# DEPLOYING SMEs ENGAGEMENT IN SDI IMPLEMENTATION

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## ABSTRACT

Impact of the influence of small and medium enterprises (SMEs) on the spatial data infrastructure (SDI) was the leading motive for writing of this paper. The significance of the necessity for more thorough approach in inclusion of SMEs in SDI was presented through framework established by institutions identified as stakeholders in the field of geospatial technologies. Validation of this thesis is shown through best practice case demonstrating the availability and benefits of tools and means of geographical information system (GIS) implemented into existing production processes of one representative small bureau.

Paper shows overview of current situation concerning today's presence of geospatial data in business environment. In the first place standards and the environment in which GIS users operate are analyzed with SMEs as focal point. Possibility of GIS realisation is considered, bearing in mind outlines set by SDI and, simultaneously, respecting needs for a specific local use of spatial data in daily activities of SMEs. Furthermore practical use of acquired conclusions and routes for deploying engagement of SMEs in SDI implementation is shown. As an all-inclusive outcome, model of GIS architecture and the example of its implementation is presented according to identified needed characteristics of GIS modules, standardisation requests, interoperability and openness.

Outcomes of the presented material ought to emphasize current constellation concerning SMEs in market of South East European countries which are still in process of establishing spatial data infrastructure. Recommendations for better adoptions are given, as well as the conclusions for further engagement in this course.


**Key words:** SMEs, SDI, GIS standards, open source GIS software, service orientated GIS architecture, road infrastructure construction

## 1. INTRODUCTION

Looking at the first geoportals, as mediums for open access to spatial data, service quality improvement led to the level at which use of global geoportals became significant at the local level for the daily activities of small and medium enterprises. Spatial data infrastructure in that sense put through interactive relations among spatial data, metadata, users and software tools. Purpose of such initiative aims at decentralisation and interoperability of spatial data and metadata managing, by which user is lead straight forward to the data source.

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From the early beginning the reasons behind SDI initiatives were undisputed since they considered several crucial points (Woldai, 2002):

- developing the neglected spatial data potential and stimulate economic activity,
- distributing spatial data to the widest possible range of users through the use of standards,
- encouraging the new profitable services through enabling better interaction of data from multiple sources,
- improving quality and reducing costs related to spatial data,
- increasing benefits of new way of data integration and establishing cooperation with states, regions, academic and private sector for the overall enhancement of the field of spatial data use, and
- decrease redundancy in data production and effort involved in it.

In order to accomplish the stated objectives and purposes, SDI needs to be organized in such way that it can meet all the requirements concerning data sets, regulations and related aspects. In any application field, the types of shareable data have to be known and identified to apply it. Data forming the desired spatial infrastructure can be divided in two categories concerning its purpose: fundamental and application data. (Groot and McLaughlin, 2000)

Fundamental data provide essential base information upon which other organizations can create datasets by overlaying with other data. These include: data that can show geographic reference systems, topographic data sets that can serve as geometric references, common codes, etc. on which other thematic data sets can be built on. The basic spatial data producers are those that are mandated at the national level for collecting, processing and disseminating spatial data and other related data at large. These include land administration authorities, surveying and mapping authorities, planning departments. Their task is tied to the foundation data and as such deal with: the national positioning system, the national digital topographic maps, digital elevation model, geographic names, administrative units, common codes, etc.

Application data includes theme specific data sets such as, land use, land cover, vegetation, etc. being not as extensively as the fundamental data sets. Nevertheless, they are also required by many organizations to produce other derived data sets, which are important for spatial decision making. Application-specific data include data collected for a very specific duty, and particular application area. Most of these institutions use the baseline information to come up with their own value-added outputs. Depending upon their thematic responsibility (e.g., geology, land use, land cover, vegetation, etc.), they produce and use geo-data of different nature on an ad-hoc basis (rather than taken as a regular duty) primarily to fulfil their jurisdiction. Unlike the spatial information basic users, most of these companies and their departments have a need of getting more up to date data on their subject. Concentrated on meeting their own internal information need and not being core stakeholder in SDI there is no adopted general mechanism to facilitate data access to other interested users. Therefore, unless it is a luckily informed user, no one can easily know what type of data they have, no matter how valuable their data are.

This is the situation where SMEs reside in the early stages of SDI implementation and the reasons why countries and regions where SDI operates for years confronted with serious issues about private sector inclusion. The demand driven approach should be more represented since the categories of users are still not well identified, nor are their specific needs well surveyed. In such environment, where market is not enough developed, analysis of spatial data market, users and their needs is the first step of creating the approach for overcoming the mentioned issue among SMEs and SDI. Bearing this in mind, following text is about to include this topic discussing the region of South East Europe (SEE) and offer answer for several questions. What is the constellation in which SMEs in the region operate? What is the position of SMEs, their needs and issues they confront in such environment? What are the current possibilities for improving the situation?

## 2. SMEs WITHIN SDI FRAMEWORK

### 2.1. SDI framework

Since the Geographic Information Network In Europe project which had the objective of creating overall geoinformation strategy in Europe and creation of some of today's European spatial key players (Infrastructure for spatial Information in Europe - INSPIRE), it was declared that political and institutional support is crucial for the development SDI. Hence, the most important standardisation organisations in the spatial field today represent the benchmarkers in the field of spatial information. They represent the focal point in reaching the goal of establishing successful infrastructure and satisfying user needs.

For the purpose of this paper, it will be given only the overview of the field that International Standardisation Organisation, Open Geospatial Consortium, INSPIRE и European Committee for Standardisation as the stakeholders in the spatial information in Europe cover.

ISO developed group of standards in the field of geomatics, concerning digital geographic information, promoted through the technical committee ISO/TC 211 with the aims of (Henry, 2009):

- support and use of spatial information,
- assuring availability, integration and exchange of spatial information,
- enabling interoperability of spatial orientated computer systems,
- contribution to integrated approach to global ecological and humanitarian problems,
- simplifying of establishing spatial infrastructures on local, regional and global level,
- contribution to sustainable development.

To summarize, it brings standards and specifies methods, tools and services for management of geographic information, including the definition, acquisition, analysis, access, presentation, and transfer of such data in digital/electronic form between different users, systems and locations.

Parallel with the work of ISO, group of interested parties in the field from all over the world and from different spheres of working with spatial data, gathered for cooperation in overcoming the existing common problems. Different development teams were formed with aim to make available open source GIS software, solve interoperability issues which demanded more than openness of the software. This was the initial mission of the Open Geospatial Consortium, Inc. Today their specifications and standards support interoperable solutions, which enable geospatial domain to services like World Wide Web and give users the means for manipulating complex spatial information for creating services available for all sorts of specific applications.

Already mentioned INSPIRE initiative of the European Commission for development of European SDI which enables to the public sector of Europe, nationwide, regionally, locally and also to the private sector, researchers, nongovernmental organizations and citizens, the discovery, access and gathering of spatial data from various sources in interoperable way, for different needs, without restrictions. In that sense it is adopted that European SDI ought to be assembled from operational, growing local, national and regional SDI. INSPIRE refers to technical standards and protocols, organisational and coordination topics, policies of data management, including access, creating and maintaining the spatial data. (INSPIRE, 2001)

The spatial standardisation environment functions in a way in which framework for standards and technical issues are covered by ISO standards and OGC specifications. European Committee for Standardisation is in charge for implementation in the field of digital geographic information in the context of the European Union legislative, with close cooperation with ISO, whereas the INSPIRE directive aims to create a European Union spatial data infrastructure. This will enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe.

The desired SDI includes interactive relationship of spatial data, metadata, users and tools with the aim of effective and flexible use of spatial data. It strives towards decentralisation of data and metadata managing, guiding users directly to the data sources. With described standardisation of the tools, services and computer networks it enables availability, exchange and effective use of information.

### 2.2. Issues with SMEs

Although the purpose of described stakeholders is to support sustainable policy, major barriers still affecting the availability and accessibility of relevant data. These barriers include: (Craglia, 2010)

- Inconsistencies in spatial data collection, where spatial data is often missing or incomplete or redundant
- Lack or incomplete documentation of available spatial data
- Lack of compatibility among spatial datasets that cannot therefore be combined with others
- Cultural, institutional, financial, and legal barriers preventing or delaying the sharing of existing spatial data

Concerning South East Europe, European SDI stakeholders' focus was put on engagement of relevant public institutions which ought to take responsibility in developing national and regional SDI. For example in the republic of Serbia the Ministries, the Republic Geodetic Authority should engage as relevant public institutions. However, although process of implementing standards and creating spatially enabled systems lasts for more than five years, coordinating institution, such as National Spatial Data Infrastructure agency has been established at the end of 2009. So far Ministry of Environment and Spatial Planning and the Republic Geodetic Authority went the furthest in Serbia, concerning spatial data use legislative and reforms in digital spatial data use. Although these encouraging results show systematic approach to developing national SDI, there are segments in which there is still much work to do. Traditional bureaucracy and administrative obstacles still play significant role in restraining availability of spatial data. In addition, low public conscientiousness in this field is present. Therefore, several main objectives emerged as terms for successful interaction between data sources and end users: (Pavlova, Boes, Roccatagliata and Luzet, 2003.)

- cooperation with European organisational initiatives in this area,
- forming spatial data infrastructures,
- supporting awareness about the importance and use of spatial data in public,
- implementation of adopted legislation,
- stimulation of SMEs in wider use of spatial data.

This paper focuses on the last of the stated objectives as SMEs are to be the most significant group of commercial users of spatial data, concerning the potential of their influence on expansion of geoinformation technologies. Since the described national conditions, with slight differences, can be applicable for the whole SEE region, it will be of significant interest to further elaborate findings about possibilities of SMEs stimulation for further engagement in this course.

## 3. SMEs AS STAKEHOLDER IN SDI

Experience from USA national SDI tells that urge for securing the role of private sector in SDI came from the rising of the consumer demand for spatial information which triggered a major shift toward local government and commercial providers. In addition, it is common knowledge that the collection and management of geospatial data are considered to be the costliest components of a GIS with almost 80% share in GIS total costs. Yet, being focused merely on providing geospatial information the federal government lacked to devote enough attention to coordinating and managing geospatial data and facilitating partnerships among fastly expanding number of producers and consumers of geospatial information. This was the new orientation they had to prioritise, which required huge engagement and still is an issue for resolving, because it brought stated barriers which affect the availability and accessibility of relevant data. The role of federal government (except coordinating function) therefore switched from being provider to the consumer side. (Folger, 2009)

SDI initiatives in South East Europe as it was mentioned before devote primary attention to governmental institutions as data providers and neglect private sector as natural stakeholder in the spatial market. Exceptions may be huge companies that cooperate with governmental institutions in producing data, but the accent here is on

SMEs, which remained isolated isles in this environment, with occasional inclusion in spatial data exchange. Bearing this in mind, it could be concluded that similar path to the USA experience is taken in the concept of conducting SDI. This is one more reason to react towards SMEs more active engagement in SDI.

Issues that need to be addressed must be accessed carefully since the clues for proving readiness of SMEs to be stakeholders in SDI are not always obvious. An example of this could be the case of identified lack of private industry data sharing. But if one consider commercial remote sensing companies, there will be identified the need of significant capital investment required to place in space imaging satellites and ground stations to capture the imagery to produce the first deliverable product. Thus, some of the underlying data sharing assumptions are not well articulated. Next obstacle could be licensing and other intellectual property arrangements in need of being defined. (STIA, 2001)

SMEs demand for the SDI can be characterized as:
General demand - considers framework data to be available nationwide. However, differences exist in the resolution, quality, coverage, currency and other characteristics depending on the source of the data.
Data providers - who also are part of the private sector. These companies sell software solutions and data content, hardware, and consulting services, etc. Their inclusion to any program fostering increased private sector participation is essential. They bring rich data sets, lists of current and prospective customers and success stories to the equation.

Within SMEs, participation in SDI has been limited even though the need for data has only grown. Many private sector companies have built their own data or purchased it and spent a lot in improving this data for their own needs. This data is not widely shared and may not conform to SDI standards.

Therefore, issues that need to be addressed to increase SMEs participation are:

- Communication between SDI and SMEs – starts from the very basic lack of private sector awareness of the SDI, inexistence or low inclusion of the private sector in the planning for the SDI, still underdeveloped of understanding about the drivers for private sector participation like revenue, profits, liability protection and intellectual property protection and confusion about the purpose of the SDI and whether it serves the interests of private sector companies.
- Data adequacy – firstly there is little synchronization amongst data sets used in SMEs, a great potential for redundant data in the SDI because different groups create data at different resolutions, question of ways of satisfying data accuracy since it determines customer satisfaction, liability and revenue issues; Tools must be employed to make the design and accessibility of data more user friendly.
- Legal issues - State and local laws relative to freedom of information, privacy, disclosure and intellectual property can hamper data sharing, especially when companies consider their information part of the assets or worth of their companies.

Described constellation serves as a ground for SMEs engagement in overriding identified problems and positioning in long term period with respect to SDIs planned development. This brings out the questions of possible solutions for SMEs deployment

in described environment. In that sense paper analyses the most suitable ways of putting through acquired goals.

Next part presents the approach that will show the best practise case for one SMEs representative using means that are least disturbing for production process having at the same time maximal effects on production outcome. It respects described standards and stakeholder institutions, SMEs needs and motivation for engagement in SDI and available models and tools for realisation of the GIS.

## 4. SMEs AND GIS WITH AVAILABLE TECHNOLOGIES

OGC enabled its information system architecture framework (OGC Reference model), which documents interoperability of geospatial data processing from simple single processor computer systems to open environment which enables communication of spatial information without obstacles in WWW. Model considers methods of architecture development, standards, specifications and system components with their interaction within system's architecture. (OGC, 2010)

Stated implies that open system carries the best characteristics for meeting the required terms of incorporating GIS in SDI outlines. Open systems are the ones which function and interact through open interface as a way for connecting and communicating of the software components. The key of openness is building the interface whose use and functionality will not depend on specific producer and in that way keep the software which uses that interface isolated. In that way users are not limited on use of just one specific producer application.

Further on open interface creates the possibility that the data format which is used for communication among systems is not an obstacle in communication. Moreover, openness enables converting of just the necessary part of data during communication, speeding up the process of transformation of different data types. Today this concept is applied through XML since OGC developed Geography Markup Language which does spatial data conversion to spatially enabled XML.

Currently concepts, standards and technology for implementing GIS interoperability are based on integration of standardized GIS Web services. Web services avoid the issues and complications of GIS applications being tied to the spatial schema of a specific RDBMS vendor and allow GIS vendors to manage their own data using the best methods and formats for their tools in whatever database environment they choose. In addition, Web services allow server-to-server sharing of data and services, as opposed to integration only happening at the client level as it does with standards that are focused on the DBMS. Web services mean that each GIS vendor can build and manage its own GIS data and readily provide GIS services (data, maps, and geoprocessing) to a larger audience in a common environment. (ESRI, 2003)

With all this means available for building GIS, open source systems could be competitive with almost any commercial software. In another words, today's open source systems have sufficient modularity, user community, supporting documentation and development team to assure their competitiveness.

Adopting web services as a centre point of the GIS gives great effectiveness in sense of system expansibility and components interoperability. This statement also represent basic concept of the Service-oriented Architecture (SOA) GIS. SOA enables creation of flexible GIS, which can easily adopt changes in organisation needs of a company. Mechanism of integration like web services

preserves modularity of the system and ensures technological independence of the components it is consisted of.

## 5. CASE STUDY

Important part of this analysis is segment that validates exposed premises and shows practical use of acquired conclusions and routes for deploying engagement of SMEs in SDI implementation. As an all-inclusive outcome, model of GIS architecture is presented according to identified needed characteristics of GIS modules, standardisation requests, interoperability and openness.

The objective was to implement GIS, as the applied solution for production process of a road infrastructure project bureau operating in the Republic of Serbia. In all phases it considered discussed topics and serves as a validation of the conclusions stated in the previous segments of the paper.

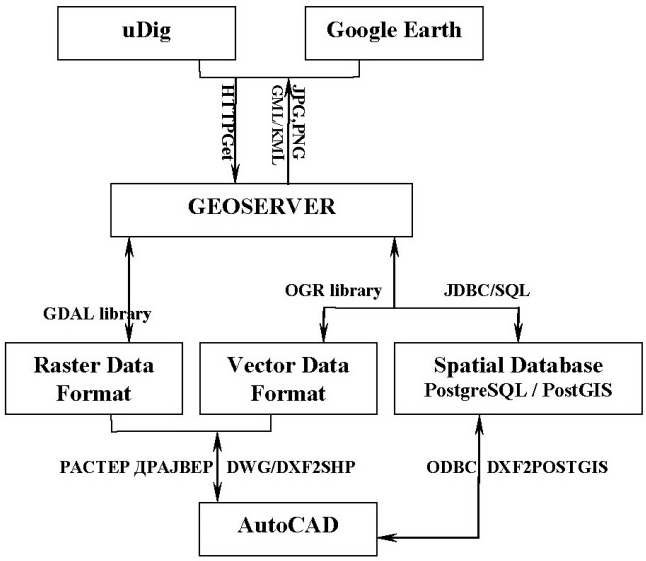
Sector of the road infrastructure was chosen as a good representative of SMEs whose use of spatial data is insufficient comparing to their needs and capabilities. Confirmation lays in authors' personal engagement in the field for more than five last years. It is the field with the necessity for spatial information from several domains: plan decisions based on topographic data, determining the priority of road construction and maintenance, analysis of traffic and transport, managing objects correlated with road infrastructure, etc. That information could be found in various forms coming from different sources. Usually the most reliable are ones taken by the company itself or bought from other SME more specialised in the field of data acquisition. This situation implies on the issues identified earlier as major barriers still affecting the availability and accessibility of relevant data.

For the purpose of this paper data flow of the typical project of the bureau was chosen as an example of implementing SDI recomandations without disturbing production process and with implementing open source technologies. Practicaly it meant in the first place incorporating commercial software used for road construction projects - Autodesk AutoCAD in GIS. AutoCAD is software that has big share in the field of road constructioning and generaly in the field of civil engineering in Serbia. Incorporating AutoCAD in GIS validation of possibilty to implement efficiant and effective GIS concerning companies production process.

Although Autodesk thought about interoperability of the supplied data formats, it is mainly supported within the companies products and a few open data formats (.dxf, .shp, .gml) as well as technologies which enable data formats compatibility and working with web services (Feature Data Object, MapGuide open source, RealDWG). Furthermore there is multilateral cooperation with other commercial software suppliers (like Oracle or Bentley). One more way that can satisfy the need for interoperability is the use of standards and protocols like ODBC. On the market other third party software products which support and manipulate with Autodesk's data formats can also be found.

The first challange in incorporating AutoCAD in SOA was to analyse supported data formats interoperable by the standardisation organisations protocols. After, interaction

with spatial database needed to be established with the same framework of standards. Secondly there was issue in communicating with client aplications through web services.




*Picture 1. Implemented SOA GIS*

First major data format supported in AutoCAD is vector format. Such data can be published on the web server and become available to other applications through the spatial database or directly if it is supported through web service libraries. Open source database PostgreSQL was used spatialy enabled through its extension PostGIS. Aplication used for exporting data to spatial database also came in open source environment - DXF2PostGIS, although there are other solutions from commercial range too. Further comunicating (for example to import data or view queries) with spatial database is available through ODBC. To send vector data directly to web server AutoCAD needs to export it in web service used libraries supported format, like .shp, which can be done through open source or third party commercial software.

Second important data format is raster images which could be created in AutoCAD by raster drivers and manipulated with basic functions (copy, cut, move, etc.). Alternatevly this kind of data can be imported in AutoCAD for manipulation and later used by other applications in GIS. In treated project, raster file which was used was in .tiff format, open and supported by web sevices.

Choosing and including components in the GIS is projected bearing in mind SOA and its central component web services. This, middle layer, placed between described data producer applications on one and client (viewing and manipulating) software applications on the other, enables data exchange as the communication channel between layers of the GIS. Thus, interoperability is limited here to the number of supported data

formats by web services. Although open data formats theoreticaly can satisfy the needs of the market, still often proprietary data formats are required when projecting GIS. In this case data format interoperability was solved by using open source data format .shp for vector data presentation and imported .tiff for raster data, as described above. Web services use them through GDAL (for raster files) and OGR (for vector data) libraries and communiaction with spatial database is implemented through ODBC/JDBC, as seen on the Picture 1.

As described, AutoCAD comunicates with web services through spatial database and available protocols as channels of communications. Some other Autodesk products already have direct support with web services. This trend goes in favour of data interoperability and openness because even the proprietary technology is becoming more and more open.

Web server distributes data to client applications in various formats and with specific capabilities which allow different rights of viewing, managing and editing data by client applications. Client applications used in observed example are shown on the Picture 1.

### 5.1. System implementation

In treated example in the field of road construction described arhitecture was implemented in the following way. For the location of the project an traffic area near public object was planned. As input, topographic map of area in the .tiff format was used. Existing comunal installations and road infrastructure was drawn in AutoCAD in .dwg format. Both raster and vector data were uploaded on the server and became available for all the components of the GIS.

GIS was used to analyse this information by reviewing influence of existing communal installation on projected new road infrastructure on the location. Rewieving was done through the client application uDig, with presentation by overlaying of all data layers in Google Earth. Few inconsistences were noticed concerning position of instalations compared to projected road and those were corrected in spatial database through client application uDig.

This updated communal installation positions were again available in AutoCAD through the spatial database. This was the validation that all GIS modules were interoperabile and funcioning as required in all segments of SOA.

## 6. CONCLUSION

In flexible and open service architecture based on ISO and OGC standards and used in a way proposed by INSPIRE initiative, AutoCAD was successfully implemented in projected GIS, proving that existing production process of SMEs representative was uninterrupted and in the same time efficiently incorporated in SDI as conclusions of analyzed framework proposed. Since this was just simple example extracted from one typical project of the civil engineering bureau, it presented possible realization of GIS architecture. Modules of GIS may vary in number and way of interaction of components depending on specific production system needs and proposed ways of its use.

Concrete results that were the outcome of SDI flavored bureau project, showed benefit to the production process in following aspects:

- planning and control of road infrastructure objects could be analyzed much faster and more efficient if such system was in use and if available data was updated regularly on the market where company operates,
- updating and exploatation of data coming from different sources (public and private, general and specific),
- contribution to development of conducting project in road infrastructure planning technology.

This case study was designed to emphasize the need of maximizing participation in the SDI by the private sector with focus on SMEs. The example shown summarizes and implements the findings of the teoretical recommandations described in chapters 1-4 of the paper with respect to the current status and issues with SMEs participation in SDI and adopted standards from relevant organisations. Hopefully this paper has prooven not just the importance of thorougher engaging of SMEs in SDI, but also proposed and validated ways of conducting these proposals.

Although presented solutions are already available and easily implemental, SMEs, in resolving these issues, will disengage if bureaucracy suppresses the efforts. Since proposed actions do not depend on occasional activism of some SMEs, but on systematic approach to solving described issues, SMEs will also lose interest in solutions that take too long to implement. In that sense, interest parties should not be just state institutions as SDI coordinators, but also SMEs as active participant in implementation.

Some of the issues cannot be resolved by the private sector. Legislative bodies and state SDI institutions must resolve them. The private sector can address these issues and participate in the educational process to bring about change. Other issues were analysed in this paper and attempt to make the step out their current static situation is made. Further awareness should be encouraged, more effort showing benefits and possibilities for SME participating should be made and additional advanced analysis should be conveyed to find mutual drivers of public and private sector towards successful SDI.

After the overview of SDI organizations' outlines and after presenting the approach and actions available to SMEs, several points came out as drivers of SMEs engagement in SDI:

- simple economic drivers like increased revenues and decreased costs,
- data quality issues like security, completeness, availability, ease of use and accuracy,
- expectations of geospatial providers and end-users,
- SDI should lead process of SMEs inclusion in process and defining it's role,
- SDI should complement the private sector's activities,
- establish a SMEs advisory group to tackle the higher level issues,
- seek private sector consultations and input on SDI initiatives.

As the private sector engagement in spatial information exploitation grows, the roles of the public and private sector will have to evolve. In order to secure that, the rising of

SMEs market demands should be met by public sector SDI initiatives and more concrete measures will be needed from SDI implementation organisations for more direct engagement of SMEs within SDI.

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