Designing a Web Processing Service Application Profile for Spatial Analysis in Business Marketing

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Abstract

This paper deals with the design of a Web Processing Service Application Profile for spatial analysis in business marketing. Since the possibilities of the Web Processing Service Specification 1.0 concerning application profiles are limited, we discuss methods how to enhance the current specification. This shall demonstrate how future Application Profiles might be developed. Therefore we present how a specific application domain can be examined in regard to the spatial analysis being used and how the results could be transferred to an application scheme. The application domain is taken from business analysis. Therefore, the basic requirements concerning spatial analysis in business marketing are being exposed and structured. To illustrate one example in more detail one method is analyzed and its structure is defined. Based on this results some general benefits and limits concerning an OGC Web Processing Service Application Profile are being identified.

Introduction

The use and development of server based web services as well as spatial data infrastructures has become more and more popular in the recent years. From a technical point of view, a spatial data infrastructure can be seen as a realization of a server oriented architecture (SOA) of standardized geographic information services. Different tasks are provided by different services. The Open Geospatial Consortium (OGC) develops standards for the different pieces of an SDI. Prominent examples include the web map service (WMS) to transfer maps or the web feature service (WFS) to transfer spatial data. In this context, the web processing service (WPS) was developed to process and analyze spatial data. As all OGC service specifications, the web processing service was conceived as an interface. So there are no restrictions on internal functioning of a WPS but a set of rules regulating the communication between client and server has been introduced. The communication mainly is configured through detailed information on the input and the output of the specific process. To make specifications on the content of a WPS there is the possibility to create an application profile. The WPS 1.0 specification describes an application profile as one single process which is described via a DescribeProcess response. Since this defintion does not satisfy the demands of an application domain, this papers states, that an application profile should include a variety of processes of one certain application domain. Those processes need to be structured and ordered in respect to the underlying questions. One example how to structure processes semantically is presented by Nash (Nash 2008) and has been taken into account in this paper. Further research on the WPS interface has been amongst others published by: Lanig (Lanig & Zipf 2009, 2010), Brauner (Brauner et al. 2009), Foerster (Foerster et al. 2009), Goebel (Goebel & Zipf 2009), Graul (Graul & Zipf 2008), Stollberg (Stollberg & Zipf 2007, Stollberg & Zipf 2008, Stollberg & Zipf 2009), Walenciak (Walenciak et al. 2009).

The intention of this paper is to ascertain a method for developing a WPS Application-Profile containing a number of processes including the example of the use of spatial analysis in business marketing. In the German language area this is often referred to “Geomarketing”. Spatial analysis in business marketing can be loosely described as the analysis, control and visualization of space-oriented market activities of business companies. The market is a synonym for actual and potential customers of a business. Space-oriented means that the geographic space does matter for example in terms of distance between customers location and the location of a store. If a retail trade company wants to establish a new store and is searching for a new location, one important aspect to consider is

the number of people who live in a defined area around the potential location. In this paper, it is used as an example for the generation of an application profile. In this context, basic requirements are gathered from a literature review. Those are ordered in a semantic structure and linked with specific processes. We would like to identify and discuss upcoming problems and issues.

WPS-Application-Profile

Since the character of the WPS-Interface is generic, the WPS only defines the structure of the communication between the server and the client. In this context an Application-Profile in regard to the Specification 1.0 basic consist of the description of one process. This papers states that a profile should include all spatial processes which are relevant for a certain application community. The profile should include all important spatial processes for this user group. Further it should be possible to describe the taxonomy of the processes at least in form of a hierarchy or even a more structured way, such as an ontology. The potential users of an application profiles are users who use GIS as a supporting tool in their surrounding application field. Neither do they have detailed knowledge about the internal functioning of the system nor do they have to know about it.
In the first step of the development of the application profile the basic spatial problems are identified. Having accomplished that, methods for each problem have to be determined, knowing that there might be several GIS methods to solve one question. As well, one method might be able to solve several different problems. Each method is described by a "DescribeProcess" document as defined in the WPS specification 1.0 (Schut 2007). In the process of identifying the relevant spatial problems it does make sense to structure them in a semantic way. This structure might help the user to find the relevant process for his purpose.

Developing a WPS-Profile "Spatial Analysis in Business Marketing"

Spatial analysis in business marketing (respectively Geomarketing) can be defined as "planning, coordination control and visualization of customer-oriented market activity with the help of intelligent GIS, statistic-software and data mining systems. It is a spatial data mining process that uses company intern and extern data to structure and derive spatial correlations and patterns and to analyze and to visualize these data. The purpose is to support decision making in the divisions of marketing, sale, organization and logistics" (Feix, 2007). Another definition is: "marketing focused on certain locations or regions with knowledge of regional spatial structures" (Frühling & Steingrube 1995). The first definition includes a very wide field of applications while the second focuses only on the field of marketing. Both definitions may be used, but both definitions cause different questions and different methods that need to be included in the profile. The first aspect that has to be considered while generating a WPS application profile is defining the scope of the profile exactly. It has to be stated which demands have to be satisfied by the profile. On the one hand it has to serve enough functions to satisfy a range of users. On the other hand, serving to many functions leads to an unclear set of functions non-experts users cannot set in context. In this paper, the topic of spatial business analysis shall be reduced to three basic themes that are to be included:

- *site analysis:* The location of a store is one of the most important factors of success. The success of a store obviously depends on the number of customers buying at the store. The customer is spatially tied through the residence, place of work and patterns of movement. Hereby, a range of questions results that deals with the support of existing stores on the one hand, and the planning of new stores on the other hand.
- *media analysis:* sales approach via advertisement is one of the most important instruments to promote the company's products or to build up an image of the company. In this matter, companies try to adjust their promotion strategy on a certain target group. Besides conceptual aspects, promotions can be adjusted spatially at their target group. This means that areas are identified where the potential customers are concentrated to place advertisement campaign and to avoid wastages.

– *Marketing and sales territory analysis:* The distribution via sales force belongs to an important sales channel. Even though the classical sales representative who sells products to private customers might be out of date, selling with the help of sales representatives is still done in the business to business scope. Hence, the assignment of sales representatives to sale areas can be re-structured to optimize the channel of distribution.

This paper focuses on the site analysis to show exemplary the generation of a WPS application profile since the examination of the whole subject outrages the volume of this paper and important issues can be shown with the help of one subject.

Fundamental methods

A range of basic types of analyses is used in different contexts. In particular these include calculation on market and customer data on the attributive level. It can be explored in which areas the market penetration of a product is high or in which areas potential customers for a certain product live. There a wide range of possible calculations exists – therefore, it is not possible to include every thinkable calculation in the WPS-profile. Though there is a common denominator to be identified which satisfies most users:

- *Target group analysis on the base of spatial units:* This method culls target group on the base of economic and demographic attributes. Since this method can be understood as an attribute based filter, it can be solved by the use of a web feature service.
- *Calculation of the market share and potential:* This method calculates the relation of two different attributes of any spatial unit. This method can be uses to calculate the market share, or the proportion of a certain population group. The question can be solved by a method called normalization.

Site Analysis:

The planning of new stores is a strategic fundamental decision for a retail company (Feix, 2007). Since there are long-running tenancy agreements and a high investment volume, the opening of a new store is linked with high expenses. Therefore, it is helpful to rely on objective information and to evaluate the potential of a location previously. It is important to be consistent in regard to the factors market potential, product and location. The basis of the site evaluation is therefore the determination of appropriate factors of success (Ahrens, 2008). Factors of success may include the population in the catchment area, number of competing stores or the characteristics of the direct surrounding of the location. Which factors are suitable for the planning of a store depends on numerous aspects like the branch of trade, the strategic business plan or dimension of the new store. Those aspects can be seen as the set-screw of a site elevation the planner himself has to adjust. Taking a systematic perspective, site analysis can be subdivided into macro analysis and micro analysis. The macro analysis identifies subareas out of superordinated area which are generally suitable for the establishment of a new store. The micro analysis evaluates potential locations in this area and supports the manager to choose the most appropriate location for the new store. These are explained shortly:

Macro analysis

The macro analysis helps to identify possible subareas of the superordinated area (Gosh, 1987). This step is done before the micro analysis. Areas are filtered by demographic and economic variables (Bienert, 1996). Since the specification of the OGC Web Feature Service satisfies this demand, there is no need for a WPS process.

Micro analysis

The micro analysis calculates the potential of one or more possible locations. It can be divided into the analysis of the location itself and the analysis of the catchment area.
The analysis of the location itself explores the setting of the location. This might include the number of parking lots, the rent, the base area or the number of pedestrians walking by. These demands are satisfied by the methods to filter attributes with the help of the web feature service as well as the branch of the fundamental processes satisfies these demands.
The analysis of the site catchment area includes several spatial calculations. Basically the catchment area of a location is calculated in the first step. In the second step, the catchment area is linked with demographic variables that are being broken down to few interpretable values. The catchment area of a potential store site can be calculated by numerous ways which can be categorized into three classes: methods based on empiric values, methods based on theoretic principles and methods based on interviews and monitoring (Bienert, 1996). The methods based on empiric values include the calculation of the catchment area on the bases of a distance buffer respectively the calculation of the distance on the base of the street network. Methods based on theoretic principles include the calculation of the catchment area on the base of the model by O'Reilly (O'Reilly, 1931) and the model by Huff (Huff, 1964). Methods based on interviews and monitoring include customer spotting. Since exploring the whole theme of site catchment analysis is very complex, this work concentrates on one model to show the benefits and the specific problems building a web processing service application profile.

Calculating the retail potential with the Huff- Model

The Huff-Model calculates probabilities that a customer tied to an area visits a certain store. The model includes a number of concurrent stores. The probability depends on the distance between a customer's location and a store location, the distances of concurrent stores and customers and the attractiveness of the stores. A higher distance between the customers' location and the stores' location reduces the probability that he visits this store. A higher attractiveness of a store increases the probability that a customer visits the store. Additionally there is the possibility to weight the impact of the distance. The presence of concurrent stores reduces the probability of a purchase. The formula of the model is:

$$p_{ij} = \frac{A_j / d_{ij}^{\gamma}}{\sum_{j=1}^{m} A_j / d_{ij}^{\gamma}} \quad ; i = 1, \ldots, n$$

A_j: attractiveness of the store j
d_{ij}: distance between areal unit i and store j
p_{ij}: probability that a customer at areal unit i visits store j
γ: weight of the distance

Formula 1: *Huff-Modell (Huff, 1964)*

The turnover of a location is calculated by the sum of the contingents of purchasing power of the areas:

$$U_j = \sum_{i=1}^{n} p_{ij} \square K_i$$

U_j: turnover of store j
K_i: purchasing power of location i
p_{ij}: probability that a customer at are

Formula 2: *Turnover (Huff, 1964)*

There are different methods to transfer this formula into a spatial analysis method. The method generally depends on the structure of the input data. Since demographic data is available mainly as areal units represented through vector data, and locations of stores are represented through point data, the workflow is developed in regard to this data structure. The customer location is represented by a data set that consists of areal units. The population of an areal unit is attribute of this data set. The store locations are represented by a point data set. The distance between the areal unit and the store location is represented by the distance between the midpoint of the areal unit and the store location. The attractiveness is an attribute of the store data set. As shown in *Formula 1*, in respect to the location of interest, for each areal unit the probability of a purchase in this store is calculated. The overall purchasing power of the potential location can now be calculated by the weighted sum of the purchasing power of the areal units as shown in *Formula 2*. The result will be appended to the location as accessory attribute. From the perspective of the generating web processing service, detailed information of the input and the output is obligated. Figure 1 shows the structure of a WPS interface for a site catchment area analysis with the help of the Huff model.

ID: RetailPotentialHuffModel
Input: PointFeature:StoreLocation(1..1), String: StoreID (1..1), String: StoreAttractiveness(1..1), Double: WeightDistance(1..1), PolygonFeature: MarketAreas(1..1), String:residents(0..1)
Output: PointFeature: RetailPotential
Description: store potential calculated through the competing stores and their size using the Huff Modell at basis of each given attribut

Figure 1: *Structure of the process "RetailPotentialHuffModel"*

Support of existing stores

The analysis of existing stores has a supporting function. It can be determined if the catchment area is compatible to the provided goods and services. Services and goods can be adjusted to the demographic structure of the catchment area (Färber, 2007). Further the structure of successful stores can be explored in respect to the catchment area (Feix, 2007). From the methodical point of view, this includes the same analysis as the planning of new stores with micro analysis. In the first step the catchment area is calculated and in the second step the catchment area is analyzed in respect to the underlying demographic data.

Site Analysis Scheme derived though process classification

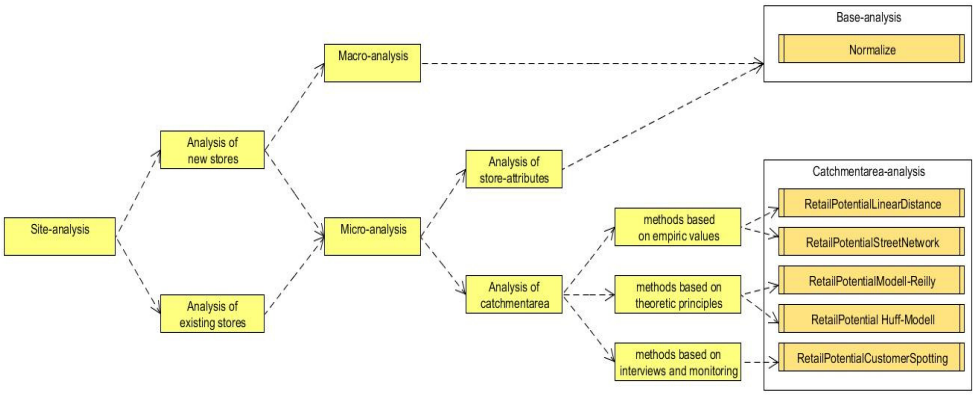

***Figure* 2**: *Overview of the semantic structure of the site analysis*

Figure 2 shows the semantic structure of the WPS-Profile site location analysis. As mentioned, not all analysis need to be calculated by a WPS.

Conclusion

The paper shows how a WPS Application-Profile might be developed and which aspects might be considered in further development of the WPS Specification. In order to do so the domain of spatial business analysis has been investigated and the relevant tasks and processes have been identified and structured in a top-down approach. One example showed this into detail. Not all aspects stated in this paper can be implemented in terms of OGC-conformance. For instance there is no way to structure a set of methods into a hierarchy so far. In this context the paper can be seen as recommendation for further discussions of the Application-Profile section of upcoming WPS-Specifications.

In this paper, a WPS-Subprofile is defined that gives a representation of relevant basis processes and abilities of spatial business analysis. It is not meant to be exhaustive, but shall define relevant building blocks for further refinements of this profile for a typical GIS application domain. The paper shows how an application profile might be set and which steps have to be kept in mind developing a profile.

- The scope of the application profile needs to be identified in detail. Serving a wide range of questions might distend the requirements of a certain user group while serving a tight range might be restrictive and lack some functionality.
- In regard to a well-defined scope, questions and problems need to be identified.
- Questions and problems have to be arranged and interactions have to be exposed.
- For each problem, methods have to be found that serve the problem. Regard that each problem might be solved by different methods. One method might be as well deployed for serving several questions.
- For each problem the interface in terms of a DescribeProcess document should be defined. Regard that the OGC WPS 1.0 specification of DescribeProcess lack some possibilities to clearly define the structure and functionality of methods.
- The overall naming of the processes and the input and output has to satisfy the specific language of the application.

Additionally the paper shows some technical limits of the current WPS application profile:

- *Some* methods are built up by clearly defined formula. There is no way to define formula via the DescribeProcess section of the web processing service interface.
- *Some* methods built up on clearly defined workflows. Those workflows cannot be transmitted via the interface in a standardized way.
- *Some* processes are being used in different contexts. Though the process is supposed to be used in specific applications, descriptors have to be adjusted to these specific applications. In the current specification each adjustment needs to be stated in a unique process.
- *Some* methods are complex in their nature and require a detailed description. Visual methods of description might be useful especially for non-experts. However, the ability to describe processes is limited to a textual description.

Summing up, the OGC WPS interface offers a framework to provide application interfaces related to GIS analysis. Though supporting functions are limited yet, more research work needs to be done to figure out general requirements and demands on application profiles. In the first place, this discussion needs to be focused rather on the intention of WPS-Application profile than on technical issue. In this context, it needs to be stated, what an Application-Profile exactly is meant to be and which demands it should satisfy. From the authors' point of view, it should be also possible that the application profile should serves as spatial toolbox for a user group from a certain application domain in addition to some generic profiles of basic functions. This applies on the one hand on theoretical work as well as on the development of uses cases from the complete range of users of spatial analysis.

LITERATURE

Ahrens J., Filialplanung. In M. Herter (ed): Handbuch Geomarketing. Wichmann Verlag. 243-246, 2008

Brauner, J. ; Foerster, T; Schaeffler B. & Baranski, B., Towards a Research Agenda for Geoprocessing Services. In: J-H. Haunert, Kieler, J., Milde J. (ed) Proceedings of 12th AGILE International Conference on Geographic Information Science, 2009

Bienert M., 1996 Standortmanagement. Methoden und Konzepte für Handels- und Dienstleistungsunternehmen. Gabler, Wiesbaden, Germany

Färber K., 2007 Business GIS. Integration in Unternehmen. VDM, Saarbrücken, Germany

Feix C., 2007 Bedeutung von ‚Geo Business Intelligence' und Geomarketing zur Entscheidungsunterstützung unternehmerischer Entscheidungsprozesse im Kontext wirtschaftlicher Liberalisierung: Konzeption, Entwicklung und Anwendung komplexer räumlicher Algorithmen für den Aufbau eines GIS- gestützten Geomarketing- Systems am Beispiel Deutsche Post World Net. Dissertation: Freie Universität Geowissenschaften, 2007

Foerster, T., Schaeffer, B., Brauner, J. & Jirka S.: Integrating OGC Web Processing Services into Geospatial Mass-market Application. In: P. Kellenperger (ed) Proceedings of the GEOWS 2009, IEEE Computer Society Press, 2009

Frühling J & Steingrube W,: 1995 Geomarketing: Neue Begriffe = Neue Methoden? In Zeitschrift für Wirtschaftsgeographie, Jg. 39.:184-198, 1995

Ghosh A., 1997 Location strategies for retail and service firms Lexington Books, Lexington, United States

Göbel, R & Zipf, A.: How to define 3D Geoprocessing Operations for the OGC Web Processing Service. (WPS)? Towards a Classification of 3D Operations. In: P. Kellenberger (ed) Proceedings of the GEOWS 2009. IEEE Computer Society Press, 2009

Graul, C. & Zipf, A.; Biogeographic Research and the Spatial Web: Towards Interoperable Analysis Tools for Global Change Based on the Web Processing Service (WPS). In: Ehlers M. (ed) Digital Earth Summit on Geoinformatics: Tools for Global Change Research. Potsdam Germany, 2008

Huff D.L., 1964 Defining and estimating trade areas. In Journal of Marketing H. 29, 34 - 38

Nash E.: WPS-Application Profiles for Generic and Specialized Processes. In: F. Probst, C. Kessler (ed) GI-Days, Münster. Natur u. Wissenschaft, 2008

Lanig, S. & Zipf A.: Towards generalization processes of LiDAR data based on GRID and OGC Web Processing Services (WPS). In: Geoinformatik 2009. Osnabrück.

Lanig S. & A. Zipf (2010): Proposal for a Web Processing Services (WPS) Application Profile for 3D Processing Analysis. GEOProcessing 2010 - The Second International Conference on Advanced Geographic Information Systems, Applications, and Services. Netherlands Antilles.

Schut P., 2007 OGC Web Processing Service (WPS) Specification. OGC 05–007r7.

Stollberg, B.& Zipf, A., Development of a WPS Process Chaining Tool and Application in a Disaster Management Use Case for Urban Areas. In: A.Krek et al. (ed) 27th Urban Data Management Symposium, Taylor & Francis, 2009

Stollberg, B. & Zipf, A.: Geoprocessing Services for Spatial Decision Support in the Domain of Housing Market Analyses - Experiences from Applying the OGC Web Processing Service Interface in Practice. In: Grigori Melnik et al. (ed) Agile 2008. Computer Society Press, 2008

Stollberg, B. & Zipf, A.: OGC Web Processing Service Interface for Web Service Orchestration - Aggregating Geo-processing Services in a Bomb Threat Scenario. In J.M. Ware & G.E. Taylor (ed) Web and Wireless Information System. Springer Berlin, 2007

Walenciak, G., Stollberg, B., Neubauer, S. & Zipf, A.: Extending Spatial Data Infrastructures 3D by Geoprocessing Functionality - 3D Simulations in Disaster Management and environmental Research. In: P. Kellenberger (ed) Proceedings of the GEOWS 2009. IEEE Computer Society Press, 2009

Reilly W., 1931 The law of retail gravitation. New York, United States