RM-ODP for WPS Process Descriptions

Theodor Foerster [a,1] & Bastian Schäffer[b]
[a] *Institute for Geoinformatics, University of Münster, Germany*
[b] *52°North GmbH, Münster, Germany*

Abstract. Web-based geoprocess models are currently published through Web Processing Service interface. For interoperability of these models, profiles of these geoprocess models have been developed. However, these profiles are rarely documented and are not human-readable. Based on the lack of well-documented profiles and the absence of adequate semantic descriptions, this article presents an approach how to document profiles using the viewpoints of the *Reference Model for Open Distributed Processing* (RM-ODP). The presented approach is described exemplary in a walkthrough.

Keywords. Web Processing Service, WPS, profiles, RM-ODP, interoperability.

1. Introduction

Geoprocessing on the web is often described as the next evolution step of Spatial Data Infrastructures (SDIs) from data serving to information provision [1]. Information provision on the web is enabled by web-based geoprocess models, which transform web-based data as currently available in SDIs into web-based information. These geoprocess models are available as distributed and loosely-coupled resources on the web encapsulated as Web Services. In this context, interoperability is a key requirement to make use of such Web Services. To provide geoprocess models as interoperable Web Services, the Open Geospatial Consortium (OGC) specified the Web Processing Service (WPS) interface [2]. In particular, profiles are regarded to enhance the interoperability of geoprocess models which are available through WPS interface. Profiles are web-based descriptions of common interfaces of a geoprocess model. If one profile is referenced by different geoprocess models providing the same functionality and using the same interface, the different geoprocess models become semantically equal from an interface point of view. Besides some elements for linking and providing machine readable information, a profile contains of a textual description, which is the only source for humans to retrieve the semantics of the specific process. Currently, this textual description is unstructured but highly relevant for inspecting the semantics of the specific process, as semantic descriptions are still missing. However, a coherent and structured approach to document the functionality of a process in such textual descriptions has not been proposed yet.

In this article, we will apply the *Reference Model for Open Distributed Processing* (RM-ODP) to structure the textual description of profiles. RM-ODP is a widely accepted model to document complex structures such as web services comprehensively by using several views. RM-ODP will help to enhance the existing descriptions and thereby tackle the problem of semantic descriptions, which is identified as one of the challenges in web-based geoprocessing [3].

[1] Corresponding Author.

Section 2 describes the related work of web-based geoprocessing and RM-ODP. Based on this, the proposed approach is described (Section 3), which is then exemplified by a walkthrough regarding profile interaction (Section 4). The article ends with a conclusion.

2. Related Work

This section describes the related work as applied in this article to create comprehensive textual descriptions of profiles and puts the presented work into context.

2.1. Web-based Geoprocessing

Geoprocessing is the application of functionality representing real-world processes (e.g. hydrological runoff models) or processing of geodata (e.g. generalization, (coordinate) transformation). Providing these models and functionality on the web is a relevant topic in research and industry, as it allows users to generate web-based information to support decision making.

The WPS interface specification is OGC´s attempt towards a standardized interface for web-based geoprocess models. The WPS specification describes three operations. *GetCapabilities* provides service metadata, *DescribeProcess* provides process metadata with input and output parameters of the designated process and *Execute* allows the client to perform the specific process according to the process metadata. The process metadata currently only consists of syntactic information about the input and output data (e.g. schema, datatype). Profiles are used to address semantic interoperability of processes. A profile has the following properties [2]:

- An OGC Uniform Resource Name (URN) that uniquely identifies the process (mandatory)
- A reference response to a DescribeProcess request for that process (mandatory).
- A human-readable document that describes the process and its implementation (optional, but recommended).
- A WSDL description for that process (optional).

A few profiles are available and are listed in Table 1. All these profiles focus on a specific classification of processes and input and output parameters (second property of a profile), but are rarely described in a structured and comprehensive way (third property of a profile).

Table 1: Overview of published WPS profiles.

Profile topic	**Editors**
Vector and raster-based processes	Nash 2008 [4]
Analysis of 3D data	Lanig & Zipf[5]
Geomarketing	Walenciak & Zipf [6]
Decision support	Ostlaender [7]
Feature and Statistical Analysis	Foerster & Schaeffer [8]

Besides the design of profiles, semantic annotations and semantic descriptions of geoprocess models have been investigated. For instance [9] investigated the use of fine-granular ontologies for Geoprocessing Services, whereas [10] proposed a course-

granular semantic descriptions of Geoprocessing Services based on the service classification of ISO 19119 [11].

2.2. Reference Model for Open Distributed Processing

RM-ODP is a standardized approach from International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) to develop distributed systems. RM-ODP´s realization consists of object modeling, viewpoint specification, distribution transparency and conformance [12]. Object modeling allows building abstractions of the basic system concepts. Viewpoints are used to specify a system from different perspectives (Figure 1). Distribution transparency of specific distributed components and conformance supports interoperability of the components. For this work, viewpoints have been selected, as they allow describing a component (such as a profile) comprehensively.

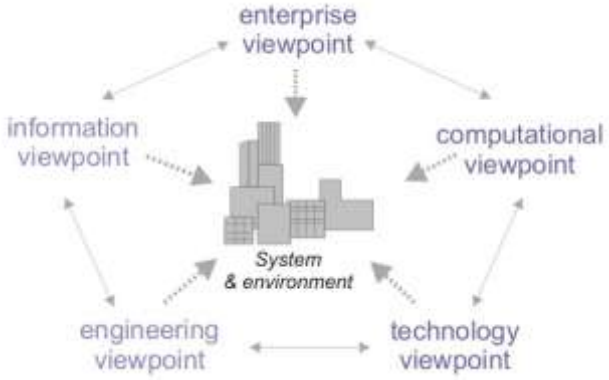

Figure 1: RM-ODP viewpoints.

3. The Approach

To enhance the description of WPS Profiles, an approach is required, which provides a comprehensive view on the specific process. It can thereby be seen as human-readable metadata, which helps users to reason about the specific process. RM-ODP and its viewpoints have been identified as appropriate to help developers and communities in designing and documenting profiles. Table 2 describes the different viewpoints (areas of concern) and how they can be used (main concepts). The engineering viewpoint is not listed in the table, as it provides implementation specific information, which is not considered due to the encapsulation of web service interfaces. The Feature and Statistical Analysis report of the OGC testbed phase 7 [8] can be considered to be a first attempt to structure textual process descriptions by RM-ODP viewpoints.

Table 2: RM-ODP viewpoints and their function in WPS profile development.

Viewpoint	Enterprise	Information	Computation	Technology
Areas of Concern	Objectives of processes	Information models and information manipulation	Logical decomposition of processes	Technical artifacts and solutions
Main concepts	Artifacts, roles	Data schemas	Computational interfaces	

The documented viewpoints can be linked as a plain file in the metadata element of profile or directly be included in the profile to support search regarding the different viewpoints. In particular, we propose a new set of XML elements in the WPS DescribeProcess document extending the *ProcessBriefType* as presented in Figure 2.

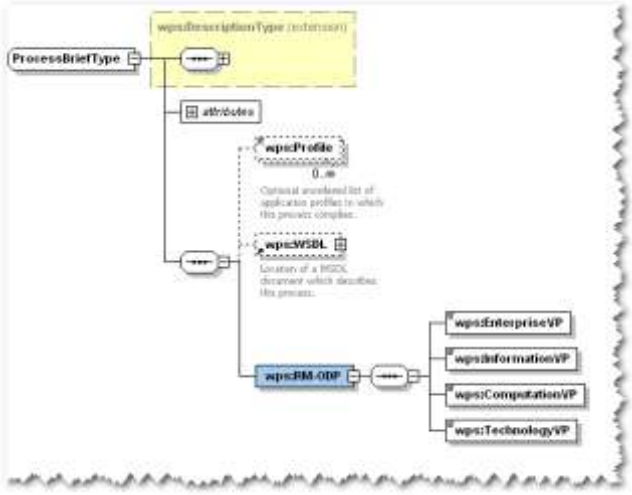

Figure 2. Profile with RM-ODP extension.

A top-level RM-ODP element contains four child elements labeled according to the corresponding viewpoints. Each child elements holds a human readable description of the view point according to the description from above. It is thereby possible for a client to query specific parts of the metadata.

4. Walkthrough

This section exemplifies a walkthrough for interacting with web-based geoprocess models using profiles from a user´s perspective. This perspective, already assumes, that the profile is described accordingly (based on RM-ODP, Section 3) and has been registered officially. This walkthrough (Figure 3) does not take a catalog search into account, as profiles are not considered in catalogs yet. Thus, given a WPS entrypoint,

the WPS user accesses the GetCapabilities and the DescribeProcess documents of a specific WPS. The Profile URN included in the DescribeProcess is used to retrieve the profile information using an official URN resolver. The URN resolver returns the WPS profile with the documented RM-ODP viewpoints. Based on the WPS profile, the user can inspect the syntactic interface. The documented viewpoints (Section 3) provide specific information about the process and its application. Based on this information the user can decide, if this process fits his needs and can specify the request to perform the process with the designated data.

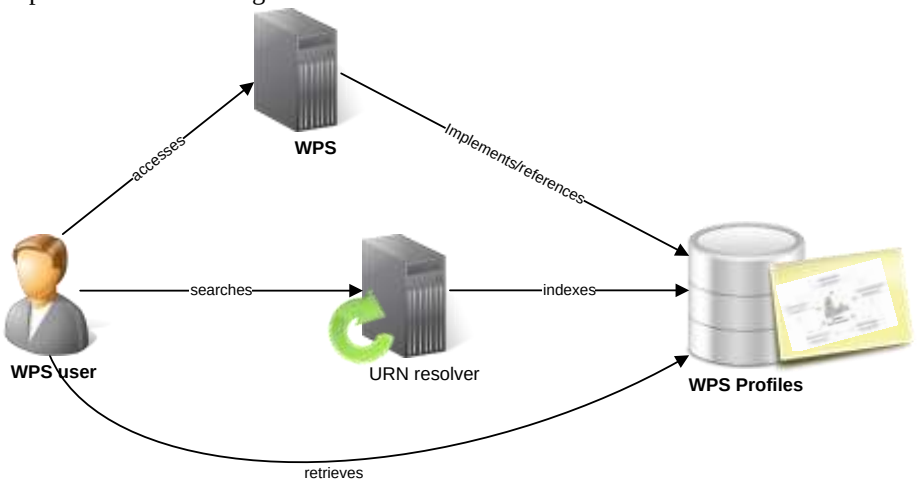

Figure 3: WPS profile walkthrough.

5. Conclusion

Based on the lack of well-documented profiles (as also shown in the overview of available profiles in Section 2), this article proposes the use of RM-ODP to document profiles of geoprocess models. RM-ODP allows documenting distributed architectures using a viewpoint analysis. These viewpoints have been adopted in the approach for profile description (Section 3). Based on the structured way of viewpoint analysis, RM-ODP helps to create comprehensive and well-designed descriptions, which are human-readable. Using this approach to document well-known and referenced profiles will increase the interoperability of the profiles and will limit misinterpretation by the specific user. This becomes especially important in the Model Web [13], which exposes many different models as standardized Geoprocessing Services. The RM-ODP document can be referenced as a separate metadata file or be included as an extension of the structure of the profile. Using such a structure and the proposed encoding, is a first step for querying of profiles. The walkthrough (Section 4) shows the course of action involved for using a profile and how RM-ODP can support it.

However, the approach is also limited in terms of establishing semantic interoperability for automatic web service interaction. Consequently, future research needs to enhance the proposed structure by including semantic descriptions using ontologies [9], [10] or the Object Constraint Language (OCL) from object-oriented modeling [14]. As demonstrated in the walkthrough, a unified approach for the interaction with profiles is not yet specified. Future research will need to investigate the

handling of URNs and the querying of profiles for instance in catalogs. The presented approach here can be used as a starting point.

References

[1] C. Kiehle, C. Heier, and K. Greve, "Requirements for Next Generation Spatial Data Infrastructures-Standardized Web Based Geoprocessing and Web Service Orchestration," *Transactions in GIS*, vol. 11, no. 6, pp. 819-834, Dec. 2007.

[2] OGC, *OpenGIS Web Processing Service*. Open Geospatial Consortium, 2007.

[3] J. Brauner, T. Foerster, B. Schaeffer, and B. Baranski, "Towards a Research Agenda for Geoprocessing Services," in *12th AGILE International Conference on Geographic Information Science*, 2009.

[4] E. Nash, "WPS Application Profiles for Generic and specialised Processes," in *Proceedings of the 6th Geographic Information Days*, vol. 32, pp. 69-79, 2008.

[5] S. Lanig and A. Zipf, "Proposal for a Web Processing Services (WPS) Application Profile for 3D Processing Analysis," in *2010 Second International Conference on Advanced Geographic Information Systems, Applications, and Services*, pp. 117-122, 2010.

[6] G. Walenciak and A. Zipf, "Designing a Web Processing Service Application Profile for Spatial Analysis in Business Marketing," in *13 th AGILE International Conference on Geographic Information Science*, p. 8, 2010.

[7] N. Ostlaender, "Creating Specific Spatial Decision Support Systems in Spatial Data Infrastructures," Phd thesis, University of Muenster, 2009.

[8] T. Foerster and B. Schaeffer, *OWS-7 Feature and Statistical Analysis Engineering Report*. OGC, 2010, p. 41.

[9] M. Lutz, "Ontology-based Descriptions for Semantic discovery and composition of Geoprocessing Services," *GeoInformatica*, vol. 11, no. 1, pp. 1-36, 2007.

[10] R. Lemmens, "Semantic interoperability of distributed geo-services," PhD thesis, Delft University of Technology, 2006.

[11] ISO/TC 211, *Geographic information - Services*. International Organization for Standardization, 2005, p. 67.

[12] ISO/EC, *Information technology - open distributed processing - reference model: overview*. Geneva , Switzerland: ISO, 1998.

[13] G. N. Geller and W. Turner, "The model web: a concept for ecological forecasting," in *2007 IEEE International Geoscience and Remote Sensing Symposium*, pp. 2469-2472, 2007.

[14] J. Warmer and A. Kleppe, *The Object Constraint Language*, Second Edition. Addison Wesley, 2003.