MAPS OF SERBIA - WEB BASED GIS SERVICES

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ABSTRACT:

New and redesigned version of Internet service MapsOfSerbia is presented in the paper. High quality data for the territory of Serbia cannot be found on worldwide existing services of similar category (Google Maps - GM, Microsoft Virtual Earth - VE, Yahoo Maps - YM). Territory of Serbia is mostly covered by small scaled satellite imagery (Landsat) and major roads network. There are also areas (around some larger cities and on few other locations) where imagery from Ikonos or Quickbird satellite missions is used. The reason for this situation is that large worldwide providers of vector datasets (TeleAtlas, Navteq and others) still do not have larger datasets for Serbian territory (for example, data for the capital city of Serbia, Belgrade). Satellite imagery in fine resolution is available only for areas and locations mentioned above and therefore leading dataset providers do not have significant amount of raster datasets (orthophoto) of Serbian territory in their archives as well. Therefore, Internet services that would fill this gap on the market were needed. A Complete description of such a system is given in this paper – used data, system and application software, and statistical data on system utilization. Having in mind that data was distributed on Internet, and that the system is one of the most visited services of this kind on the Balkan region, certain optimizations of the software were made in order to support high overload of the system. Software techniques and procedures of preparations of the data for Internet distribution are also given.

1. INTRODUCTION

1.1 General Instructions

Each of the three world leading search engine companies is offering maps to the customers as one of the basic services. Solutions are based on the software developed by Google, Microsoft or Yahoo and on the data provided by large vector datasets providers (TeleAtlas, Navteq and others), and on the data provided by large raster datasets providers (DigitalGlobe, TerraMetrics, NASA, Europa Technologies and others).Software solutions are characterized by simple and efficient user interface, geolocation capabilities and simple navigation.

Figure 1. Belgrade area on Google Maps, Microsoft VE and MapSoft's service MapsOfSerbia (2008 Google Image Copyright - Mapdata ©2008 Tele Atlas; ©2008 Microsoft ©2008 NAVTEQ, © AND; ©2008 MapSoft and Geokarta)

For those users who demands more advanced applications Google offers GoogleMaps API – SDK that can be used for the development of customized solutions for all sorts of applications. Because of the lack of the data for the Serbian territory that was already mentioned, new services offering similar capabilities as those offered by leading search engine companies were developed.

2. DATA

Data produced by two leading Serbian spatial data providers in Serbia (MapSoft and Geokarta) were used.

2.1 Raster data

Complete orthophoto production of MapSoft and Geokarta – over 40% of the Serbian territory where lives more than 70% of the total population of Serbia (Mihajlovic, 2004). Data is comprised mostly of orthophoto maps of resolution (GSD) of 0.3m and 0.6m accuracy. Digital aerial camera Intergraph DMC has been used for aerial photography since second half of 2006 (example of orthophoto made produced by using this camera is displayed on Figure 2).

Figure 2. Orthophoto for town of Novi Sad from 2007 GSD=0.1m

2.2 Vector data

Vector data published on MapsOfSerbia geoportal are:

- road network of Serbia – all international, major, regional and local roads in Serbia; over 40.000 km of roads with official labeling of road sections and road routes;
- street networks for 37 towns in Serbia with total length of more than 10.000 km;
- locations of more than 5000 settlements;
- locations for more than 150.000 house numbers;
- about 10.000 Points of interest (POI) in more than 40 categories (Figure 3).
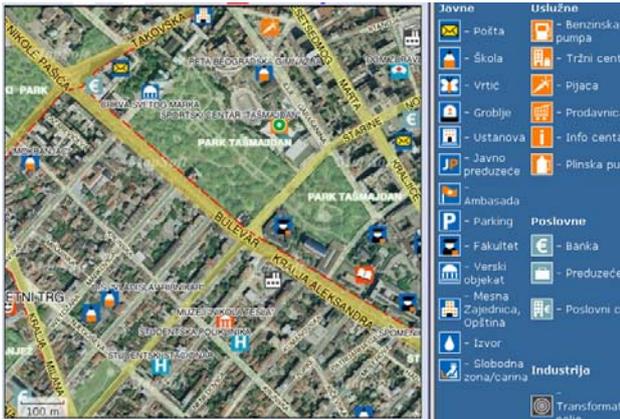

Figure 3. Some of the 40 categories of POIs displayed on MapsOfSerbia geoportal

3. DATA PROCESSING

Raster and vector datasets are completely collected using MapSoft software system. Visual controls of raster datasets, as well as geometrical and topological controls of vector datasets are also carried out by using MapSoft software.

Cartographic data processing using GIS software provided maps similar to maps offered on Google Maps or on Virtual Earth. Colors identical to those used for Google Maps were selected for map data rendering. In order to provide efficiency of the system all the data were transformed into raster form. Solutions used by Google Maps and Microsoft Virtual Earth were analyzed and resolutions chosen for pyramid levels are quite similar to those used in these solutions. However, MapsOfSerbia datasets contains pyramid levels that cannot be found on Google Maps or Virtual Earth. This was possible because imagery published on MapsOfSerbia was acquired with 0.3m resolution and therefore pyramid level with resolution of 0.5m could be generated. MapsOfSerbia also provides vector data (buildings and house numbers from address database) on 0.3m resolution level. This kind of data cannot be found on Google Maps or Virtual Earth maps.

Figure 4. Three data layers - map, photo and hybrid

Raster maps for different pyramid levels were produced automatically by using specially developed modules working within standard GIS software. For each pyramid level vector and/or orthophoto data are used to generate raster image and to store that image into ECW file with proper georeferencing data.

Three series of raster datasets containing vector map data, orthophotos and combination of vector map data and othophoto (hybrid maps) were generated. This approach is also used by Google Maps and Virtual Earth.

In total, over 1.8 million of tiles were generated for the territory of Serbia for each data layer.

Zoom levels (Microsoft VE, Google Maps)	Zoom levels (MapSoft)	Approx. resolution 1 pixel = x [m]	Number of tiles
6	12	2048	4
7	11	1024	9
8	10 (region)	512	24
9	9	256	70
10	8	128	234
11	7 (city)	64	864
12	6	32	3.360
13	5	16	13.344
14	4	8	52.716
15	3 (part of the city)	4	209.931
16	2 (street block)	2	886.760
17	1 (street)	1	3.373.312
18	0 (house number)	0.5	13.493.248

Table 1. Number of generated tiles for the territory of Serbia

All tiles are stored in the Mercator projection. This requires that we transform imagery for the whole country, since Maps of Serbia server use the Gauss-Krüger projection by default.

3.1 Storage overview

Currently in our implementation, for storing Maps of Serbia at 13 zoom levels for 3 map layers, there are more than 18.033.876 tiles for each layer. The tiles are 5KB in size for maps, and 25KB for aerial photography and hybrid tiles. Our current storage requirement is thus [18.033.876* (5KB +2*30KB)]*3 (for 3 map layers), or approximately 350 GB.

3.2 Data accuracy

Orthophoto maps produced in the last few years were used for building and updating most of the vector data (road and street networks, POIs, house numbers…). These orthophoto maps enabled production of vector maps with homogeneous data accuracy for the whole territory of Serbia, and this data accuracy ensure that data could be used in the future for various GIS and LBS applications.

Differences in data content between MapsOfSerbia (Figure 5, Left part) and Microsoft VE (Figure 5, right part) are demonstrated in Figure 5 (part of the Serbian capital city is displayed). It can be seen that, besides having significantly more data quantity, MapsOfSerbia is also characterized by better quality in terms on geometry and accuracy. The

difference in street geometry can be noticed from the Figure 5 (red on Microsoft VE, green on MapsOf Serbia). As a reference geometry positions of the vehicle equipped with GPS are used (Figure 5, purple). Error displayed on this figure is about 70m, and average error for the territory of the town of Belgrade is about 50m.

This demonstrates that Microsoft VE and especially Google Maps data for the Serbian territory, at this point of time, can be used just for limited number of applications. On the other side, thanks to its high level of detail, data quality and data that is updated recently, MapsOfSerbia can be used in many LBS scenarios.
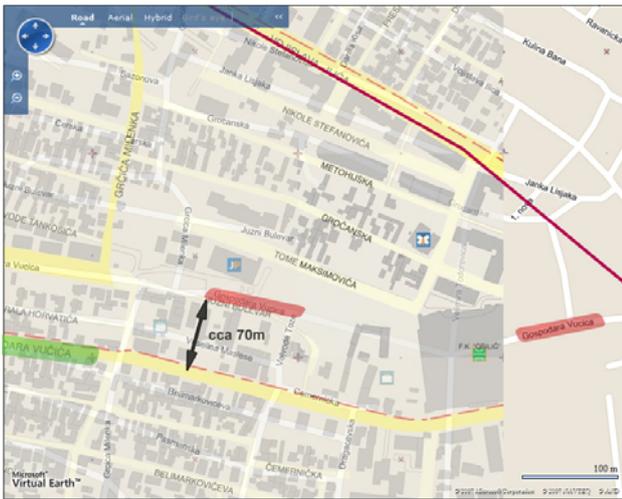

Figure 5. Level of detail and data accuracy for the Serbian territory data - MapsOfSerbia vs. Microsoft VE

4. SOFTWARE

All major GIS vendors have their own WebGIS software solutions. They are characterized by data analysis capabilities, rich graphical interface, and rich functionality. However, in cases where massive datasets has to be published simultaneously to a large number of users and where system is to be overloaded with large number of data queries it is desirable to design a system based on pre-generated raster imagery, a system called Web Map Tile Server (Liu, Pierce, Fox, 2007).

Firstly, MapsOfSerbia solution is developed. This solution is based on custom made software components. Open Source project SharpMap is used for the development of the software. Software is based on multitier architecture similar to architecture of the Google Maps.

Afterwards, solution based on tiles is developed. These tiles are similar to those used by GM, VE, and YM. Tiles are usually generated with size of 256x256 pixels (Figure 6) and depending on user request several of these tiles in sent to the user over the net. Shortcomings of this solution are more complicated and slower update of the data and limited functionality of the system. However, this is the most efficient way of data publishing, especially when system is overloaded and the speed is a primary issue. This approach is also used by Google, Microsoft and Yahoo ("Building a Map Caching Tile Server").
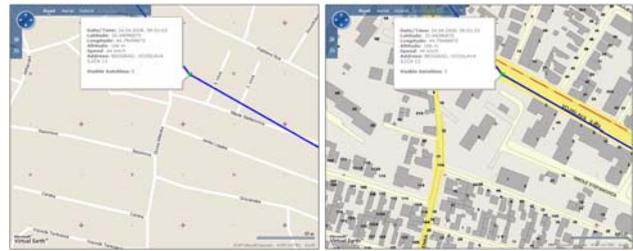

Figure 6. Corresponding tiles of Microsoft VE and MapsOfSerbia (red + lower left corner of the tile, red x center of tile)

Client side software (Figure 7) is developed using Ajax technology (Jesse James Garrett, 2005). However, there also some differences. Images are not tiles stored in png or jpg format but large images stored in ecw file format. It was estimated that it is sufficient to use Web Map Ecw Server on middle tier instead of Tile Server even though the latter is somewhat faster.
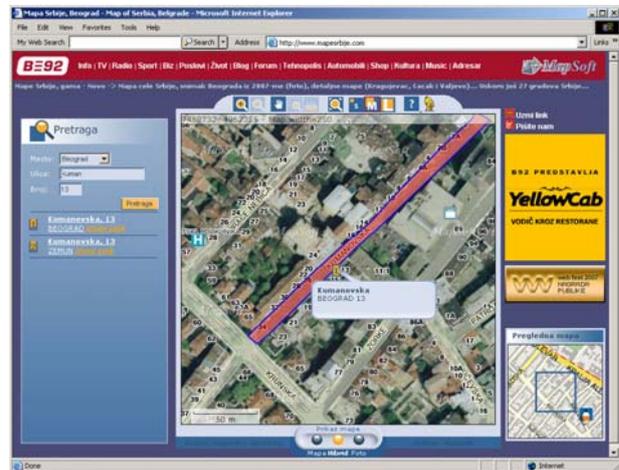

Figure 7. MapsOfSerbia geoportal

5. SERVICE MAPS OF SERBIA IN EXPLOITATION

First release of the MapsOfSerbia service was released in 2003. It was based on MapSoft 2000 Web Server. Only orthophoto maps were published, it was part of the MapSoft company web presentation, and it had about 1000 queries per day. New release (set on April 2007) is based on the software solution described above and it provides publishing of orthophoto, vector and hybrid data. This service is part of the most visited portal on the Balkan www.b92.net (Alexa rank – ranked as 890th in the world, for October 2007). About 7000 unique users visit MapsOfSerbia and make 120.000 queries per day (data from April 2008).

The ProgrammableWeb is an excellent source for browsing mash-ups and discovering APIs to on-line services ("The ProgrammableWeb", Figure 8). This service has become reference site for various applications - real estate agencies, Internet marketing, Location Based Services (Figure 9), etc.
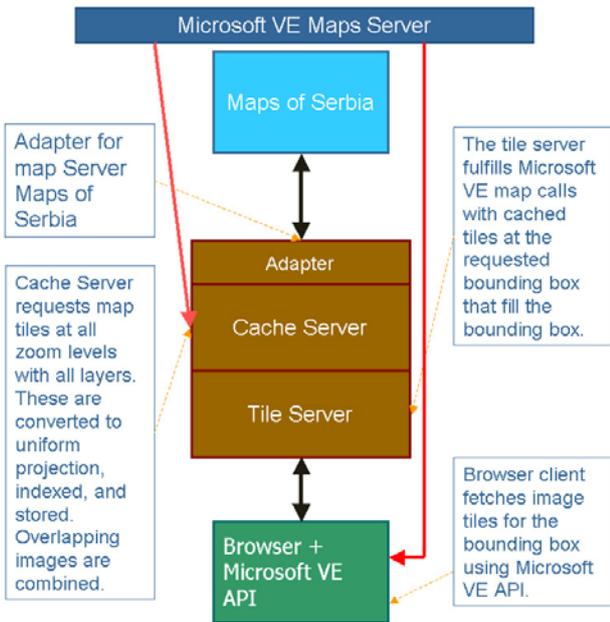
Figure 8. Architecture of application based on Microsoft VE, MapSoft Tile and Cache server
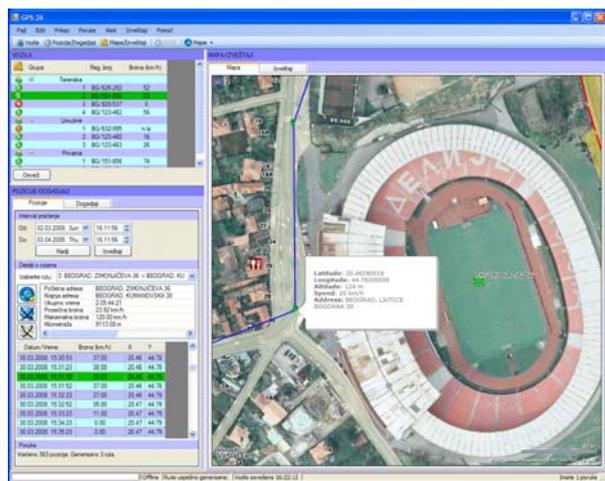

Figure 9. Application for automatic vehicle location (AVL) where MapsOfSerbia and Microsoft VE are integrated

6. FURTHER DEVELOPMENT

Addition of detailed city maps (up to the street level) for all cities larger than 25.000 inhabitants is planned in the very near future. Also, it is planned to produce another level of othophoto maps of 0.25m ground pixel size for all areas where available data exists (territories for almost all cities where orthophoto with ground pixel size of 0.3m and better is available).

Vector data model of road network provides possibilities for routing. Therefore, it is planned to develop software additional functionality that will be available for the end user of the geoportal.

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