Studmap 3.0: An Interoperable Web-Based Platform for Geospatial Data Offers in Academic Life

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Studmap 3.0 – An interoperable web-based platform for geospatial data offers in academic life

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Abstract. Geographic Information Systems has now entered the realm of web and yields for feasible solutions to balance the technology offers with the users’ needs to share, access and explore the massive amounts of geodata available. Challenges occur when moving forward from old 2D platforms towards innovative and integrated webGIS systems that align functionality with the necessity to grant a complete understanding of the surrounding reality. 3D space responds to this necessity but, however, stands only at the beginning of its era and cannot yet reach the development of 2D web integration. Research is now aiming at possible webGIS solutions to adapt to the special structure imposed by 3D data. In this context, this paper focuses on designing an architecture for 2D and 3D geospatial data integration on a student-oriented web platform. This concept was further delivered and validated through a real case scenario – Studmap 3.0, a webGIS platform to serve the students of the University of Muenster in their academical life. The portal currently grants availability of geospatial data and web services of regional interest in a smart GIS environment that allows access and comparison of official services with own data. The implementation of Studmap 3.0 aided in the continuous improvement of the proposed architecture model and hence, developed under a design science research methodology. The cycle reached its end once the final approval of its users was attained via a mixed usability evaluation. Final strengths and drawbacks of the proposed architecture were ultimately identified in terms of data, system functionality, ease of implementation and usability. The usability for academical use was evaluated via a customized expert inspection, followed by a standardized student usability test of the resulting portal interface. The results fall under the acceptable range with an 83.75 score for the System Usability Scale standardized questions when addressed to experts and a score of 83.87 when addressed to students. For the open-ended questions, the interface received an overall positive critique. A summary of future participants’ opinion on the benefits, drawbacks and proposed improvements was also delivered according to the answers to the final open-ended questions. Peers interested in similar concepts can use both this model and its final remarks as a reference for their work.

Keywords: WebGIS · Geodata · 3D · Web portal
1 Introduction

New tendencies of GIS integration with Internet technologies or simply, webGIS, enable geospatial data to move towards a new accessibility and interoperability culmination [1]. Due to the flood of geodata available, an increasing number of users and a limited number of resources to cope with them, the technological advances are pushing the geospatial sciences to rethink the way data are understood, stored, handled and delivered [2].

WebGIS allows the efficiently sharing of the geospatial data among its users around the world [1]. To synchronize with the current tendencies in GIS and geodata offers across the web, students crosscutting with this realm now require a smart, 3D-friendly web environment to respond to their practical needs: to allow the access of public and official data and to upload and share own data with the others. In this scenario, this paper is motivated by the lack of scientific solutions to balance both 2D and 3D functionality in a webGIS system dedicated to the student’s academic needs. Therefore, we aim to offer a new architecture for an integrated web platform intended to allow the download, exploit and upload of the datasets of regional interest in a webGIS environment.

Researchers in the GIS field are delivering innovative ideas to promote progress usually in written forms which are not always applied to real-world practices [3]. The present research responds to this call as the validation of the proposed architecture was done via a practical implementation of Studmap 3.0 [4], a webGIS platform designed to support the students of WWU University of Muenster in real life altogether with a design science framework that can always be adapted according to specific needs and improved upon feedback. The implemented architecture wishes to serve as a reference tool for all peers interested.

2 Methodology

The aim of the research is to integrate complex geospatial data and web-based services on an interoperable web platform by proposing and evaluating a GIS client-server architecture. Hence, design science research framework [5] is adopted as the intention is to build knowledge through the creation of reality (Fig. 1).

The awareness of the problem phase is introduced by the objectives of the research: the proposal and implementation of a client-server architecture for complex GIS data and web services integration. The suggestion phase reflects in the solutions proposed by the existing GIS integration research and the empirical experience gained through the operation and goal knowledge discovery. The development phase is the construction of the artefact based on the suggestion phase. The artefact is represented by the proposal and design of a client-server architecture to serve for the integration of the motivated data and services. The evaluation consists of the practical implementation of the proposed architecture and validation of its functionality throughout the student dedicated platform: Studmap 3.0 [4]. The outcome of this phase is feed back to the previous one and hence, the artefact is reshaped accordingly. The process iterates as experience is
accumulated and new theories emerge. The conclusion is drawn from the evaluation of
the artefact. As a measure for the ultimate approval of the end-user to terminate the
process, a customized usability evaluation is designed.

Fig. 1. Design-science research framework implementation

Among the software solutions available, ArcGIS Server was chosen for its powerful
geoprocessing functions. The ArcGIS Server Site is federated with the Portal for
ArcGIS and configured as a hosted server using registered ArcGIS Data Stores to allow
the publication of cached maps, feature and scene layers as hosted services [6]. An
enterprise database was chosen to work with the ArcGIS Data Stores to allow the real-
time updates and the fully administrator management of the GIS services in parallel
with the ArcGIS managed ones. The database was created using the PostgreSQL open
source database management system because of its extended spatial functionality, ease
of administration and compatibility with the ESRI software. For an intuitive web
applications configuration on top of the GIS server, WAB SDK [7] was used. The
aimed webGIS services compatible with the software choice, are OGC compliant web
map services that reduce the need to store the data locally and to take the workload off
the GIS server to give fast responses to the users’ requests.

A three-tier client-server architecture was chosen [8] to divide the workload between
different machines and enhance the overall functionality. The presentation tier is repre-
sented by the web browsers that allow the users and administrators to interact with the
GIS server and portal. The application tier consists of the web servers and the GIS
server holding the logic of the system. The GIS server provides the core GIS function-
ality of the system and supports the derived web maps [1]. The database tier is repre-
sented by two relational databases - a PostgreSQL enterprise database and an ArcGIS
managed data store- and a non-relational database - the ArcGIS tile cache data store.
While the relational databases hold the GIS function of handling 2D and basic 3D fea-
tures, the tile cache the manages hosted scene layers which allow storage and manipu-
lation of the complex 3D data. To secure the communication between the components
of this architecture, all communications are restricted to HTTPS-only. The administration of the requests is done via the REST API and is handled by two web applications, the ArcGIS Server Administrator Directory or the ArcGIS Server Manager [9].

3 Results

To validate the artefact, the client-server architecture was implemented and evaluated using the Studmap 3.0 portal (Fig. 2). The data was generated from three different sources: an old portal, Studmap 1.4 [10], the students’ UAS2018 projects and some relevant third-party providers. The data coming from the old portal and the recent projects are stored in a common PostgreSQL geospatial database. The complex 3D data, in this case the point cloud layer generated from the UAS2018 project, are stored locally in a converted format, SLPK [11] as this type of data structure doesn’t allow storage in a database. The data coming from the third-party servers are represented by the web map and feature services provided by the official geodata servers of the German state of North Rhine-Westphalia [12] and by the cloud-based platform of the Institute for Geoinformatics of the WWU University of Muenster [13].

Fig. 2. General diagram of the architecture implementation for Studmap 3.0

1 Source derived from the intranet (not publicly available) of WWU Muenster.
The implemented web portal has a hybrid system architecture at all three component levels. The presentation tier consists of desktop GIS applications (ArcGIS Map and ArcGIS Pro) and web applications (Portal for ArcGIS, ArcGIS Server Manager) or REST Admin APIs (ArcGIS Portal Directory, Portal Administrator Directory, ArcGIS Server Administrator Directory) that allow the users and administrators to interact with the IVVGEO portal and server. As for the application layer, it consists of the two web servers holding the logic for both the portal and the server and the IVVGEO Server itself. The database tier consists of two relational data stores (a PostgreSQL enterprise geodatabase and the Managed ArcGIS Data Store) and one non-relational data store (the Tile Cache ArcGIS Data Store).

4 Discussion and Conclusion

A comparison between the concept and implementation of the proposed architecture was done in terms of data, system functionality, system usability and ease of implementation. The first three criteria were specified according to nowadays’ mapping trends [14] and focus on the technical objectives of this study, while the latter focuses on the overall implementation of the system. The proposed and evaluated architecture is limited by a series of non-functional requirements depending on the context of the implementation of the Studmap 3.0 portal. The first dependency is given by the resources available in terms of both hardware and software and influences the overall performance of the system. System security comes as the second dependency as the communications of the implemented systems are done via both HTTP and HTTPS protocols which gives a less secure alternative compared to the conceptual model. Last, the cost of equipment comes as a restriction for the designed architecture as the chosen software to offer the main GIS function is provided by ESRI.

The output of this study is Studmap 3.0 [4], an integrated webGIS platform to grant relevant services and geospatial data to students. To evaluate the users’ appreciation of the platform and to reach the end of the design science cycle, a mixed usability evaluation was developed. First, the study was done by two experts that were asked to inspect the interface of the portal and answer questions formulated according to its intended functionalities and audience. Second, the interface was evaluated by 20 students that were given a set of tasks designed corresponding to the intended functionality of the platform. The tasks were generally well received, with a completion rate of 100% for all students whose graphics were compatible with the products’ requirements. All participants responded to a standardized SUS questionnaire [15] which delivered a score of 83.75% for the experts and 83.87% for the students. The benefits, drawbacks, future improvements and overall opinion were summarized for both categories of participants and should contribute to further improve the platform.

Two main strengths were identified: the platform provides students with an effective tool to interact with available official data and previous projects via an interactive web mapping portal interface and it integrates both 2D and 3D features in a smart webGIS environment. One essential compromise was necessary to fit with the chosen schema: the storage of the SLPK datasets is done separately from the databases, in a local folder.
An additional usability study is recommended to further improve of the platform and to provide comparative results. Moreover, an extension of the machines hosting the main components should be considered to increase the overall performance. For an improved quality of the storage system, a solution to organize the complex 3D data files needed to be saved locally is required. Nonetheless, this work can be perceived as a reference for any peers interested in similar problems.

References