Integrating OGC Web Processing Services into Geospatial Mass-market Applications

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Abstract

Enabling the integration of information provided by OGC Web Processing Services into geospatial mass-market applications is promising, as it increases the availability of information for most ordinary users. This information will be most likely based on the latest available data (e.g. collected by sensors) and can thereby support the user in time-constrained decisions. This paper presents an approach to actually configure and integrate such processes into geospatial mass-market applications. The applicability of the approach is demonstrated by a risk management scenario. The software presented has been developed within the Geoprocessing Community of the 52°North initiative and is available through an Open Source license.

1. Introduction

Sharing and accessing web-based geo-information (GI) is a key aspect in geospatial mass-market applications (such as Google Earth and Yahoo Maps) and helps people answering spatially related questions. Currently, data services are organized in Spatial Data Infrastructures (SDIs) and allow anybody to access data on the web from anywhere at anytime. Those data services matured within the last years, such as the Web Feature Service (WFS) or the suite of services published in the context of the Sensor Web Enablement (SWE) initiative. However, such available data often requires certain processing to answer a specific question. As most of the current data is available through web services, the processing should also be available through the web. In the context of standardization of such services, the Open Geospatial Consortium (OGC) released the Web Processing Service (WPS) interface specification (OGC 2007) and realizes thereby a shift from services providing data towards services providing information. Besides that, Web Processing Services are promising as the availability of network (gigabit bandwidth) and processing capabilities (multiple processor cores) increase. In general, Web Processing Services provide a means to customize data offered by data services mostly located in a SDI. The integration of such web-based information is promising for current geospatial mass-market applications to provide the users comprehensive access to up-to-date information and thereby help users to answer their questions regarding a geospatial context. However, such integration has not been realized yet.

This paper will analyze the technological requirements of geospatial mass-market applications towards web-based process integration and propose an approach to integrate web-based geoprocesses into such geospatial mass-market applications. Finally, the paper will demonstrate the applicability of the proposed approach by a fire threat use case. This use case demonstrates how ordinary users can access the most current information through their geospatial mass-market application and take actions accordingly. The described scenario addresses a forest fire assessment use case, which is one of four key areas of the OSIRIS project[1]. OSIRIS (Open architecture for Smart and Interoperable networks in Risk management

[1] OSIRIS project website: http://www.osiris-fp6.eu.

based on In-situ Sensors) is a European integrated project within the Sixth Framework Programme, aligned with GMES (Global Monitoring for Environment and Security). The main goal of the project comprises the design, specification, development and testing of a Service Oriented Architecture for risk monitoring and crisis management. A special focus is put on web services for integrating in-situ sensors and sensor data as well as higher level user services. Furthermore, during the design of the OSIRIS architecture, open standards, especially those provided by the OGC, are used as a valuable input.

The tools implementing the presented approach have been developed within the Geoprocessing Community[2] of the 52°North initiative and are available through an Open Source license (GNU General Public License).

The remainder of the paper is structured as follows. First the key concepts applied in the presented approach will be described. Based on this, Section 3 will present the developed approach, which will then be applied to the risk management scenario in Section 4. The paper ends with a conclusion and elaborates on future work items.

2. Background

The term *geospatial mass-market application* is closely related to what has been called *Neogeography* (McFedries 2007, Turner 2006) and *Volunteered Geographic Information* (VGI; Goodchild 2007). Both concepts describe a process of creating, sharing and annotating geodata (e.g. locations) through web-based applications by the public and can be summarized under the term *Geoweb* (McFedries 2007). There are a lot of different software vendors active within this market, providing data, applications and services such as Google, Yahoo, Microsoft or even the NASA. One of the commonly used formats to exchange geospatial-related content within geospatial mass-market applications is *KML*. The following subsections will shortly introduce the KML standard and the WPS interface specification.

2.1. The OGC KML standard

KML is widely used in the context of Google Maps and Google Earth and most lately it became an official OGC standard (OGC 2008). KML is unique in the family of OGC data encodings, as it combines data encoding, styling and the special network facilities, which are called *NetworkLinks* and are also known as dynamic KML. These NetworkLinks are especially interesting in the context of web-based information, as they allow the dynamic integration of remote resources. Therefore, the content of a KML file might become dynamic and provide temporal data (e.g. from sensors). As NetworkLinks use URLs, KML is not only bound to file-based access, but can link any web service, as long as it operates via HTTP-GET and serves KML. NetworkLinks provide additional properties such as update, scheduling etc.

2.2. OGC Web Processing Service

The WPS interface specification (OGC 2007) describes a standardized set of operations to publish and execute any type of geo-process on the Web. According to the WPS interface specification, a process is defined as an algorithm, calculation or model that operates on spatially referenced data.

In detail, the WPS specification describes three operations, which are all handled in a stateless manner: *GetCapabilities*, *DescribeProcess* and *Execute*. GetCapabilities is common to any type of OGC Web Service and returns service metadata. In case of a WPS it also returns a brief description of the processes offered by the specific WPS instance. To get further information about the hosted processes, the WPS is able to return the process metadata through the *DescribeProcess* operation. This operation provides the description of all parameters, which are required to run the process. Based on this information the client can perform the *Execute* operation upon the designated process. As any OGC Web Service, the WPS communicates through HTTP-GET and HTTP-POST using a messaging based on an OGC-specific XML-encoding.

Besides that, the WPS interface specification describes mechanisms for asynchronous processing, processing of URL-referenced data and storing of process results. Especially storing of process results is promising in the context of the presented approach, as it allows to access process results server-side whenever required using a simple URL without re-initiating the process itself. Additionally, it is possible to request process results in a raw-data mode.

WPS implementations have already been successfully applied in several projects ranging from groundwater vulnerability analysis (Kiehle 2006), bomb threat detection scenarios (Stollberg & Zipf 2007) and map generalization (Foerster & Stoter 2006). Additionally, an extensive discussion about the

[2] 52°North Geoprocessing Community website: www.52north.org/wps.

applicability of the WPS and its current drawbacks can be found in Friis-Christensen et al. (2007).

3. The Approach for Integrating WPS in Geospatial Mass-market Applications

To integrate WPS-based processes, several requirements of the geospatial mass-market applications have to be met. The major requirement is, that the communication pattern (REST architecture & KML encoding) of the geospatial mass-market applications does not have to be changed. Thereby, the processes become capable of being seamlessly integrated into such applications. This requirement is met by the WPS interface specification, as it allows the invocation of processes via HTTP-GET. Additionally, the WPS interface specification does not foresee any data encoding for its input and output parameters, thus KML is a valid format for the WPS. Finally, as the WPS is able to return process results as raw data without any WPS-specific message overhead it is highly applicable for an integration into geospatial mass-market applications.

However, as the configuration of such processes is highly complex and not supported by current geospatial mass-market applications, this paper proposes a two folded approach. At first, the selection and configuration of the process should be done by an expert user, utilizing an expert user interface, most-likely a Geographic Information System. At second, the user can integrate the pre-configured process into his geospatial mass-market application of choice. This is possible, as the WPS interface meets the requirements of geospatial mass-market applications, as explained in the previous paragraph. It is important to note, that the pre-configuration is not necessary because of the lack of support for process configuration in geospatial mass-market applications, but is also highly applicable, as process configuration involves a lot of expert user knowledge. Thus the pre-configuration eases the application of such models in Google Earth for the user and is thereby not a drawback.

The processes are configured through a WPS client, which is available as an extension of the *User-friendly Desktop Internet GIS* (uDig[3]). This client extension has been described in Foerster & Schaeffer (2007). uDig has been enhanced to export those configured processes, and thereby to enable the integration of those processes easily into geospatial mass-market applications. This is also shown in Figure 1.

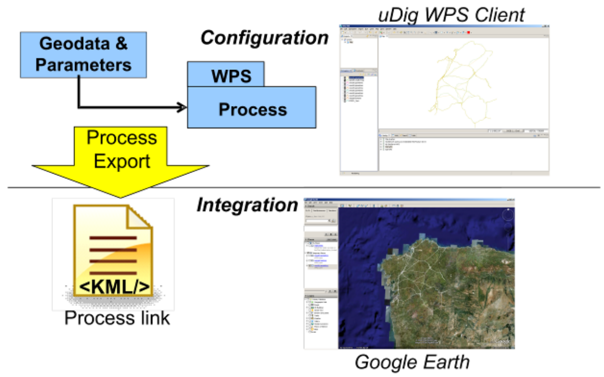

Figure 1: ***Approach to integrate WPS processes in mass-market applications such as Google Earth.***

The export of the process from uDig to KML can be configured in two ways:

1. Export the KML file as a link to a stored process result. This is the *static* option, in which no process will be triggered when visualizing the KML file in Google Earth. This uses the store functionality of the WPS interface specification

2. Export the KML file as a link, which triggers the process on the WPS. This is the *dynamic* option and enables to trigger the process live, when incorporating the file in Google Earth. This allows one also to set a refresh rate to initiate the process on the server again. It is important to note, that in this case, the WPS process is triggered and if any WPS input data is defined as reference, the (updated) data is fetched and used as the basis for the calculation. This approach allows the processing of the latest available data and thus visualizing the latest results in mainstream applications.

In both cases the files incorporate the links using the *NetworkLink* functionality of KML. Figure 2 depicts the GUI dialog in uDig to configure the KML file referencing the configured process (regarding the applied process strategy).

Listing 1 shows the generated NetworkLink using the dynamic option in the KML export of uDig (option 2). The generated KML includes an Execute request via HTTP-GET to a Douglas Peucker Algorithm for simplification, which is also used in the scenario described in Section 4. The request references remote WFS data.

[3] uDig website: http://udig.refractions.net.

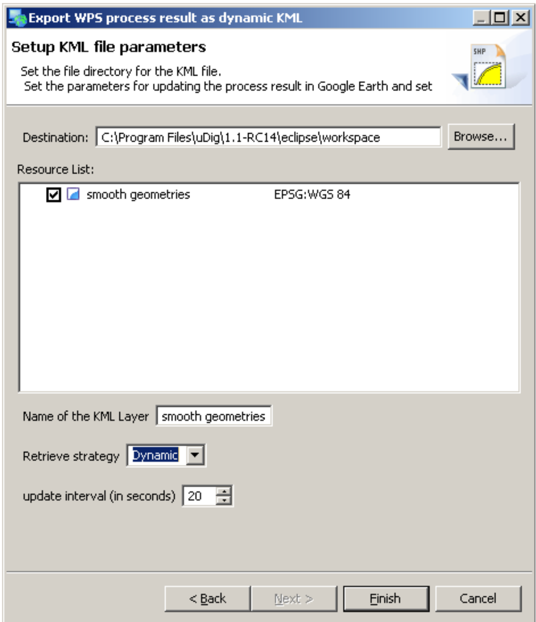

Figure 2: User interface to export the configured process in uDig as KML.

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://earth.google.com/kml/2.2">
  <Folder>
     <name>smooth geometries</name>
            <visibility>0</visibility>
            <open>0</open>
            <description>WPS Layer</description>
              <NetworkLink>
                   <name>WPS Layer</name>
                   …
                   <description>WPS Layer</description>
                   <refreshVisibility>0</refreshVisibility>
                  <Link>
<href>http://geoserver:8080/wps/WebProcessingService?request=ex
ecute&amp;service=WPS&amp;version=1.0.0&amp;Identifier=org.n
52.wps.server.algorithm.simplify.DouglasPeuckerAlgorithm&amp;D
ataInputs=FEATURES=@mimeType=text/xml@href=http%3A%2F
%2Fgeoserver%3A8080%2Fgeoserver%2Fwfs%3FSERVICE%3D
WFS%26VERSION%3D1.0.0%26REQUEST%3DGetFeature%26ty
pename%3Dtopp%3Aspanish_roads@Schema=http://schemas.openg
is.net/gml/2.1.2/feature.xsd;TOLERANCE=1&amp;RawDataOutput
=SIMPLIFIED_FEATURES@mimeType=application/vnd.google-
earth.kml%2Bxml@schema=http://www.opengis.net/kml/2.2</href>
            <refreshMode>onInterval</refreshMode>
            <refreshInterval>20</refreshInterval>
   …
</kml>
```

Listing 1: KML NetworkLink with a WPS-Execute request via HTTP-GET. The request references remote data hosted on WFS.

By supporting these two options (dynamic vs. static), the integration is well-scalable and applicable to scenarios requiring dynamic or even static process results.

4. Use Case Scenario

The scenario is settled in the context of a risk management use case, in which in-situ-sensor data has to be analyzed for assessing a fictive fire threat in Northern Spain. The scenario and the involved services have been extensively presented in Foerster & Schaeffer (2007). Currently, the services and data are taken from the Orchestra project, which addresses a similar fire risk management scenario (Friis-Christensen et al. 2006). In a later stage of the project, data will be collected by sensors, as it is also the aim of the OSIRIS project. This section will focus on a modification and extension of the OSIRIS fire threat scenario, in which information has to be derived in time out of sensor data while the process results have to be disseminated to inform the public about the current situation.

The expert configures the process in the WPS client extension for uDig by buffering the fire threat areas and intersecting them with the road data. The road data has been additionally simplified to improve the process performance and to improve portrayal at smaller scales. Overall, this allows the expert to assess which parts of the road infrastructure are at risk by a fire threat. The expert user exports the configured process as a KML file and links it on the national portal site. The citizen (i.e. ordinary user) is now able to visualize the latest analysis results in his/her geospatial mass-market application by loading the KML file from the portal site. He/she can inspect the latest data with underlying base information from areal imagery and/or topography. Thereby, the geospatial mass-market application makes use of distributed Web Services to get the latest data (sensor data & feature data) for each user request and processes it live using OGC WPS. Figure 3 depicts the result of the configured process in uDig and the same process accessed through Google Earth.

5. Conclusion & Outlook

The presented approach enables the seamless integration of process results executed by OGC WPS instances into geospatial mass-market applications. This is especially promising, as processes can deliver applicable geo-information, which is required by today's applications. As elaborated in Section 3, the WPS interface specification meets all the requirements for the integration into geospatial mass-market applications. By enabling KML support and the support of the HTTP-GET Execute operation the WPS is capable to be integrated in any geospatial mass-market application. The presented approach is two-fold, as it first supposes to configure the process within an expert client environment (such as uDig). At second, the exported process can be consumed by a geospatial mass-market application such as Google Earth.

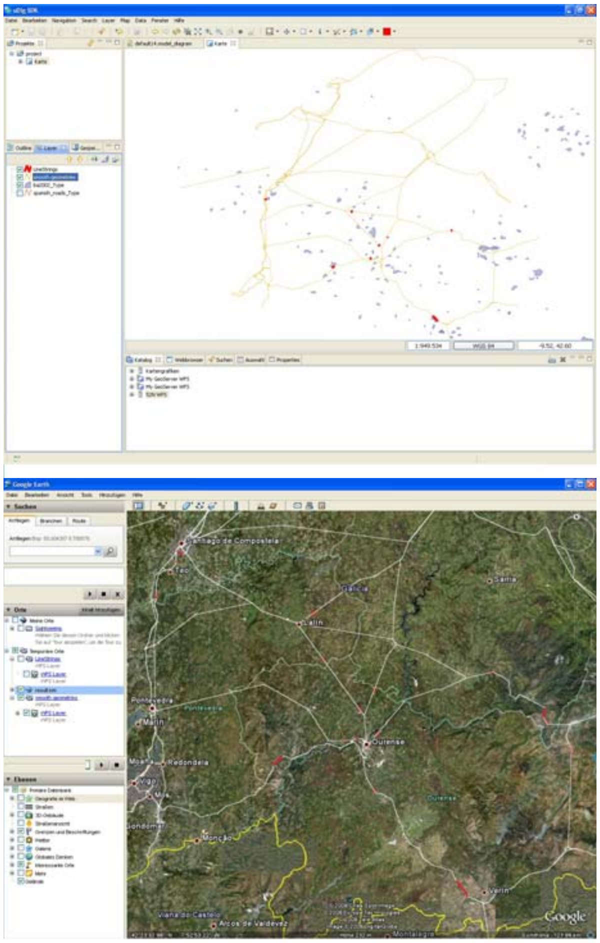

Figure 3: Screenshots of the configured processes in uDig (top) and exported to Google Earth (bottom) – simplified roads & affected road infrastructure (red).

The presented use case scenario, demonstrates the necessity and applicability of the developed approach for a risk management scenario. Without the integration of process results into such applications, citizens would be unaware about current information and could not act accordingly in times of danger. The visualization of process results, such as affected road infrastructure combined with static satellite imagery or topography, provides sufficient information to the ordinary user regarding the aimed scenario. Additionally, the approach is interesting for research communities, which want to exchange latest research results in terms of processes results (e.g. latest results of climate change models).

The approach is scalable as the process results can be integrated as dynamic or static processes (Section 3). It is important to note that the presented approach is fully compliant with the applied standards (KML & WPS), without amending or modifying any interfaces or encodings. Overall, the OGC WPS interface specification and the dynamic KML have shown great flexibility to enrich information on the currently evolving Geoweb by enabling to integrate geospatial processes into geospatial mass-market applications.

In the future, the performance of such processes integrated into geospatial mass-market applications is of major interest as it opens a new market beyond enterprise applications. Also, the integration of more complex process chains is subject to research.

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