GEOG 495

Web GIS Fundamentals

Bo Zhao

Zhaobo@uw.edu

Department of Geography

Web GIS

GIS, *an acronym for Geographic Information System, is a transformational technology that exists to make our life easier and the world a better place if rightly harnessed.*

Web GIS is a type of distributed information system, comprising at least a server and a client, where the server is a GIS server and the client is a web browser, desktop application, or mobile application. In its simplest form, web GIS can be defined as any GIS that uses web technology to communicate between a server and a client.

Key elements

- **Web Existence:** The server has **a URL** so that clients can find it on the web.
- **Data request:** The client relies on HTTP specifications to **send requests** to the server.
- **Data response:** The server performs the requested GIS operations and **sends responses** to the client via HTTP.
- **Standardized interoperability:** The format of the response sent to the client can be in many formats, such as HTML, binary image, XML (Extensible Markup Language), or JSON (JavaScript Object Notation).

The web GIS advantage

- **A global reach:** You can present web GIS applications to the world, and the world can access them from their computers or mobile devices. The global nature of web GIS is inherited from HTTP, which is broadly supported. Almost all organizations open their firewalls at certain network ports to allow HTTP requests and responses to go through their local network, thus increasing accessibility.
- **A large number of users:** In general, a traditional desktop GIS is used by only one user at a time, while a web GIS can be used by dozens or hundreds of users simultaneously. Thus, web GIS requires much higher performance and scalability than desktop GIS.
- **Better cross-platform capability:** The majority of web GIS clients are web browsers: Internet Explorer, Mozilla Firefox, Apple Safari, Google Chrome, and so on. Because these web browsers largely comply with HTML and JavaScript standards, web GIS that relies on HTML clients will typically support different operating systems such as Microsoft Windows, Linux, and Apple Mac OS.
- **Low cost as averaged by the number of users:** The vast majority of Internet content is free of charge to end users, and this is true of web GIS. Generally, you do not need to buy software or pay to use web GIS. Organizations that need to provide GIS capabilities to many users can also minimize their costs through web GIS. Instead of buying and setting up desktop GIS for every user, an organization can set up just one web GIS, and this single system can be shared by many users: from home, at work, or in the field.

The web GIS advantage

- **Easy to use:** Desktop GIS is intended for professional users with months of training and experience in GIS. Web GIS is intended for a broad audience, including public users who may know nothing about GIS. They expect web GIS to be as easy as using a regular website. Web GIS is commonly designed for simplicity, intuition, and convenience, making it typically much easier to use than desktop GIS.
- **Unified updates:** For desktop GIS to be updated to a new version, the update needs to be installed on every computer. For web GIS, one update works for all clients. This ease of maintenance makes web GIS a good fit for delivering real-time information.
- **Diverse applications:** Unlike desktop GIS, which is limited to a certain number of GIS professionals, web GIS can be used by everyone in an enterprise as well as the public at large. This broad audience has diverse demands. Applications such as mapping celebrity homes, tagging personal photos, locating friends, and displaying Wi-Fi hot spots are a few of the many current examples of web GIS.

These characteristics reveal both the advantages and challenges facing web GIS. For example, the easy-to-use nature of web GIS stimulates public participation, but it also reminds you to take into account Internet users who have no GIS background. Conversely, **supporting a large number of users requires web GIS to be scalable.**

GIS Server and OGC Web Services

- The GIS Server is software that actively listens for specific requests sent by a client. These requests could be for different OGC compliant services e.g a GetMap request in Web Map Service (WMS), GetFeature request in case of Web Feature Service (WFS), get coverage requests in Web Coverage Services (WCS), etc.
- The GIS server loads the dataset been requested (e.g., a shapefile or a raster) renders it, splits the image into tiles, and sends it to the requesting client. Every time a client interacts with the map, the GIS server receives requests and sends image tiles as responses at a very fast speed.
- There are various open-source options to choose from for a GIS Server, you can find a detailed description here, but for this course, we would be using *GeoServer*.
- Geoserver is one of the most commonly used GIS servers. It has a web-based administration interface and deploys datasets in OGC compliant protocols, which makes it an ideal option.

OGC Web Services

- OGC services are specified by the Open Geospatial Consortium(OGC) that allows all kinds of geospatial functionality. They allow the exchange of geographic data across the web. Extensible Markup Language (XML)-based Geographic Markup Language (GML) is used for exchange of information.
  - Web Map Services (WMS): It is an OGC standard that allows users to remotely access georeferenced map images via hypertext transfer protocol (HTTPS) requests.
  - Web Feature Service (WFS): It is an interface specified by the Open GIS Consortium (OGC) that allows for the exchange of geographic data across the Web. Users are able to create, delete, update, or lock a feature instance.
  - Web Coverage Service (WCS): It offers multi-dimensional coverage data for access over the Internet. e.g raster imageries. Check *here* for other OGC services.

C Language Open-Source GIS Software:

- This is the more mature of the groups of open-source GIS, probably for the simple reason that is the group that has been working on GIS software applications the longest and has a long history of resuse of code.
- The libraries in the “C” group, from the base infrastructure, and include some capabilities like coordinate reprojection that make them very useful and popular.
- Popular “C” based open source GIS software applications include GRASS, a project started in 1982 by the US Army but is now open source, and QGIS (otherwise known as Quantum GIS).

JAVA Language Open Source GIS Software

- The second group of Open Source GIS would be the ones that use **JAVA** programming language as the implementation language. JTS, central library for the Java GIS development, offers some geospatial functions that allow to compare objects and return a boolean true/false result indicating the existence (or absence) of any questioned spatial relationship.
- Other operators, like Union or Buffer, which are very hard to code, are offered in this group making it very appreciated by GIS developers. GeoTools, Geoserver, gvSIG, and OpenMap, are among the most popular open source GIS in this group of JAVA tools.

.NET Language Open Source GIS Software

- Outside of the three major language groups, open source web mapping is another group. Popular open-source web mapping includes OpenLayers and MapBuilder, widely used due to their simplicity and accessibility.

The WebGIS Clients

- Clients of a web GIS can include local desktop applications, and native mobile apps, or any browser-support applications.
- Several open-source and proprietary application programming interfaces (APIs) are used for creating web and mobile frontend applications that consume OGC compliant web services. These include *Open Layers*, *Leaflet*,*Mapbox GL*, *ArcGIS APIs* etc.
- In order to provide an intuitive user experience, these client apps, and APIs often abstract the details of all the web service requests that occur in the background.

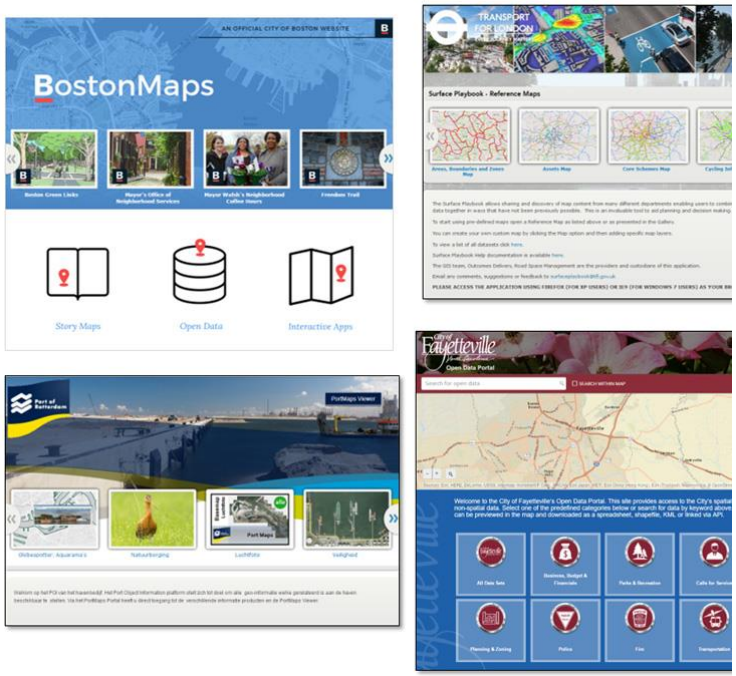
Applications of WebGIS

The WebGIS has diverse applications. Some of them are listed below:

- **Collaborative collection** of Geospatial Data e.g Geoportals, clearinghouses, SDI, etc.
- **Volunteering Geographic Information (VGI) System** e.g., *OpenStreetMap*
- WebGIS can be used to design and plan government projects like urban flood management, natural disasters, etc.

What is a portal?

- Web GIS can be implemented in the cloud (using ArcGIS Online), on-premises (using ArcGIS Server), or more typically as a hybrid combination, leveraging the best of both worlds.
- A portal is an essential component of a modern GIS, and an inherent part of the Web GIS pattern. It provides a framework for sharing and using maps, apps, and data. It also supports identity, and provides the needed infrastructure to manage users, and how they collaborate.
- A portal is often understood as the center of an organization's geographic information ecosystem. It enables wider use and access to GIS data, serving GIS professionals, knowledge workers, decision makers, and developers as well as public access.



The Battle of Web GIS

- https://gisgeography.com/web-mapping/