Using GIS Technology to Identify New Taxpayers

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SUMMARY

For a longer period in the Republic of Serbia there is a trend that holders of rights over certain cadastral parcels build objects of different types and purposes without respecting existing regulations. Such objects are physically present on the ground and are often fully equipped with utility, but they are not legally exist.
Municipality Irig is neighboring town of Novi Sad, which is the administrative center of the Autonomous Province of Vojvodina. Municipality Irig use different types of spatial, cadastral and alphanumeric data. During inspection of taxpayers data we have established that municipalities Irig has only 7859 of taxpayers.
In this paper we present a method of using spatial data, service-oriented structure and ISO / OGC standards, as a solution to improve the collection of taxes on real estate and that could provide significant funds in the municipal budget. The proposed solution involves the use of existing orthophoto images owned by municipality Irig and the creation of new orthophotos for the whole municipality using WorldView 2 satellite images. In fact that municipality Irig has no address register, another layer of spatial data is built using existing address from the database of taxpayers and mapping with addresses that are available through the GeoSrbija service.
This solution combines all the alpha-numeric and spatial data held by municipalities and new spatial data that have been created to facilitate existing and future new taxpayers.
Implemented a three-tier SOA architecture allows the display and distribution of all the above mentioned data for all users of municipality Irig. Within this paper it is proposed one solutions which is showing how alphanumeric and geospatial data can be used for easier identification of potential new taxpayers.

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1. INTRODUCTION

With advanced technology in 21st century, each local government is faced with growing volumes of data. Establishing control over the data is very important in systems of local government or organization. In addition to alphanumeric data, local governments possess, handle and create large volumes of geospatial data, and in addition spend large amounts of money to create different types of data. Geospatial data can be from different satellite or airplane platforms, then large amounts of LiDAR data, various types of GIS or CAD data, and of course there are different types of digital formats of alphanumeric data that are in some way associated with spatial data, which is primarily refers to the various types of documents, whether they are word, excel or pdf data, various photos or video clips.
Local governments is faced with the problems such as managing a large amount of data or the problem of access to these data, since they are located in different places within the local government or organization, or maybe different work groups or individuals working with data, or the data is simply misplaced somewhere, or finally employees do not know that data exist somewhere in the company. Also when processing data, copies are created which at the end leads to redundancy or somehow the data are not updated. All this problems, without the ability to manage their data, leading to the fact that the organization does not become productive and not effective. Access to information, access speed, and interoperability between different parts of the system is also one of the big problems which is evident, especially when you need access to geospatial data that have different formats.
The solution to these problems lies in the implementation of spatial data infrastructure. Spatial Data Infrastructure should establish respect the following basic principles:

- The data should be collected once and maintained at the level where it can work most effectively
- It must allow combining spatial data from different sources and share it between users and application
- It must allow that information collected at one level can be shared on different levels of organizations
- It is necessary to enable easy retrieval of available spatial data, to assess whether they are suitable for use and achieving goals and requirements for their preparation and use
- Geographical information should be simple to understand and interpret so that they can be visualized in a particular context, which will be adjusted to suit the different users.

The solution to the above problem is to use a service-oriented architecture (SOA) and ISO / OGC standards (W * S web services), thus obtaining a loosely connected software components, which are based on standards.

2. SPATIAL DATA INFRASTRUCTURE AND GIS

The term Spatial Data Infrastructure (SDI) [Nebert 2004] is used to indicate a basic set of technologies, policies and institutional arrangements that provide availability and access to spatial data. SDI defines the basis for the finding and assessment of spatial data and applications for all types of users and producers from all levels of government, business, nonprofit organizations, academic institutions and the public sector.
SDI services are realized through the implementation of OGC interface specification. Visualization is achieved using OGC WMS specifications, while raster and vector data access is implemented by WFS and WCS implementation specifications. Finding data is implemented using OGC specifications for Catalogue services. All OGC interface specifications are massively used in modern GIS distributed systems [Sladić, Govedarica, Ristić, 2011].
With regard to the use of OGC standards and their role in the development of GIS, we first need to explain and give some basic notes. Each GIS system works with a large amount of data, which is necessary to perform a variety of visualization, analysis, assist in decision-making, or create integration with various systems and applications. All this requires fast access to data or access to data in real time. There is also a need for a personalized and specialized services, search sites, coordinate transformation and dynamic way of discovering and obtaining information.
When considering such requests, it can be concluded that the traditional GIS systems, which are based on applications and specific manufacturer formats, have a major problem to respond to the given request. These "vendor-driven" systems are dependent on a single vendor and such applications are primarily for professionals who collect, manage and analyze this data. The solution to these problems is in the application and implementation of OGC standards, a narrow set to implement service-oriented architecture, SOA and Web services, as well as the development of independent components, which are based on open protocols and standards for the exchange of XML data, accessible through HTTP protocol and implementing standards that ensure interoperability. The main purpose of developing these standards is solving the problems of interoperability among GIS software [3]. Most other previous related works have the common goal of making GIS applications more common and open. Some efforts worry about applying component oriented approaches to GIS application development [Shengjun, Liang, 2008, Tan, Feng, 2008]. Some of them focused on OGC capabilities through utilizing OGC web services in their architecture [Lu 2005, Kim, Kim2, Choz, Lee 2001]. And some others focused on SOA concepts and patterns implementation without considering OGC standards in the architecture [Shujun, Liang, Chengqi, 2008, Rui-sheng, Yan, Hong-mei, Xi-juan, 2008, Xiang, Ling, Jin, 2009].
Figure 1 shows an example of a service-oriented architecture. This example is a website for planning a trip or web page for displaying taxpayers. Web page uses services such as road networks, services with the names of towns or services that represent taxpayers, where these data are based on information contained in the system.
Such an example would use OGC specifications such as WMS[11], WFS[12], WCS[13], or WPS[14], for the presentation of results to end users, where users do not need to know to implement these standards. This example shows the advantages and benefits of service-

oriented architecture and implementation of OGC standards. Interoperability is made possible through the implementation of these services.

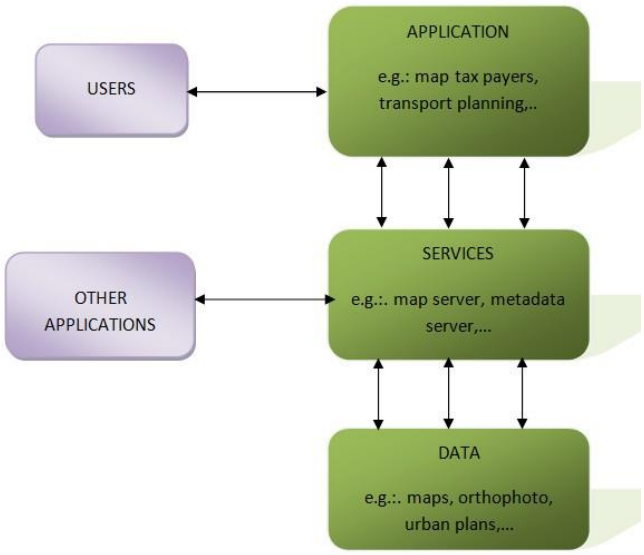

Figure 1 Example of SOA

3. IMPLEMENTATION

Municipality Irig is neighboring town of Novi Sad, which is the administrative center of the Autonomous Province of Vojvodina. The territory of the municipality Irig is located in the famous wine growing and fruit growing region, and also it is bordering with the National Park "Fruška Gora". The municipality belongs to the underdeveloped municipalities, with low income at the local level, so the collection of taxes on real estate represent a very important item in the municipal budget. Due the reviewing the database of tax authorities, it was determined very small number of real estate and taxpayers, in fact that in last twenty years it was build a lot of real estate in the area of National Park "Fruška Gora" that belongs to municipality. In fact that municipality Irig use different types of spatial data, and the importance of spatial data infrastructure today is a basis for the development, they have decided to try to find solution for better income from taxes. One way for that is to combine existing data with new geoinformation technologies.
Establishing a spatial data infrastructure in local governments is one very demanding and serious task. Spatial Data Infrastructure includes services which help in finding and interacting with data. These services are divided into three types of services: services to locate geospatial data and associated attributes (discovery services), services to access geospatial data and associated attributes (access services) and services for processing and analyzing geospatial data and associated attributes (processing services).
The main role of the system that was implemented is Geoportal of Spatial Data Infrastructure of municipality Irig, based on Erdas Apollo [15], where is defined way of distribution and exchange of information. Erdas Apollo Erdas Apollo is an enterprise-class, comprehensive data management, analysis, and delivery system enabling an organization to catalog, search,

discover, process, and securely disseminate massive volumes of both file-based and web-enabled data, which allows users to identify and access spatial information that exists within the municipal administration Irig.
The system is organized in a three-tier service architecture. The first layer are users applications that require different services from services in the second layer (e.g., metadata server, the index of geographic names, map server, http server, ...), which rely on the data warehouse from the third layer.

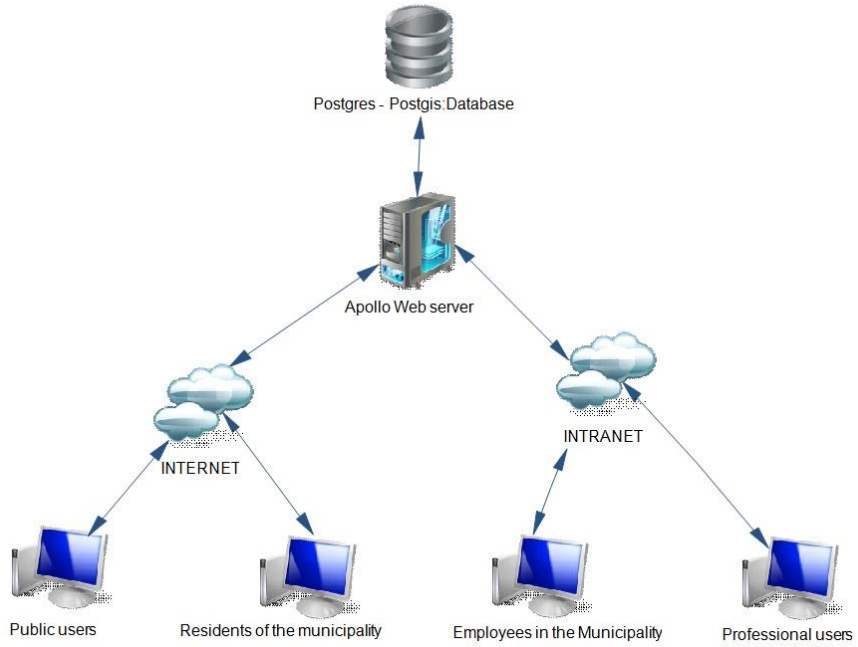

Figure 2 System architecture

Three-tier service architecture system is shown in Figure 2. As shown in Figure 2, for a database was selected Postgres database with PostGIS extension for spatial data, which represent first layer in our three-tier service architecture. As a mid tier is chosen Erdas Apollo. Erdas Apollo is an interoperable OGC / ISO-based application that implements an out-of-the-box service-oriented architecture (SOA). Erdas Apollo is the solution for data management, which through its Data Manager collects data from different place (server file system, databases, network storage) and create services to access the same data. Three-tier architecture ends with client application - the Geoportal of municipality Irig. Geoportal is the starting point for the search and retrieval of geographic data and services. Data access is allowed for different types of users, public users, employees in the administration or professionals, where interoperability allow that all information can be used in different applications and are no longer linked only to individual applications.

4. TEST CASE - TAXPAYERS

Implemented solution for finding new taxpayers is based on the Geoportal of municipality Irig, whose software architecture promotes flexibility and interoperability. Geoportal of the municipality Irig client applications is starting point. The application supports multilingualism (Serbian, English, German, French, ...) and it is divided into several basic components. Geoportal allows you to load the basic context files as start page, through which you can access to the basic spatial data that are registered, also all data from Geoporatl may be available in other tools using OGC services (WFS, WMS, WCS).
For the purposes of identification of new taxpayers, and improvement of tax collection from taxpayers in the municipality Irig, implementation of Geoportal was in some way control point for this kind of application.

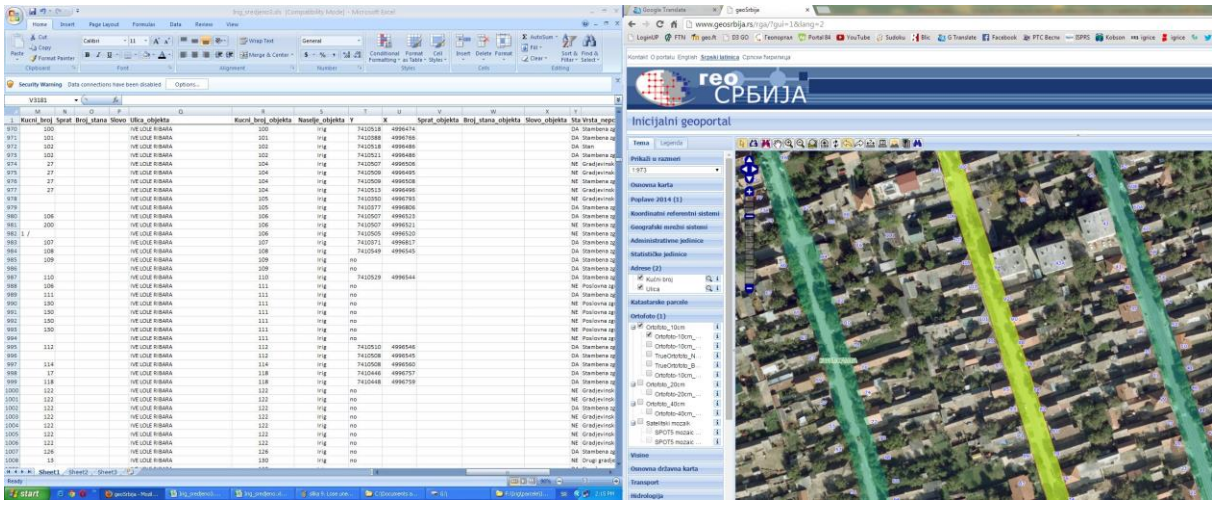

Figure 3 Example of creating X and Y coordinate for taxpayers

A key part of the proposed solution is based on creating relations between the existing alphanumeric data about taxpayers of the municipality Irig with a newly created spatial data. Within alphanumeric data about taxpayers, for every taxpayer in addition to other information, we possessed the information about the object street, house number and settlement of facility in which the tax is paid. Municipality Irig is consists from town Irig and another 10 settlements of rural type, in which the dominant type of object representing housing facilities for individual housing while facilities for collective housing is almost nonexistent. In agreement with the workers of municipality Irig, it was decided that each facility for which there is evidence that pays taxes will be presented with one point.
During the analysis of available data it is established that the municipality Irig posses the following data:

- taxpayers alphanumeric data contained information about the street and the number of object
- alphanumeric data with the street and number of house, as well as the information on the parcel number
- parcel land use information.

Based on these alphanumeric data in possession by municipality Irig, new spatial data is created, representing streets and numbers of existing taxpayers, and containing all the information provided.
The process of creating spatial features in the form of coordinates of each of the existing taxpayer consisted of several steps:

- preparation of csv files based on existing data on taxpayers
- add new columns (columns X and Y) which represent the geographic coordinates of the taxpayer in the created csv file in previus step
- creating the appropriate tables in the database (PostgreSQL + PostGIS)
- creating views on tables with geometry columns and tables with alphanumeric data.

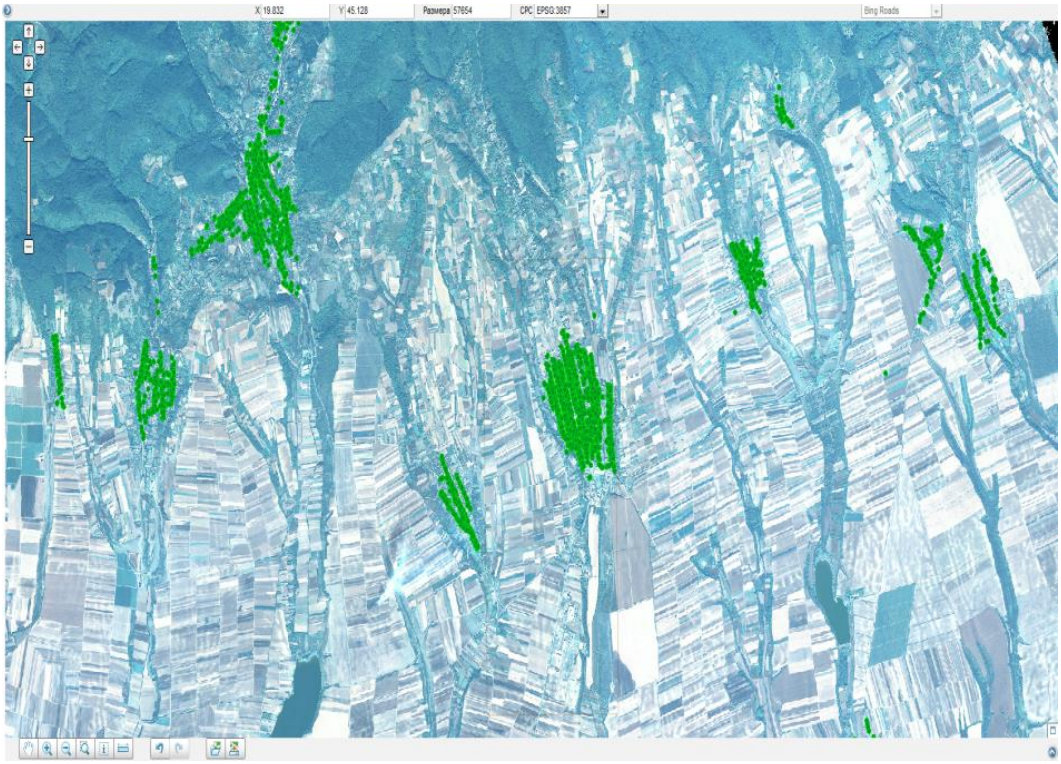

Figure 4 Taxpayers represented with green circle above WV2 ortophoto

For the purposes of identifying the coordinates of the corresponding taxpayer we used the available services, primarily GeoSerbia [16] what can be seen in Figure 3.
During the implementation some irregularities in the data on taxpayers were found, which can be divided into two groups:

- incorrect or not existing street names, and information about the objects that do not belong to the municipality Irig - a total of 400
- lack of house number in the data about taxpayers - a total of 1589

Information about 5870 taxpayers with valid data of address from total of 7859 tax payers was created. After that WFS and WMS was created, which is enable the display these data in Geoportal or any other application. Example of all taxpayers who is identified can be seen on

Figure 4. In this way it is enabled that employees of the municipality Irig can display and in an easy way overlap spatial data about existing taxpayers with any other kind of spatial data. For this project we also create a new orthophoto with scale 1:5000 for the whole territory of the municipality Irig based on of images WorldView2 satellite platform. 15 control points was used in the process of georeferencing satellite image, and for the procedure of orthorectification, DEM with 5m spatial resolution is used.
Figure 5 show example of existing taxpayers overlapped over the new orthophoto, what is the key point, and what allow users who work for the municipality of Irig, to visually detect potential new taxpayers.

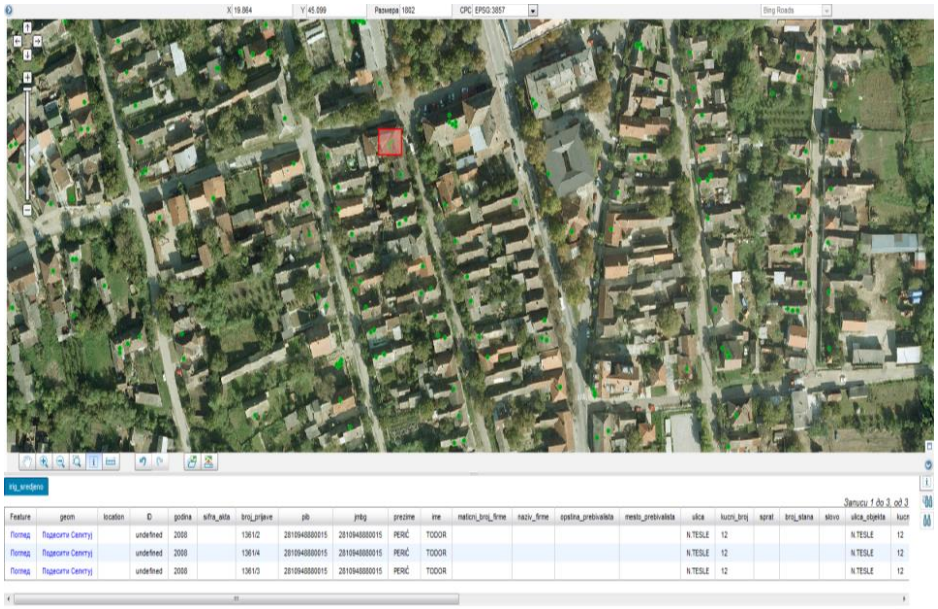

Figure 5 Taxpayers represented with green circle above WV2 ortophoto with aditional data

5. CONCLUSION

By implementing a service-oriented systems, with respecting the standards and recommendations concerning the management and distribution of spatial data and GIS system, it is established enterprise software solutions for managing cartographic material - Geoportal, which enable the management of information in accordance with the standards. In this way, municipalities Irig has become the municipality that in a simple way, using a service-oriented architecture (SOA) and ISO / OGC standards (W * S web services), may inspect and distribute their spatial data.
By creating orthophoto with scale of 1: 5000 based on satellite image, it is created up to date cartographic basis for the municipality Irig.
In this work it is presented a solution that combines all the alpha-numeric and spatial data held by municipalities and new spatial data that have been created to facilitate existing and future new taxpayers. Implemented a three-tier SOA architecture allows the display and distribution of all the above mentioned data for all users of municipality Irig. Within this paper it is proposed one solutions which is showing how alphanumeric and geospatial data can be used for easier identification of potential new taxpayers.
By creating a new spatial data with information of existing taxpayers, and integration with other spatial or non spatial data of municipality Irig, enable the identification of new taxpayers by examining the data through the Geoportal or any other tool that supports the work with the aforementioned standards.

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BIOGRAPHICAL NOTES

M. Sc. Dušan Jovanović, since Aug, 2004 is a teaching assistant and Ph.D. student at Faculty of Technical Sciences, University of Novi Sad, Serbia. He has published several papers in international and national journals and conferences, including 4 paper in international journals, more than 20 papers on international conferences and more than 20 papers on Serbian national journals and conferences. He has also participated in several research projects including GIS for the Serbian Republic Water Management Authority, GIS (geoportal) for the Ministry of Environmental Protection and Ecology and Information system of the real estate cadastre for Republic Geodetic Authority of Republic of Srpska. He has 10 years experience with lead software in the field of geographic information systems and technologies, such as ERDAS Imagine, ArcGIS, TerraSolid, MicroStation, CAD, and others. His areas of interest include remote sensing, airborne laser scanning, and GIS.

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