ANTEO: Sharing Archaeological Data on a WebGIS Platform

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Abstract. Handling and sharing geospatial data from etherogeneous sources in a collaborative way can be addressed by a WebGIS platform, built with open source components. An important role is played by open standards, metadata and open source (OSS) architectures, which we review in the present paper. We introduce Anteo, a WebGIS realized with standard and open software technologies, devoted to exchanging and sharing archaeological data from Aquileia. Current functionalities of Anteo are presented and discussed.

Keywords: WebGIS, Open Source, Data Sharing, Collaborative Work

1 Introduction

Archaeological data are spatially distributed and originate from heterogeneous sources: excavation reports, geophysical prospection, cartography, aerial and satellite photogrammetry. GIS software technologies provide effective solutions to gather data onto a unique platform; put them in relation on a georeferenced basis and better exploit their information content. In the Aquileia area different Institutions from several Countries are doing their research work, which makes data integration issues even more relevant. WebGIS systems enable GIS platforms distributed over the Net to co–operate, by exchanging and sharing data through standard technologies. Indeed, open WebGIS are the main issue addressed in the present paper. An overview of current software standards suggest an architectural scheme to be adopted in order to enhance cooperation over the Net. We also introduce and show the characteristics of Anteo, a WebGIS system devoted to the studies on the ancient city of Aquileia.

2 Open standard technologies

Open standards rely on consultative and inclusive groups including vendors, academicians and other stakeholders. The resulting documents are endorsed as standards to be subsequently released to the public. Open standards provide solutions for an effective interchange among computer platforms, i.e., interoperability. According to the Information Technology Vocabulary ISO/IEC 2382-01, interoperability is “the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units” [37].

2.1 Spatial data exchange

As far as spatial data are concerned, the Open Geospatial Consortium (OGC) [26] issues directives to ensure interoperability among compliant GIS systems. We list a few popular OGC standards.
Geography Markup Language (GML) [24]. Basically a XML grammar for expressing geographical features. It is also the ISO standard 19136:2007 [19].
Keyhole Markup Language (KML) [25]. Formerly a XML language focussed on geographic visualization, including annotation of maps and images. Geographic visualization includes not only presentation of graphical data on the globe, but also control of user's navigation. It is a widely–used language for spatial data exchange and publishing over Google Earth applications. Submitted to OGC by Google Inc.
Web Map Services (WMS) [28]. Provide a HTTP interface for requesting geo-registered map images;
Web Feature Services (WFS) [27]. Allow a client to retrieve and update geospatial data encoded in GML;
Catalog Services for the Web (CSW) [23]. Define application profiles to publish and access digital catalogues of metadata for geospatial data, services and related resource information.

In the realm of spatial data, the ISO Technical Committee TC 211 [20] takes care of Geographic Information/Geomatics. It aims to establish a set of standards for information about objects or phenomena associated with a location on the Earth. Regarding metadata, current standards are ISO 19115 [17] and 19119 [18] which will be detailed in Section 2.2.

The European Union recognizes the importance of infrastructures using open standards with the directive INSPIRE — Infrastructure for Spatial Information in Europe [15] — to support Community environmental policies or activities which may have an impact on the environment.

2.2 Metadata

With the diffusion of digital information, metadata are used for describing digital media contents, which ensures data indexing and retrieval. Moreover, metadata play a crucial role as semantic tools to support knowledge representation and inference in a GIS.

Standard ISO 19115 defines metadata sections, entities and elements; the minimum set of metadata required to serve applications; data access and transfer; use of digital data; optional metadata elements.

Under a Service–Oriented (SO) perspective, ISO 19119 identifies architectural patterns for service interfaces of geographic information. It presents a taxonomy of geographic services and a list of examples. It also prescribes how to create a platform-neutral service specification; how to derive standards to comply with platform-specific services; how to select and specify geographic services.

2.3 Open architectures

Open source (OSS) GIS architectures address geospatial data tasks sometimes more flexibly than commercial products do. As far as sharing is concerned, OSS desktop GIS like Quantum GIS [34] and GRASS [14] provide connections to remote data sources, but do not contain effective data sharing solutions as yet.

Web-oriented OSS products like GeoServer [10] and MapServer [22] adopt the OGC WMS and WFS interfaces. In this way they reach a wide range of users simply adopting OGC–compliant client modules. GeoServer is encoded in the Java language and offers an easy–to–use web administration console. MapServer is encoded in the C language and adopts an administration approach by files.

GeoNetwork [8] is an OSS server application that stores metadata in a standardized way — ISO 19115 is supported — with powerful editing and search functions, as well as an embedded interactive web map viewer.

A more advanced approach in data sharing is realized by GeoNode [9]. It brings together the capabilities of GeoServer and GeoNetwork, adding a secure, collaborative multi–user environment.

3 Platforms for cooperation

Open standard technologies make it possible to design platforms for cooperation among Institutions.

3.1 Requirements

A basic principle of cooperation is that each Institution maintains the property of its own data, i.e., it remains responsible of rights, as well as data security and maintenance (see also ref. [35]) As a consequence, a number of requirements should be fulfilled by the co-operation platform in order to ensure authenticated access to data; autonomous management of rights; administration of privileges.

As far as data transfer over the Net is concerned, software systems should be compliant with OGC interfacing technologies. At the raw data level, the need is apparent of handling both raster and vector data, with the capability of merging them as layers into a map. Another functionality is using several Spatial Reference Systems (SRS) while producing map overlays in a common SRS. As a consequence, it should be possible to use public sources of data imagery like Google Maps [13], Bing Maps [2], OpenStreetMap [30]. Once data is stored, it should be searchable by other users; to this aim it's mandatory to adopt a standardized way of representing and managing metadata.

3.2 An architecture

The requirements listed in Section 3.1 suggest to adopt an architecture as in Figure 1, with components distributed over the Net. It includes three basic sets of elements. On the users' side, a number of client software modules operate on desktop or mobile devices, or even field instruments, to ensure connectivity, data transfer, access to shared archives. A WebGIS server site includes other modules, charged to serve geographical data; internal database systems provide information that have been physically transferred by partner Institutions. The latter may be viewed as remote nodes, each of which maintaining OGC–compliant data sources and external databases. The Net is an infrastructure connecting users, instruments and data sources. Users may query remote data; they may publish their own data allowing queries from other users.

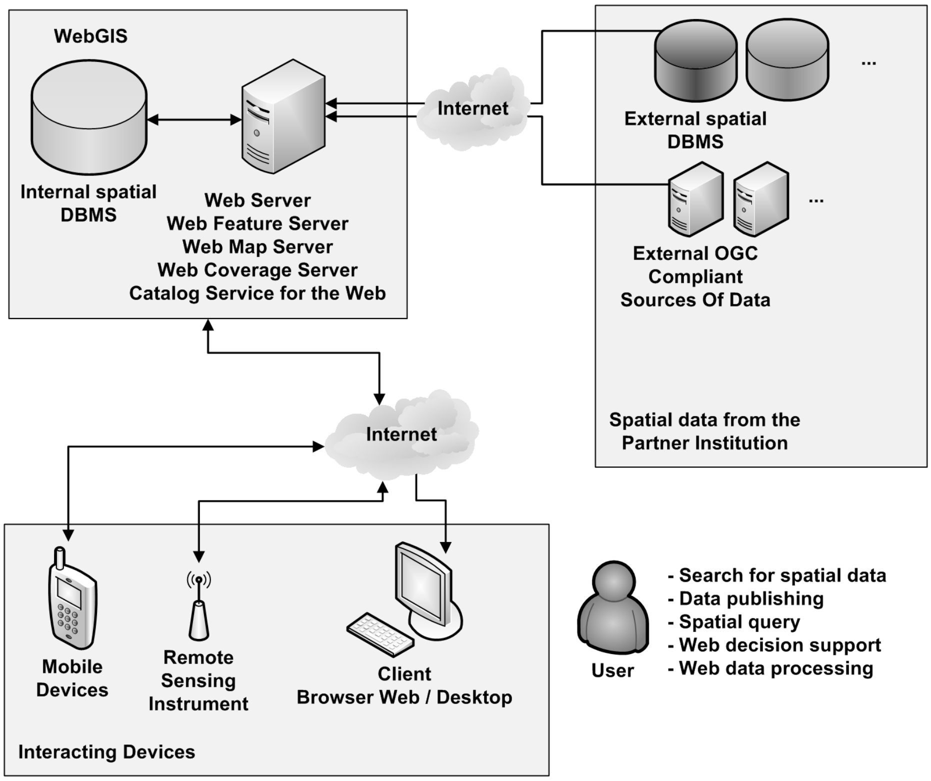

Fig. 1. Generic architectural scheme of a collaborative WebGIS. Bottom left: client modules. Top left: central server site. Top right: external nodes.

4 Anteo, an open WebGIS platform

Based on the principles introduced above and using OSS components we developed Anteo, a platform for spatial data sharing over the Net.

4.1 An overview

Anteo's functionalities take advantage from integrated components, whose interfaces remain accessible, as well as the coding effort to make them work together seamlessly.

On the client side, users interact with Anteo via browser, which is provided with OSS Javascript libraries: OpenLayers [29], GeoExt [7], GeoExplorer [6] and ExtJs [5].

OpenLayers handles data supplied by the WMS and WFS interfaces. ExtJs is a web application client supplying interface control components like buttons, panels, forms and viewport. GeoExt integrates functionalities to make maps and web interfaces work together. GeoExplorer is a library using all of the above facilities to build customizable maps in real time directly by end-users, and offers a set of standardized tasks on both raster and vector data.

As far as the central server site is concerned, Anteo runs on top of an Ubuntu Linux operating system. As described in Figure 2, the web server Apache is combined with GlassFish [12] as a Java application server. The former is responsible of serving web pages using Django [3], a web framework written for the Python [33] environment, while GlassFish delivers GeoServer and GeoNetwork functionalities. PostgreSQL [31], with the PostGIS [32] extension, is used as DataBase Management System (DBMS) for storing vector data, metadata and administration information.

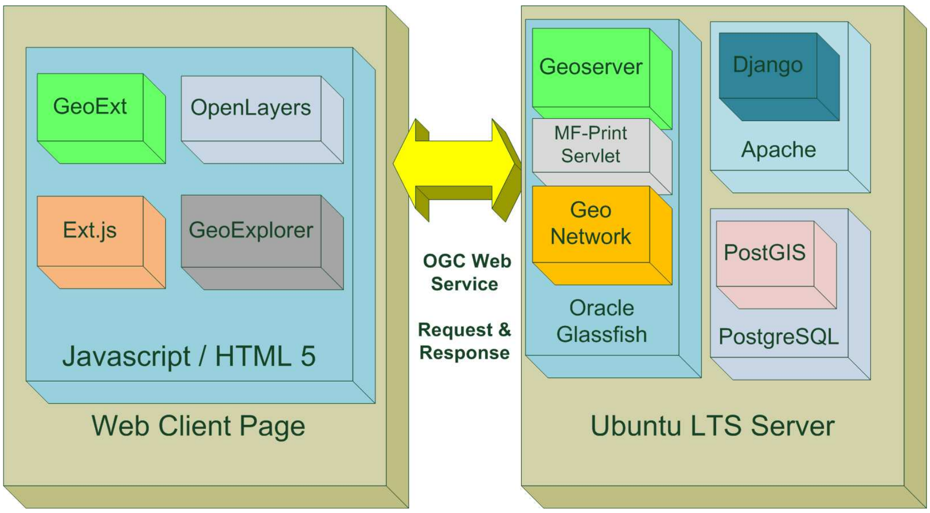

Fig. 2. The Anteo system architecture.

4.2 Access and security

User interactivity and security management are innovative features of Anteo with respect to other WebGIS. Unregistered users access public data only, but may perform actions like downloading or search for metadata lists. Registered users fully exploit the core functionalities of Anteo. They upload data and build their own maps, i.e., assemblies of layered data; they can also decide who can access their own data: anyone, registered users or a subset of them. On top of the user hierarchy are administrators, having access to the administration panel. They can set individual and group privileges; even, grant access to the administration panel itself. At the developer level, content and presentation of pages and menus can be modified. Customized pages can be added and their access restricted to specified user groups.

4.3 Data loading and visualization

Data can be uploaded as ESRI Shapefile [4], or GeoTIFF [11] format, for vector and raster data, respectively. Once the upload process is done, the user is prompted to fill in metadata fields according to ISO 19115 specifications. The user is also prompted to set data access privileges. Data can be viewed with associated metadata, as in Figure 3. The central data frame can be queried, zoomed and panned.

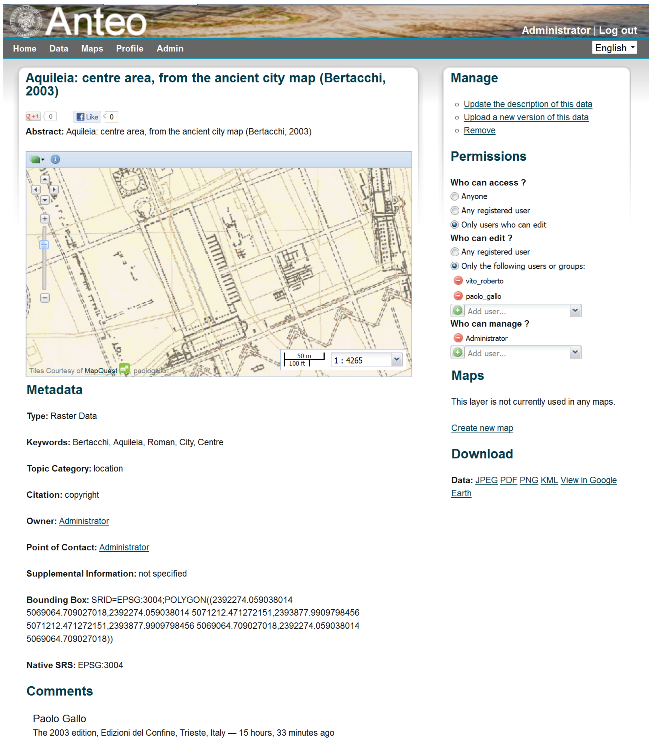

Fig. 3. City centre of the ancient Aquileia, as reported on the plan by ref.[1]. Full data and metadata visualization (left side), along with data handling and administration functions (right).

4.4 Retrieval functionalities

Taking advantage from metadata, Anteo can be used for a keyword-based search. An advanced option is the capability to restrict the search results within a specified geographic bounding box. Search reports may contain information about data, like abstract and formats. In Figure 4 results are reported of search functionalities in Anteo.

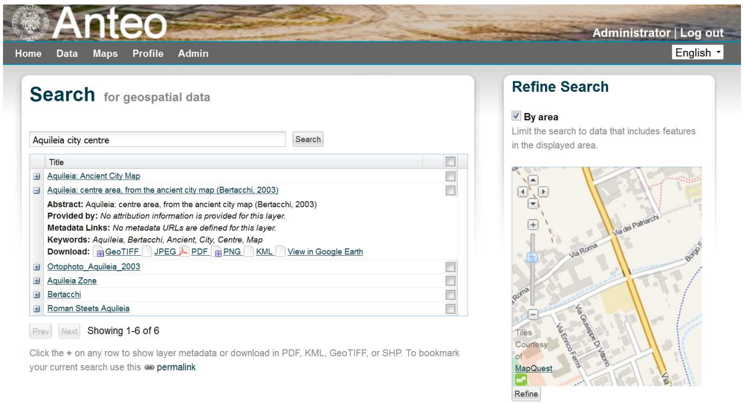

Fig. 4. Data search in Anteo. Top left: the keyword query 'Aquileia city centre'. Right side: query by area, acting upon data retrieved by the keyword query. Bottom right: final list of data in response to the query by area.

4.5 Creation of maps

As in any GIS, data can be seen as layers and merged with other layers to create a map. An example is reported in Figure 5. Base layers can be chosen from data stored in Anteo or from external providers via the WMS interface. A map can also be embedded into another external page like a widget, using code provided directly by Anteo.

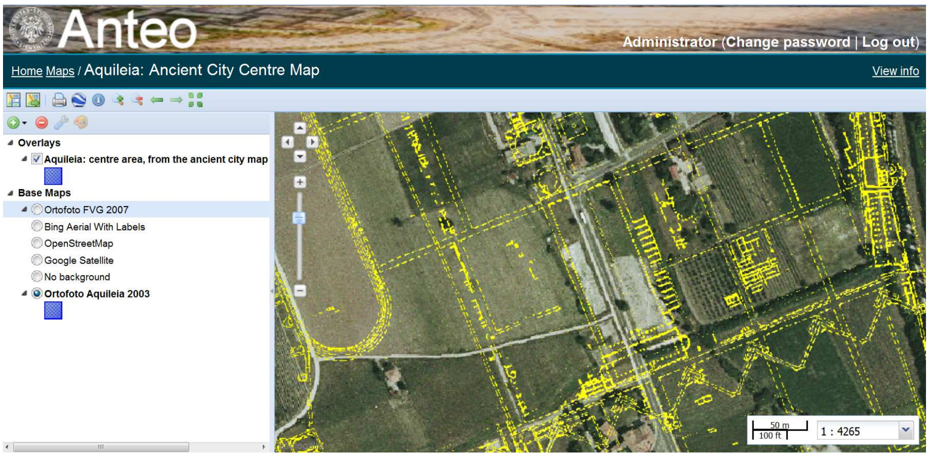

Fig. 5. A full map view. The ancient city centre appearing in Fig. 3 has been superimposed to an aerial photo of the same area (2003). The list of layers appears on the left; different base layers can be selected.

5 Conclusions

Sharing — not merely transmitting — geospatial data within a joint research programme is technically feasible using current ICT technologies. A WebGIS platform is a suitable solution for data integration, naturally oriented to cooperative work among remote partners. Exchanging data through open standards provides opportunities to derive new knowledge, while being a cost– and time–effective solution.

Anteo is an Open-source WebGIS platform built with OGC–compliant software components, ready for experimentations among remote partners. It ensures uniform, secure data access over the Net according to a federated scheme, in which an Institution maintains the property of its own data, while agreeing to share data subsets with partners. Search facilities, both keyword– and area–based, provide basic query/retrieval functionalities. Besides this, Anteo allows to share a metadata scheme; the INSPIRE international standard has been tested. Adopting a unique metadata scheme is a step towards a profound way of collaborating over the Net, by achieving a shared semantics, i.e., a unified data interpretation scheme to organize and distribute knowledge in effective ways.

Semantically-driven data sharing is currently a challenge which opens new perspectives of further research work.

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