From Local SDI to E-Government

Case study in municipalities in the south of Hesse

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Key words: Local SDI, INSPIRE, SOA, Web 2.0 citizen service, GIS-based E-Participation

SUMMARY

The increase of E-Government solutions associated with spatial data is one of the goals of the European Union. The citizens should get access to spatial related services provided by all administrative levels. Thereby new challenges occur, especially for small municipalities as some of the main producers and owners of spatial data. The direct contact between the municipality and the citizens in conjunction with the limited capabilities in the local administrations contradicts the demand for new solutions in terms of spatial data online.

The process of capacity building even in the superordinate administrative levels has to be established first to launch the use of spatial data online. The paper discusses the solution for a cost-efficient local Spatial Data Infrastructure (local SDI) with the aim of capacity building and technical development of SDI components. Based on a project of the federal state Hesse a cooperation between administrative bodies has been found with a high degree of financial self-sufficiency.

Through the establishment of reliable structures the project could be transferred into a permanent institution. Beyond the technical requirements the cooperation has the capabilities to analyze and annotate the INSPIRE[1] process. The cooperation focuses on the impact of the E-Government and INSPIRE directives to the work of municipalities.

Furthermore, this text pictures the technical requirements as well as the concept and implementation of local SDI by means of the service chain to discover a land-use plan as the first step to a Service Oriented Architecture (SOA) for geospatial data in a municipality. The preliminary work creates new opportunities for municipalities using local SDI to develop user-oriented offers in planning and administrative processes. Based on the use of the latest geo standards and map viewers out of the Web 2.0 sphere user-friendly SDI-applications can be developed. A case in point is a service for citizens in the city of Wiesbaden which is under development. This example also demonstrates the potential in extensibility and access e.g. via mobile interfaces.

[1] Synonym for the directive of the European Parliament and the council "Infrastructure for Spatial Information in the European Community" (Directive 2007/2/EC, 14. March 2007)

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1. Introduction

Most municipalities in Germany suffer from monetary tightness along with staff shortness (Statistisches Bundesamt 2009), these facts leads increasingly to difficulties in fulfilling their tasks. Furthermore, the municipalities in the German state have to deal with a significant number of services besides the local self-government (Püttner 2000; Hill 2005). Thus the effective administration becomes not only an imperative, but it is also a large challenge for German municipalities. Since the past decade E-Government[2] as the superordinate concept covers the effort to provide public services in a digital manner. Using information- and communication technologies these services should optimize the administrative processes. For the implementation of E-Government the Internet or more precisely the World Wide Web is likely to play a crucial role within this context. Especially the developments in the context of Web 2.0 provide new “Web features” to the E-Government concept and various administrative and planning processes require directly or indirectly spatial information. Through the emerging spatial data infrastructures (SDI), this spatial information becomes more and more available online. The combination of modern web technologies and local SDI generate new options to develop more efficient E-Government solutions.

E-Government

The technical and social development in the past years enables more and more the effective provision of E-Government[3] applications. According to Moon (2002) the general definition of E-Government covers four aspects:

1. Secure intranet with centralized database to improve the administrative interaction
2. Web based service delivery
3. E-Commerce for more efficient government transaction activities
4. Digital democracy for more transparent accountability of government

This and earlier identified aspects of E-Government have to be adapted in the development of new services. Based on these demands the European Commission has set the focus on the knowledge-based economy. The first step was taken in 2000 with the eEurope initiative to *accelerating Europe's transition towards a knowledge based economy and to realise the potential benefits of higher growth, more jobs and better access for all citizens to the new services of the information age*[4]. This aim has been renewed and extended by the subsequent programs eEurope 2000-2005 and the aim is now specified in the Digital Agenda i2010[5] in conjunction with the INSPIRE directive (Directive 2007/2/EC) and the directive on services in the internal market (Directive 2006/123/EC). The eEurope initiative demands the *access* ....

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[2] Electronic Government .

[3] In this contribution the term “E-Government” includes the underlying concepts of E-Administration or E-Democracy with its further branches E-Voting and E-Participation

[4] http://ec.europa.eu/information_society/eeurope/i2010/archive/eeurope/index_en.htm

[5] http://ec.europa.eu/information_society/digital-agenda/publications/index_en.htm

to the new services of the information age and the Digital Agenda i2010 defines the framework for advanced digital services for citizens.

SDI and E-Government

Geospatial data supports decision making processes in the private business as well as in the public administration and become a key source in the information society. Normally, the data are spread widely over multiple independent sources and are not exploited comprehensively. With the INSPIRE directive the European Union has set itself the goal of *establishing an infrastructure for spatial information to support Community environmental policies, and policies or activities which may have an impact on the environment*. To achieve this goal Spatial Data Infrastructures (SDI) are being implemented on different administration levels from European through national down to local level. These SDIs enable the provision of geospatial data through new services and geospatial standards by the administration. Based on SDIs various tasks in Government could benefit and many applications could be improved considerably. Especially on the local level the municipal planning and administration might benefit from local SDIs:

1. Establishing SDIs allows an enhanced distribution of qualified geospatial data. Qualified geospatial data in turn are an essential part of decision making in administrative and planning processes in municipality.
2. Geo standards defined by the Open Geospatial Consortium (OGC) ensure interoperable access to geospatial data as an important aspect and a prerequisite for increased effectiveness. Geospatial data from local SDI could be easily used from different departments over the internet or intranet independently from any software system utilized.
3. Integrating spatial thematic data within the framework of a local SDI ensures the persistent storing of the data gathered. As result geospatial data needs no longer to be stored locally inside the department’s IT structure. Furthermore the data from one department might be useful for other departments accessing the data by local SDI.
4. The availability of and the easy access to qualified geospatial data as well as different kinds of spatial thematic data enable further analysis and new applications within municipal planning and administrative tasks.

The improvement of procedures in municipal planning and administration by a better involvement of geospatial data provided by local SDIs also leads to an enhanced E-Government. In consequence the local government benefit from it, in terms of increasing their efficiency.

Web 2.0

The ubiquitous Facebook and Twitter are evidences that the phenomenon Web 2.0 has established itself in our daily life. The contribution on the Web content become a common attitude and the Web 2.0 technologies provide an easy to use access to real-time information. Additionally the access via mobile devices becomes location-independent. The user changes his cognition and expects more and more the availability of Web 2.0 based offers from the administration to communicate and participate. O’Reilly (2005) identifies the move from simple publishing to *participation* as a key criterion of Web 2.0. Moreover people getting involved and taking part on a voluntary base. Not only social networks, but also online

geoservices and games with a spatial relation, like various route planning services, Open Street Map or GeoCaching, are *hip* and are supported by numerous voluntary users.
The opportunities of Web 2.0 could be adapted by the E-Government environment to take advantage out of this trend:

1. Voluntariness and the participation of citizens is one crucial aspect for the successful establishing of E-Government tasks. Thus, considering Web 2.0 principles, the citizens are getting motivated in using the new "digital options".
2. If more citizens make use of E-Government the processes will be accelerated and in turn, this leads to a reduction of time and costs for the local administration.
3. Successfully operational E-government improves the interaction between citizens and administration and...
4. ...results in higher acceptance by the citizens.

Through the opportunities of Web 2.0 in combination with SDI a spatially enabled E-Government could become a common tool in the communication between citizens and the administration. Moreover, cross-agency cooperation could also benefit from this communication. This also integrates new activities for enhanced E-Participation (e.g. Blankenbach & Schaffert 2010), which might solve gaps identified in the past, like the lack of transparency to the underlying mechanisms, lack of feedback and lack of visualisation as the key deficits (Maier & Reimer 2010).

On the basis of these considerations examples for E-Government tasks in municipal administration that could benefit from local SDI in combination with Web 2.0 (for the second example) are introduced.

2. Local SDI in Hesse

Hesse is one of the 16 federal states of Germany with the state capital Wiesbaden. The SDI activities in the state are initiated and supported by the network of "GDI-Hessen"[6] as part of the federal administration for Land Management and Geoinformation (HVBG). Based on this network the pilot project "GDI-Südhessen" has been set up in 2003. The GDI-Südhessen is a regional project with partners on local and regional level of the public administration and has the target to build the basis for a local SDI in the south of Hesse. All partners are located in the area around Frankfurt down to the southern boundary of the state Hesse (see Fig. 1).
The aim of the project is on collaborative use of geospatial data by creating a network based on the idea of the European INSPIRE Directive and specified in detail by the technical specifications (Commission Regulation EC No 976/2009). In this content the cooperation focuses on the organizational

Figure 1: GDI-Südhessen region in 2008

[6] GDI is the German abbreviation for SDI

and technical structures and capacity building to encourage the cost-efficient integration and use of SDI based services in the administrative daily work. The cooperation between municipalities could be a cost-efficient solution to maintain existing and offer new services to the citizens (Köhler 2010).
The design of the cooperation includes practical implementation of a Service Oriented Architecture (SOA) as well as the capacity building for all participants of SDI including politicians and staff in the administrations. This capacity building is a continuous process through regular meetings in working groups and through workshops for the other participants as well. The main topics of a SDI are documented in framework documents which have been generated in collaborative work and could be used as a guideline for further implementations.

3. Discover a land-use plan

To increase the technical knowledge in terms of SDI, the workflow to discover a binding land-use plan was chosen. Land-use plans are one of the main tools of spatial planning in Germany. The design and implementation of such a land-use plan is under the independent responsibility of the municipality. Every project partner is touched by this planning topic and thus this workflow was selected for the development of a service chain to find the information for a given plot of land. Especially the interaction between different organizations encouraged the cooperation to implement the service chain as a SOA. SOA is one *of the main drivers to facilitate Internet-scale provisioning and use of services and to reduce costs in organization to organization cooperation* (OASIS 2006 Page 11)
By using the address or plot number the service should present the detail information of the land-use plan for the given location.
The service chain combines SDI components like Web Feature Services (WFS), metadata search via Catalogue Service for the Web (CSW), Web Map Services (WMS) and map viewer. To maintain maximum interoperability the service follows the OGC specifications. Based on these standard interfaces the integration of further upcoming services, for instance new WMS providing land-use plans, are embedded automatically.
To start with, the user initiates the procedure by entering the address of the requested location. The address is geocoded by a protected WFS to retrieve the coordinates. The requested address described by city, street name and house number is send to the WFS. These WFS converts this address into coordinates and forward the result back to the process. As an option in the workflow the coordinates, depending on the required spatial reference system (SRS), could be transformed to a supported SRS. This option is required because not all services support the new main national SRS (UTM 32N EPSG 25832) in Germany yet. The overall SRS World Geodetic System 1984 (WGS84) does not provide convenient for all requests. In addition the combined viewing of UTM based and WGS84 based services at once is not possible for now.
Based on this coordinates the search in the metadata catalogue for Hesse[7] identifies all WMSs for the area. The services are identified by their bounding box.
The metadata catalogue for Hesse is a catalogue for spatial information provided and hosted by the federal government of Hesse. Apart from services the catalogue contains datasets and

[7] http://geodatenkatalog.hessen.de/MIS-Hessen/Start.do

applications. The catalogue service provides a Web frontend as well as an Application Programming Interface (API) to send requests to the service.
Due to the identification of the WMS via their corresponding bounding box each WMS will be checked if a land-use plan is available for the specific plot of land requested. This request uses the standard GetFeatureInfo-request for WMS to retrieve the information about the existence of a land-use plan. The positive answer of the WMS results the generation of a Web Map Context document (WMC) for the map viewer. The external hosted map viewer receives this WMC document and integrates the WMS to present the requested plot of land. Additionally several services providing spatial base data, for instance satellite imagery or protected areas are integrated (see Fig: 2).

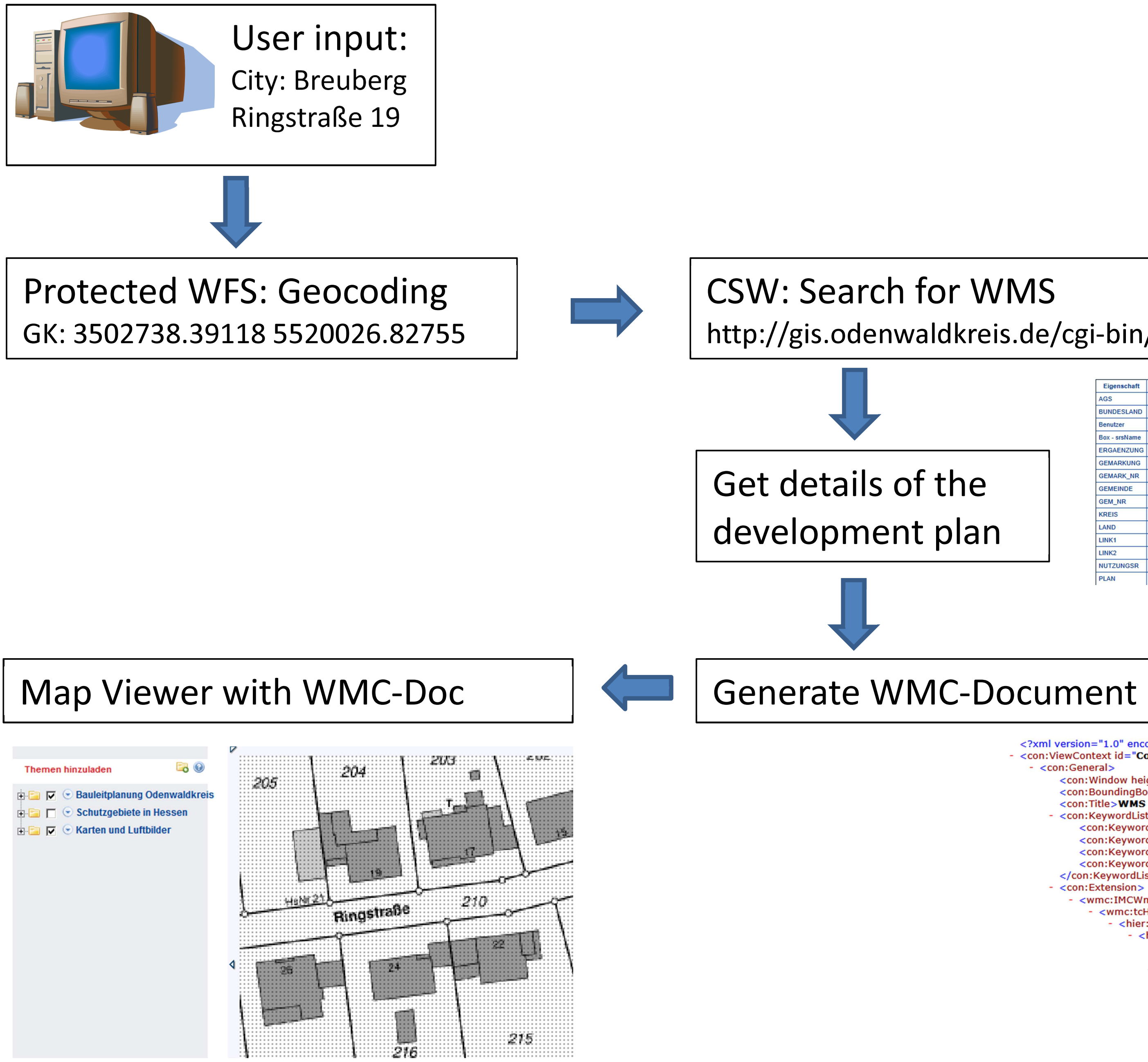

Figure 2: Technical workflow: Discover a land-use plan

4. SDI-based Citizen Service for improved Participation

In cooperation with the capital of the Federal State of Hesse, Wiesbaden, the idea has been taken up starting with the development of prototypical applications using local SDI as part of the future municipal E-Government portal.
As a first application, an E-Participation service is implemented to enable Wiesbaden´s citizens to inform the city administration about infrastructural problems – in first step street

lamps and trees along public roads. By using this service the reporting citizen does not have to look for the telephone number of the right contact person in an inconvenient way or to send the incident's location imprecisely by a free text posting to an anonymous email address (without knowing the recipient and without notice of arrival).
Furthermore, the principles of Web 2.0 should be considered to motivate potential users on a voluntary manner. Voluntariness and the involvement of people is the crucial aspect for successful participation within a citizen service. Unlike existing applications with similar functionalities (e.g. Mängelmelder 2011, Maerker Brandenburg 2011), the idea therefore is to combine both, the principle of Web 2.0 and the concept of a local SDI, to take optimal advantage for an efficient citizen service (cf. Blankenbach & Schaffert 2010). As result the citizen service which is called "Bürgerservice" is supposed to become an integral part of the municipal SDI within the city's E-Government structures by the use of OGC geo standards. Figure 3 shows the proposed ideal architecture of the citizen's service as an application of local SDI.

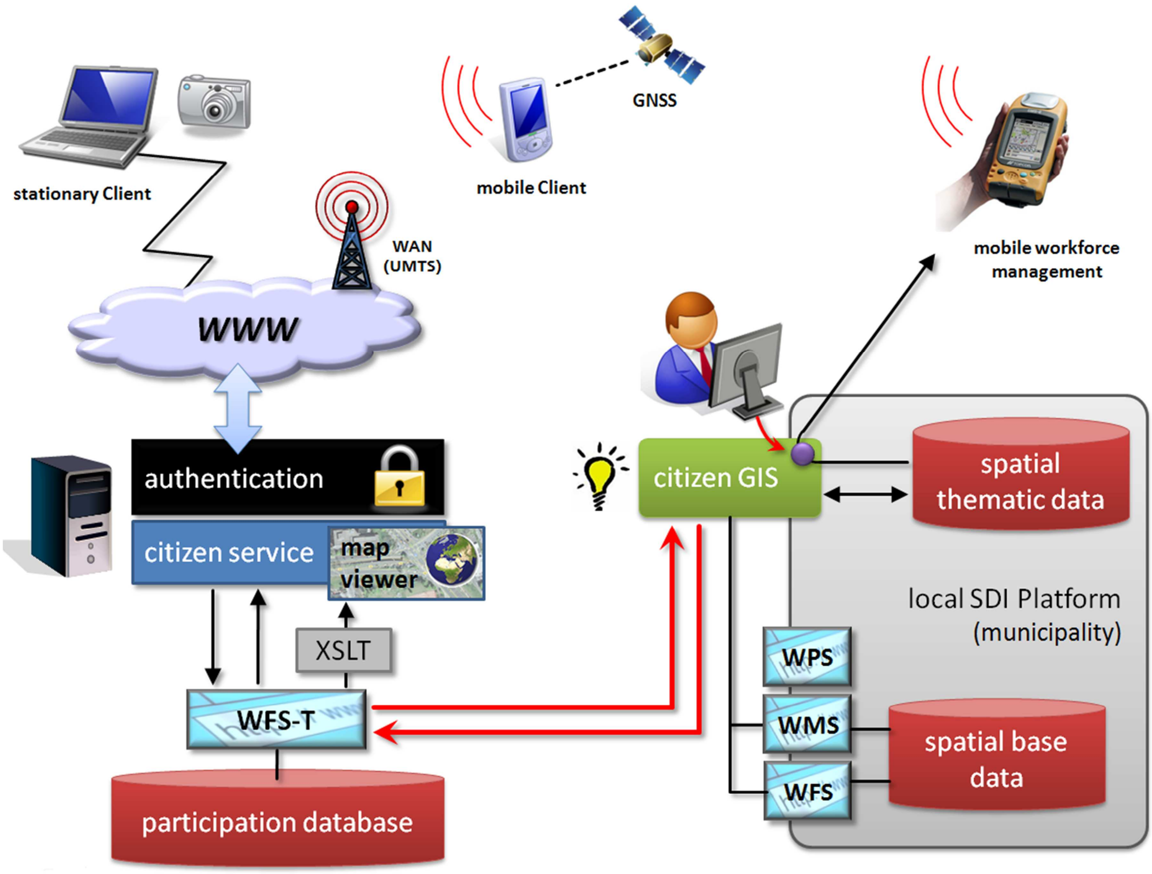

Figure 3: Ideal architecture of the citizen service as application of a local SDI (Blankenbach & Schaffert 2010)

4.1 Architecture and function principle

The idea is to enable citizens reporting infrastructural problems over the Internet. Therefore the user starts the application in the web browser on his home computer and after authentication a report can be submitted online. Besides the descriptive report information, an integrated map viewer is used for exact geolocalization and the graphical view. One of the main tasks of the user interface implementation was not to deter potential users, but to animate them to get involved. Therefore the basic idea was to keep it simple and intuitive usable, enabling everyone to carry out a fault report. For this reason besides a well-considered input form, Web 2.0 map viewers like Google Maps and OpenLayers are utilized and evaluated. After submitting, the report is stored via OGC interfaces to a geo database attached to the local SDI (see Fig. 3).

The OGC interface of the local SDI also enables the direct access to the report database from the city´s GIS[8] applications (see Fig. 3). By merging the report with specific municipal geospatial data (e.g. relating to the public roads), SDI-derived spatial base data (plots, traffic zones, etc.) and GIS analysis the contact person might have the ability to check the report´s integrity and set an editing status. Subsequently, he could delegate work order on a GIS level to the field staff, to verify and solve the reported problem on-site. Additionally, he could monitor the work process and manage the report´s digital status. After the problem has been solved, the report ought to stay for a predefined time period in an active mode (e.g. seven days) and is deleted from the data base automatically afterwards.

4.2 Implementation

The frontend (and user interface) of the service is implemented as web page consisting of an input form and a map viewer. Choosing a predefined category and optionally attaching additional text as well as a picture of the incident, the problem could be described very easily by the citizen (Fig. 5). For geolocalization the incident is marked in the integrated map viewer. Furthermore, already existing reports within the selected area are shown in the map viewer to prevent multiple reports of the same incident. Traffic light indicators (red / yellow / green resp. blue) mirror the processing stage in order to make the status transparent (Fig. 4).

The backend is composed using the OGC geo web services of the local SDI. The geospatial feature of interest (trees and street lamps), which were already digitally stored in the cadastral information system, were migrated to the participation geo database (Oracle Spatial).

For this purpose feature tables for street lamps and trees based on Oracle’s geometry object data type (SDO_GEOMETRY) are created within the participation geo database. The reported problems are stored in a separate report table for each feature. For the joint query of features and reports two database views (joining the feature and report table) are created (Fig. 7).

[8] Geographic Information System

Figure 4: Visualization of geocoded fault reports in Google Maps (Gibitz 2011)

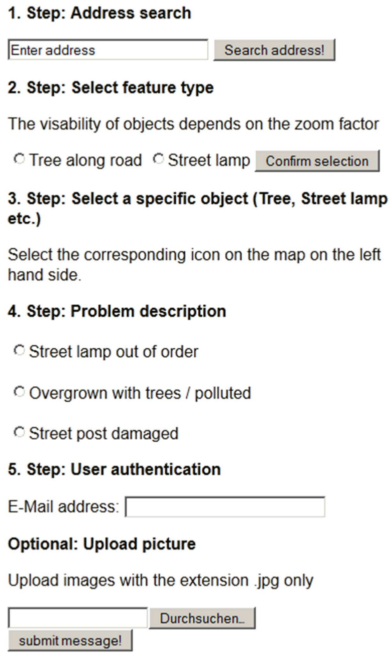

Figure 5: Web form for fault reporting (Gibitz 2011)

4.3 Versions

In the first version Google Maps was utilized as map viewer (Fig. 4). Therefore the frontend was developed as a dynamic HTML page by the use of the Google Maps javascript API (Google 2011a). The advantage of this approach is the possibility to use the basemap (orthophotos, streetmap or hybrid) of Google Maps directly without requiring underlying official data. For interoperable access to features and reports a WFS linked to the database views is utilized. The response of the WFS request in GML[9] format is subsequently transformed to GeoRSS by an eXtensible Stylesheet Language Transformation (XSLT) and displayed directly as Google Maps layer. For changing the features status an additional server component (java servlet) was developed to interact with the client.

Despite the straightforwardness of this approach, the main disadvantage is the geometrical deviation between the Google Maps basemap and the overlayed features of interest due to different SRS used. Thus, in the current version Google Maps was replaced by OpenLayers (Openlayers 2011), which provides an opensource javascript library to load, display and render maps from multiple sources on web pages (Fig. 8). As basemap the official municipal orthophotos (with identical geodetic datum as the features of interest) stored in an Oracle GeoRaster database (see Oracle 2011) are used and accessed by a Web Coverage Service (WCS) chained with a WMS. Moreover the street lamps and trees can now be accessed directly as GML vector overlay (without XSLT). For bidirectional access to the features, in the current version the transactional WFS interface (WFS-T), enabling the features' status

[9] Geographic Markup Language

manipulation with write access to the report tables, was deployed (Fig. 6 & 7). Furthermore, the exclusive use of own data within OpenLayers avoid any license issues that would arise immediately when using third party data distributors like Google (Google 2011b).

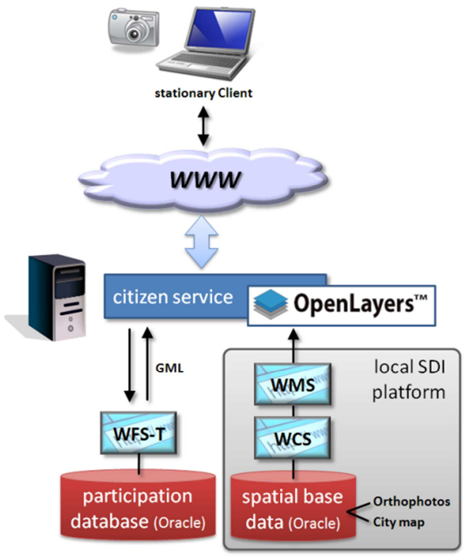

Figure 6: Current citizen service software architecture

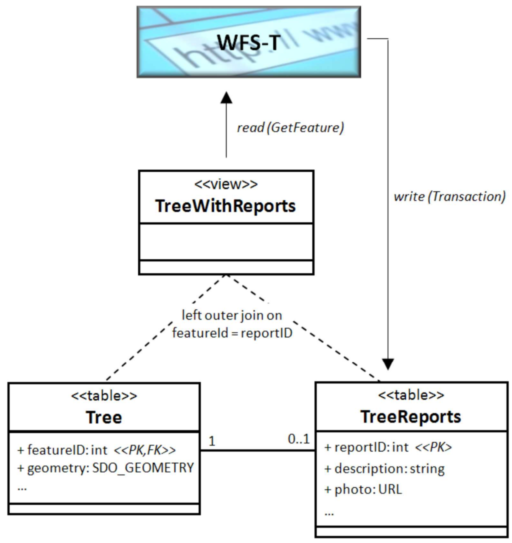

Figure 7: Datamodel of the citizen service's participation database

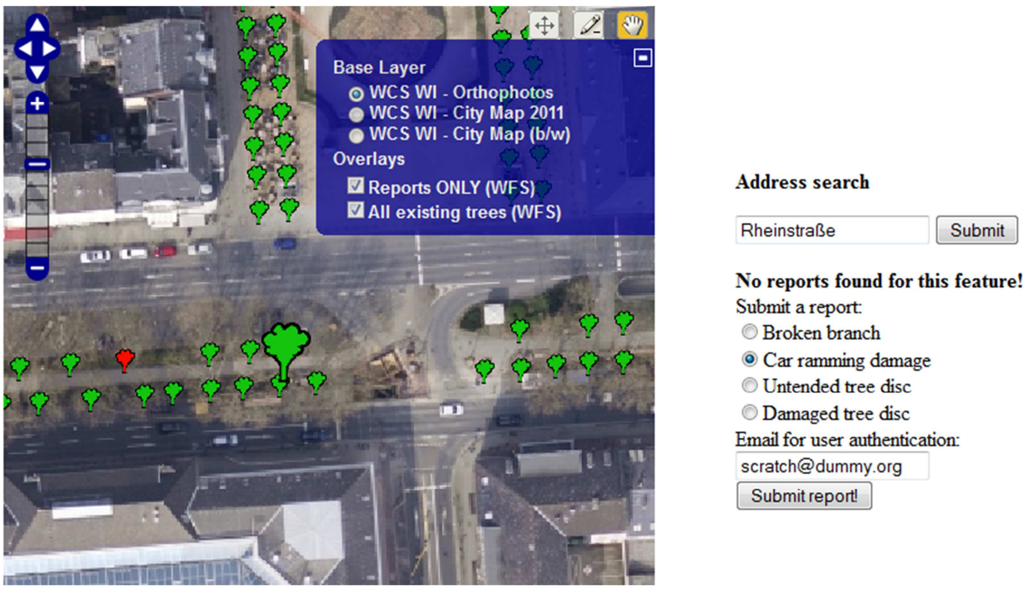

Figure 8: OpenLayers client for report visualization

4.4 Mobile extension

The inhabitants of the city using the citizen service described above are going to be provided with a mobile access to the platform. It enables them to call the municipality´s attention quasi at walking past and on site by the use of a mobile phone. This mobile interface requires fewer manual tasks, which in turn reduce time spent and sources of errors. Currently, the mobile interface is implemented through developing a client application running on almost every smart phone. Similar to the "stationary" version the users select a topical category and entering free text. The reports geocoding and its picture documentation aimed to be done seamlessly using the smartphone´s embedded sensors, in this case GPS-receiver respectively its camera.

5. E-Participation instruments in the course of municipal planning

The citizen service described above can be understood as application of local SDI as well as modern E-Participation instrument. Provided with similar functionality this instrument could also be used in municipal planning processes. As E-Participation instrument it enables citizens to take part in planning processes via the internet (one-stop non-stop). By the use of OGC interfaces the citizen´s criticism, comments and suggestions can be stored in a database which is deployed in planning processes (Fig 9).

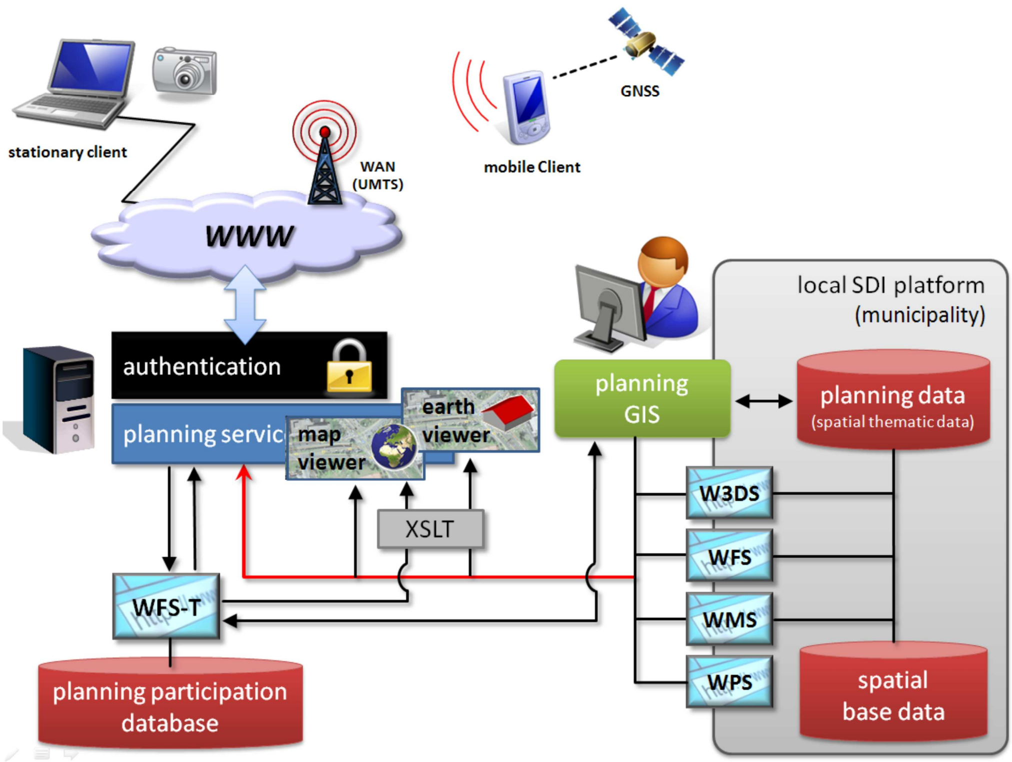

Figure 9: SDI based planning service for municipal planning (Blankenbach & Schaffert 2010)

Similar to the functionality of "Bürgerservice" the E-Participation instrument allows the geocoding of the citizen's remarks in a map viewer. Again, traffic light indicators can be used to inform the citizen about the planning processes stage.
To meet municipal planning demands, additional interfaces to spatial base data or qualified planning related data – e.g. by using of additional local SDI geoservices – are required to visualize a plans consequence in the map viewer. Enhanced visualization techniques like 3D representations, which could be applied with the aid of appropriate 3D services (e.g. Web 3D Service, W3DS) and file standards (e.g. KML[10]) could facilitate the use of Earth Viewers like Google Earth and support the user´s imagination. In addition, the planning department could benefit from employing the same database via OGC interfaces. This would allow the check or evaluation of the citizen´s remarks and enrich the planning process with people's knowledge. Again, a mobile extension is reasonable, because it enables the user to evaluate and comment a plan´s consequence on site.

6. How to achieve a successful application for citizens and the administration

To achieve a high acceptance of SDI-supported applications in the E-Government it is essential to consider several aspects during the development and use of the applications.

Collaboration
The nature of SDI results in several different persons in charge of the SDI components. This includes the IT-Department for the technical provisioning of applications, the experts for legal issues and the political decision-makers. The collaboration between all departments involved is an essential aspect to success. The complexity rises if the collaboration crosses the jurisdiction of one municipality and the interaction involves more than one administrative body. Thus, the collaboration, from the starting point through the development up to the launch of the application has to be guaranteed. Especially the experience in the administration in terms of legal conditions is a key feature, which could be underestimated, if the development does not incorporate the administrative rules and the daily routine. Additionally the collaboration will tremendously increase the acceptance in the administration (Calvo, Saler, Matz 2011).

Technical challenges
The challenges during the development and maintenance of the service chain and an SDI-application could be easily forgotten. Therefore the identification and dissolving of problems take more time. Especially if the solution for a problem is not the technical challenge only, but has to be found as an agreement between all partners of the project. The partners in the project use commercial products as well as open source solutions. For instance the interaction between different solutions and providers points out the gaps in implementation of the OGC-specifications for WMS (OGC 06-042). During the project the WMS version 1.3.0 has been published. Due to the fact that not all products implement the new version comprehensively, adjustments and workarounds have to be developed. Even more than five years after the first publication of the WMS specification v1.3.0 several software packages are not capable of

[10] Keyhole Markup Language

supporting this WMS standard without inconsistencies. Notably the EPSG-Codes[11] as the actual reference for spatial reference systems in WMS 1.3.0 have not been adapted in all software products correctly[12]. As workaround the service chain still relies on Version 1.1.1 of the WMS specification. This solution is an agreement between all cooperation partners. Through the regular meetings of the cooperation and the permanent exchange between the partners the problems could be solved or minimized.

User demands
Apart from the administration itself, the users also ask for applications with a high usability especially in terms of easy to use. In this case the usability is preset by other Web 2.0 applications like Google Maps for handling spatial information or like Twitter to send short messages from any device and place. Hence, for successful provision of an application several key features have to be considered in the application. To meet these requirements the socio-technical criteria in terms of social acceptability, usefulness and usability have to be considered (Macintosh & Whyte 2008, Aichholzer & Westholm 2009). With regard to the *Bürgerservice*, the user should be able to submit his observation in a short but comprehensive way. Forms with predefined menu items have been identified as valuable compilation of reports. The generation of multiple individually verbalized reports would increase the workload for the person in charge and thus reduces performance and acceptance in the administration.

7. Summary and Outlook

The prototype of the SOA "Discover a land-use plan" as a service chain combining OGC services with multiple different providers and the integration of multiple municipalities is not a main access point to discover a land-use plan. Most of the citizens try to get the access to land-use information via the Portal of their municipality directly. But through this project many problems and challenges could be pointed out and based on this experience several independent new services have been installed and are offered to the citizens by the administration. The project gets the partners ready for the INSPIRE-Process, which relies on the knowledge in all municipalities. The use of standards like OGC is essential for the interoperable access and is a requirement to all providers. The partners benefit from the collaborative capacity building as well as from the exchange of experience and continue creating new services independently.
The citizen service "Bürgerservice" represents one example of value added applications of local SDI for municipalities. Many other areas of application (e.g. in municipal planning tasks) are also conceivable. The "Bürgerservice" implemented in cooperation with the City of Wiesbaden is currently being evaluated by the city's personnel and is going to be used for internal municipal tasks at first. After this administrative review the citizens will be involed to test and to comment this service. The further development addresses the service refinement (e.g. in terms of browser support and robustness of web service integration) as well as the expansion to new devices (e.g. to mobile phones). The increasing number of applications documents the demand and advantages of Web 2.0 based E-Participation. The access to the

[11] European Petroleum Survey Group
[12] http://support.esri.de/products/index_23090.HTML

internet becomes more and more location independent through the increasing use of smart phones. This mobile access enriches the application to report the infrastructural problem on site. (Fill that Hole 2011, Mängelmelder 2011, BM-online 2011).
The well formed and standardized SDI enables the easy developed of new applications, which can be integrated in the existing environment. The information transmission without media disruption facilitates the fast and easy handling of the reported issues. Supplemental the seamless data exchange reduces the cost of analysis and enables the direct and fast feedback to the users. It can be assumed that the citizens as well as the administration will benefit from the new SDI based applications. These SDI applications integrate the new behaviour on electronic participation in the E-Government process.

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