# Research of GIS-services applicability for solution of spatial analysis tasks.

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**Abstract.** Experiments for working out the areas of applying various gis-services in the tasks of spatial analysis are discussed in this paper. Google Maps, Yandex Maps, Microsoft SQL Server are used as services of spatial analysis. All services have shown a comparable speed of analyzing the spatial data when carrying out elemental spatial requests (building up the buffer zone of a point object) as well as the preferences of Microsoft SQL Server in operating with more complicated spatial requests. When building up elemental spatial requests, internet-services show higher efficiency due to cliental data handling with JavaScript-subprograms. A weak point of public internet-services is an impossibility to handle data on a server side and a barren variety of spatial analysis functions. Microsoft SQL Server offers a large variety of functions needed for spatial analysis on the server side. The authors conclude that when solving practical problems, the capabilities of internet-services used in building up routes and completing other functions with spatial analysis with Microsoft SQL Server should be involved.

## 1. Introduction

Lately, information systems offer different ways of working with spatial and cartographical information of various themes. Municipal geographic information systems, navigation and cartographical tourists systems, weather forecast systems etc. [1-6] are illustrative examples. Storing and visualizing spatial data is quite an important task, but a capability of spatial analysis also matters. Such elemental operations of spatial analysis could be:

- building up various buffer zones of spatial objects;
- finding out the areas of spatial objects crossings etc.

The distinctive characteristics of modern information systems are capabilities of storing large capacities of thematic information in DBMS and using the Internet for assessing it. Mainly, the information is reflected upon a cartographical substrate obtained from cartographical information providers [7,8] or local cartographical sources.

The modern level of development of cartographical information providers makes it possible to solve the tasks based on spatial information. For instance, Google or Yandex can be used to build up the route of movement between two points, instead of doing it ourselves basing on our own data. The result obtained from web-services is supposed to be appropriate, relevant, expected and predictable.

Up-to-date DBMS also enables storing spatial data and contains complicated functions of spatial analysis [9].

The following questions are discussed in the paper:

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- efficiency of applying the spatial analysis functions of cartographical web-services in comparison with analogical functions of DBMS;
- possibility of enabling other functions of public cartographical analysis in information systems.

These questions were examined in frameworks of solving a more complicated problem – foundation of the thematic internet-geographical-information system for reflecting information about historical objects of the town. The tasks were: reflecting various materials connected with the given historical objects, building up optimal summarizing trips and working out the visibility of sights from certain points of view, matching the guard bands with already existing and planned objects of the town infrastructure. For a considerable number of such tasks, spatial analysis is essential. In this paper, the capabilities of applying different tools of spatial analysis in this project are researched.

## 2. Related works

An algorithmic base of solving the tasks of spatial analysis are discussed in the papers [10-12]. Realization of web-systems and web-services is dwelt on in other papers [13, 14]. In addition, the results achieved in work [15] attract the interest as they are compared with the capabilities of web-GIS.

All in all, nowadays there are quite a lot of works considering an increase in efficiency of the developed software at the expanse of applying diverse completed programs of data handling.

## 3. Experiment setup

A special software was developed in C# as a web-application to check the research. The architecture of application is shown in figure 1. The application contains 4 controllers and interacts with data base MS SQL Server as well as with Google Maps and Yandex Maps, the most popular providers of cartographical information in Russia.

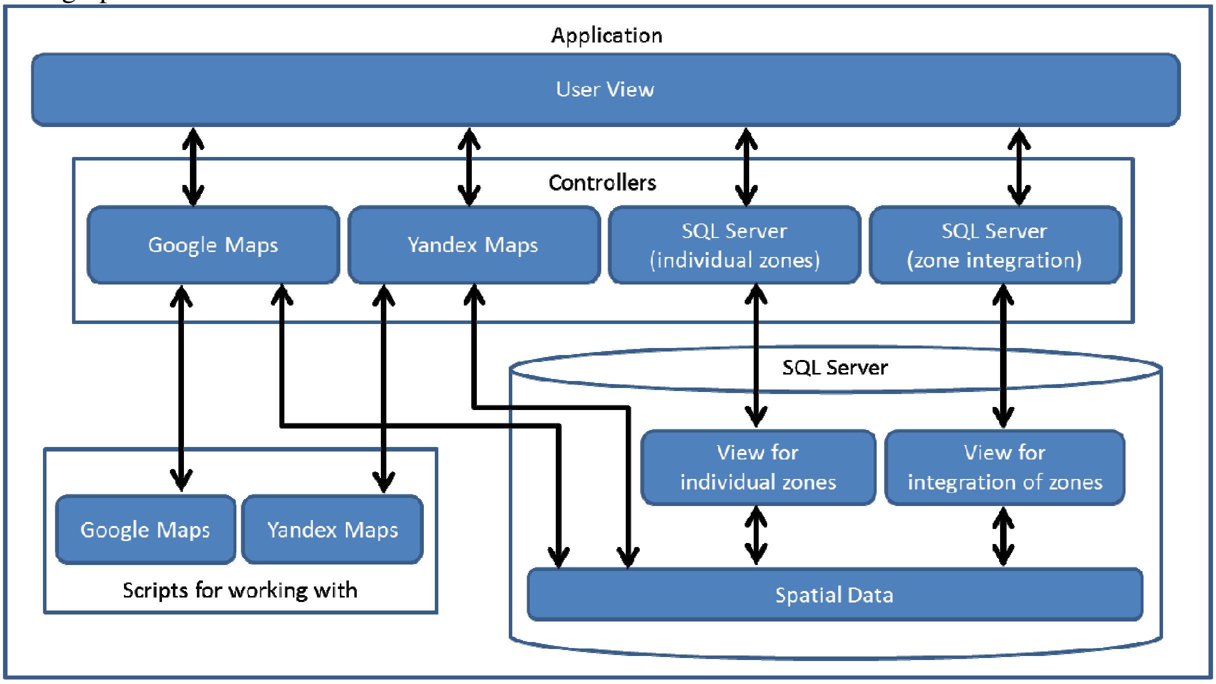



**Figure 1.** An architecture of the research software.

The database of historical objects in Tomsk city (Russia, Siberian Federal District) was used as thematic spatial information, where each object is described by a pair of coordinates.

Capabilities of building up buffer zones were used as operations of spatial analysis, capabilities of internet providers and DBMS.

As a whole, a step-by-step algorithm of the experiments looked pretty the same:

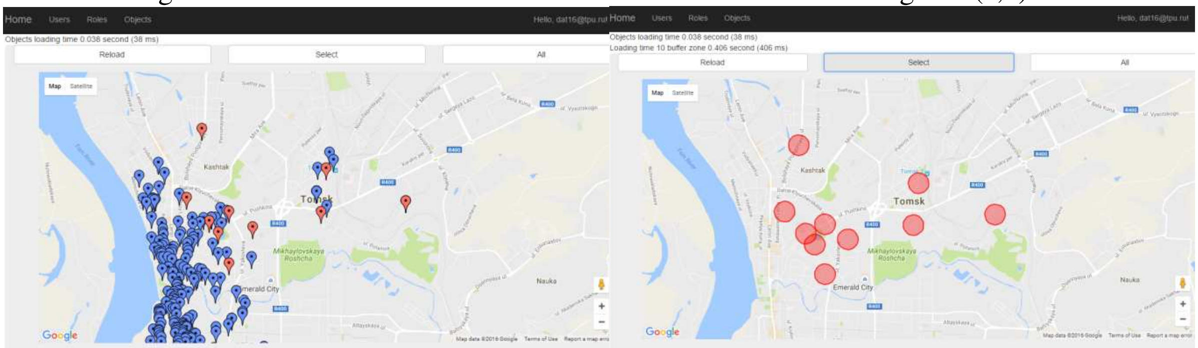
- A few spatial objects are chosen
- The objects are built up and their buffer zones are reflected on a map
- The time spent is evaluated

Series of experiments differed in a performer, which built the buffer zones (Google Maps, Yandex Maps, MS SQL Server) and in a number of spatial objects.

- 1 series – building up buffer zones with Google Maps;
- 2 series – building up buffer zones with Google Maps Yandex Maps;
- 3 series – building up buffer zones with MS SQL Server.

The number of spatial objects in the series of experiment varied from 1 to 600 with step 25. At large, data handling is similar with the paper [16].

The starting and the final condition of the research software is shown in figure 2(a,b).




a b

**Figure 2**. The main page of the research web-application software.

Figure 2.a reflects an accidental choice of point objects, figure 2.b – built up buffer zones of these objects.

During each of 3 series of experiments each of 25 requests was repeated 100 times. Thus, the data of completing 7500 requests were collected. The collected statistics (capacity of intelligence, speed of building up the buffer zone, speed of reflecting) was held in files and then analyzed in StatSoft Statistica and Microsoft Excel programs.

## 4. Experiment results

The average time spent on transferring data, building up the buffer zones, was evaluated and their mean-square deviation was calculated for each series of experiments. A fragment of a table with analyzed data is in table 1. The summarized time and the reflection of buffer zones of different quality sets are shown.

**Table 1.** Dependence of time spent to build up buffer zones on their number with SQL Server, Google, Yandex.

| Objects count | SQL Server, sec. | Google Maps API, sec. | Yandex Maps API, sec. |
|---|---|---|---|
| 1 | 0.195 ± 0.008 | 0.188 ± 0.010 | 0,03 ±0.001 |
| 25 | 0.316 ±0.018 | 0.248 ± 0.007 | 0.12 ±0.004 |
| … | … | … | … |
| 575 | 13,564 ±3.95 | 1.654 ± 0.231 | 1.253 ±0.012 |
| 600 | 13.754 ±3.41 | 1.930 ± 0.284 | 1.258 ±0.057 |

The results are also shown as a graph in figure 3. The logarithmic scale of ordinates is used for compactness. It is seen that building up buffer zones for various sets of objects is the fastest with Yandex Maps.

The JavaScripts software of Google Maps works with the same speed. The time spent by MS SQL Server is much longer. The reason is in the different ways of completing spatial operations of the Google/Yandex software and SQL Server. While building up the buffer zones in Google/Yandex only, the pairs of coordinates of spatial objects are sent to the visualization app, then the appropriate JavaScript-programs on the client side visualize buffer zones around the points.

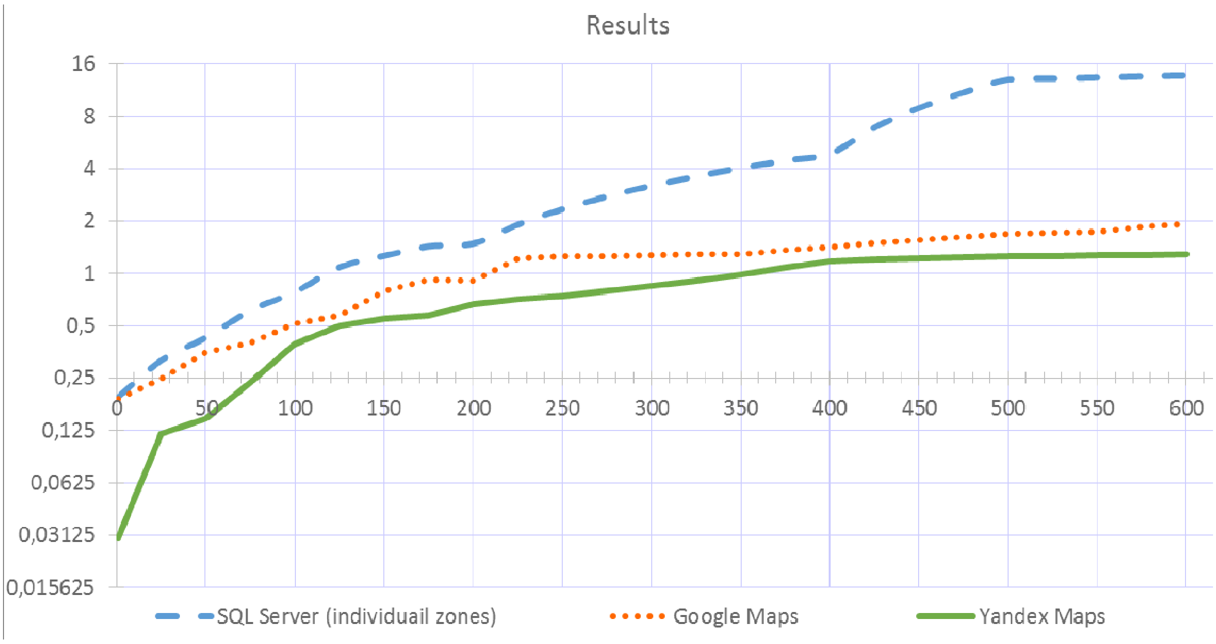



**Figure 3.** The diagram showing the dependency between the buffer zones construction time (sec.) by SQL server, Google Maps, Yandex Maps and the number of buffer zones.

MS SQL Server builds up buffer zones completely at the server side. At the same time, SQL Server transfers coordinates of all built points to the web-application. Then, the application sends this set of coordinates to the client`s browser. Next, the pointwise drawing of all obtained buffer zones is completed in the client`s browser. The intermediate results of carried out experiments show that the coordinates of all the points of a built up buffer zone take 100 times more capacity than the coordinates of the spatial object itself. Consequently, SQL Server transfers and visualizes 100 times more data than Google/Yandex do when making buffer zones. Mainly, this is the reason of considerable delay when building up buffer zones with MS SQL Server.

## 5. Conclusion

Despite the obvious lack of speed, SQL Server has its own advantages:

- The speed of building up buffer zones is quite close by the example of little capacities.
- SQL Server forms 100 times more outcomes having spent just 10 times more time by the example of large capacities.
- The internet geographic information systems offer less spatial operations than SQL Server does, including building up united buffer zones.
- SQL Server offers to build up united buffer zones for the groups of spatial objects having spent practically the same time when building up separate buffer zones as shown in figure 4.

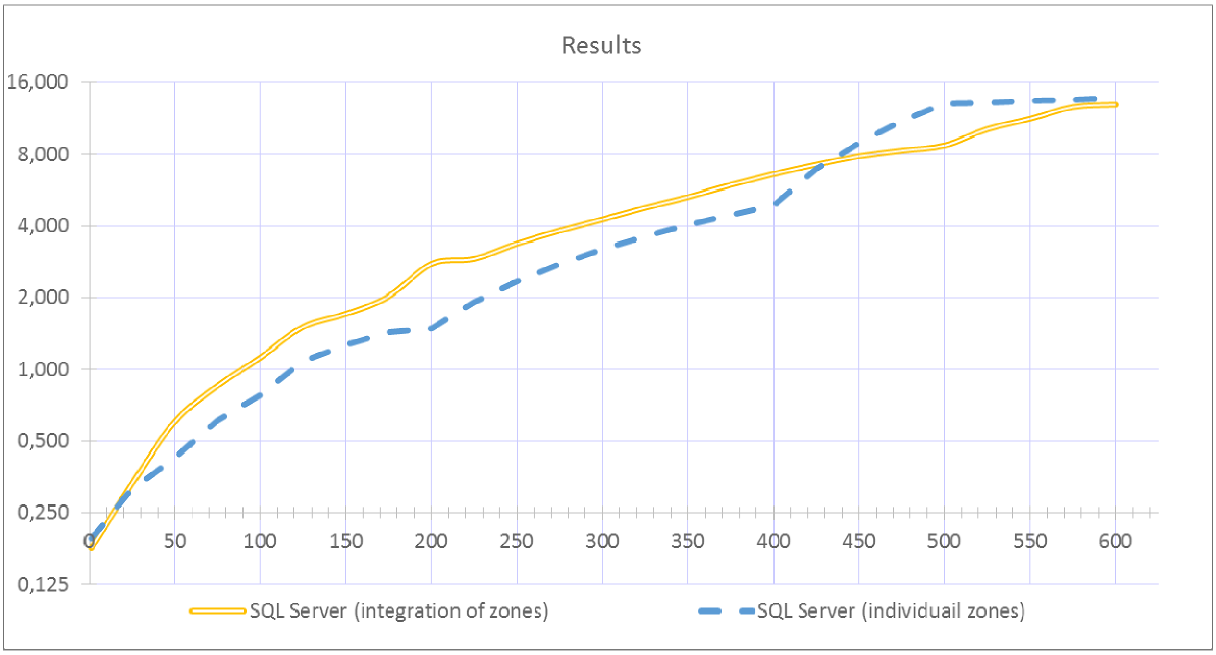



**Figure 4.** The diagram shows the dependency between integration and individual buffer zones construction time (sec.) by SQL server and their number.

Taking these facts into account, the authors justify the use of the SQL Server software for solving the tasks of spatial analysis in applied geographic information web-systems.

It should be mentioned that the main problem in applying internet geographic information systems stays the low knoware of the spatial analysis. In the short time it could be expected that Google and Yandex will solve the spatial analysis tasks as well as SQL Server.

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