3:6-8.

Strand, E. J. (1998). *What's the right way to web map data?* Synergetic Inc.

Taşdemir, Ş., Yakar, M., Ürkmez, A., & İnal, Ş. (2008). Determination of body measurements of a cow by image analysis. *In Proceedings of the 9th International Conference on Computer Systems and Technologies and Workshop for PhD Students in Computing*, June.

W3C. (2021). *W3C.* Retrieved June 07, 2021 from http://www.w3.org/

Yakar, M., Yılmaz, H. M., & Mutluoğlu, Ö. (2010). Comparative evaluation of excavation volume by TLS and total topographic station based methods. *Lasers in Eng,* 19, 331-345.

Yakar, M., & Doğan, Y. (2018). GIS and three-dimensional modeling for cultural heritages. *International Journal of Engineering and Geosciences (IJEG)*, 3(2), 50-55.

Zhihong, L. (2011). WebGIS: *Principles and Practice*. Higher Education Press.