A SPATIAL DECISION SERVICE FOR BPEL

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Commission IV, WG IV/5

KEY WORDS: Service Oriented Architecture (SOA), Business Process Execution Language (BPEL), Business Process Modeling Notation (BPMN), OGC Web Services, Web Processing Service (WPS), Geoprocessing Workflow, ERP System

ABSTRACT:

In many business decisions and business processes spatial information plays an important role. Although in computer science with the Business Process Execution Language (BPEL) a standard for modelling and controlling business process workflows exists, the instruction set defined by this standard lacks spatial operators. For example topologic operators like “touches” or “within” would be needed for branching business process workflows depending on the spatial properties of data involved. Analogous to so called decision gateways used in the Business Process Modeling Notation (BPMN) for branching workflows by comparing alphanumeric data using logical operators like “less than”, “equal to” or “greater than”, the introduction of spatial operators would lead to “spatial decision gateways”.

In this paper we discuss several approaches to extend BPEL in such a way that it is possible to define and implement spatial decision gateways. The most promising approach introduces a so called spatial decision service which could for example be based on the Web Processing Service specification of the Open Geospatial Consortium (OGC WPS). One of the advantages of this approach is to keep up interoperability with existing BPEL tools because the BPEL standard itself is not changed at all.

As a proof of concept we present a spatially enabled business process workflow dealing with real-world problems from the insurance domain.

The concept introduced here uses the BPEL for describing business process workflows which are then implemented on a distributed computing platform based on the Service-Oriented Architecture (SOA) paradigm. The aim of our future research is to not only consider SOA but platform-independently describe geoprocessing workflows at the conceptual level using a conceptual schema language like UML. The BPEL will in this case be one of several platform-specific models (PSM) which shall according to the model-driven architecture paradigm (MDA) be automatically derived from the platform-independent workflow description (PIM) by means of so called PIM-to-PSM-mappings. In the same way other PIM-to-PSM-mappings could then be defined for proprietary geoprocessing tools like ESRI Model Builder or FME Workbench or even for fundamentally different software architecture paradigms.

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1. INTRODUCTION

1.1 Need for Geo-Enabling the Business Process Execution Language (BPEL)

In order to optimize their activities and processes, organisations try to automate their business processes using information technology (IT). Often, automating a single business process means to integrate several applications or information systems which nowadays can be done according to the Service Oriented Architecture (SOA) paradigm (Mahmoud, 2005). In a SOA, Web Services expose the functionality of the systems they are provided by. Consequently, automating a business process which spans several applications or information systems means to combine several Web Services.

As in many business decisions and business processes geospatial information plays an important role – think for example of processes in the utilities, insurance, logistics and transportation domain – it should be possible to describe, execute and control business processes involving geospatial data and operations.

Although in computer science with the Business Process Execution Language (BPEL) a standard for modelling and controlling business processes in a SOA exists (OASIS, 2007), the instruction set defined by this standard does neither support spatial data types nor spatial operators.

1.2 Scope of this Paper

The scope of this paper is to discuss several ways of overcoming BPEL's lack of spatial data types and spatial operators.

The BPEL in our case is not used for describing geoprocessing workflows which mainly consist of Geospatial Web Services as it has been done by the Open Geospatial Consortium (Schäffer, 2009) but for integrating spatial data and spatial operators into those business processes which mainly consist of non-geospatial Web Services which are e.g. provided by Enterprise Resource Planning (ERP) systems.

Our main research question therefore is how to integrate spatial operators into the BPEL in such a way that it is possible to branch business process workflows depending on the spatial properties of the data involved.

This implies for example to integrate comparison operators for spatial data like "touches" or "within" in the BPEL analogous to operators for comparing alphanumeric data like "equal to" or "less than" which already exist in the BPEL.

2. A SPATIAL DECISION GATEWAY FOR BPEL

2.1 BPMN Gateways and BPEL Activities

In the Business Process Modeling Notation (BPMN) (OMG, 2009), so called Gateways are used in order to control the workflow by using logical operators like XOR.

Business process workflows, called BPEL processes in the remainder of the paper, are structured in the BPEL using so called *Activities*. They can e.g. be applied in the BPEL to implement the BPMN-concept of Gateways or for data manipulation or error handling. In order to better discriminate between these Activities, we define those Activities which control the BPEL process as *"Decision Gateways"*, which is according to the BPMN terminology. Decision Gateways which are used for branching BPEL processes dependent on the spatial properties of data are called *"Spatial Decision Gateways"* in our terminology.

2.2 Introducing Spatial Decision Gateways to the BPEL - a Short Discussion

In the following we discuss three possibilities which can be used for introducing the concept of Spatial Decision Gateways to the BPEL.

The first approach introduces new Activity types to the BPEL syntax. The second approach uses the concept of Sub Processes and the third one assumes that the functionality for making spatial decisions is provided by a Web Service.

The following discussion sums up the pros and cons of the approaches mentioned above.

Approach 1: Spatial Decision Gateways as new Activity types

The WS-BPEL standard 2.0 (OASIS, 2007) contains an extension mechanism which allows for defining additional Acitivity types. In analogy to the BPEL Activities <if> or <switch> (deprecated by WS-BPEL 2.0) which can be used to branch a BPEL process based on conditions for alphanumeric data or events, a new Activity could be defined which allows for branching BPEL processes based on spatial conditions. The advantage of this approach is that it fits well into the BPEL syntax but there are also great disadvantages to this approach. The new activities would not be supported by software implementing the BPEL standard. Spatial operators and other functionality for handling geospatial data would have to be built into BPEL engines. BPEL modelling tools would have to be extended, too.

Approach 2: Spatial Decision Gateways as Sub-Processes according to BPEL-SPE

In a white paper called "WS-BPEL Extension for Sub-processes – BPEL-SPE" (IBM, 2005), the companies IBM and SAP describe a new BPEL extension mechanism they called "Sub-Process". A Sub-Process is a BPEL code fragment which can be reused inside a process or by other processes.

With regard to the implementation of Spatial Decision Gateways, this approach provides a high level of flexibility. Spatial operators, such as "Contains" or "Disjoint" could be implemented as separate Sub-Processes which could be called using the BPEL Activity <call>.

The disadvantage of this approach is that the Sub-Process concept is not part of the BPEL 2.0 standard and is therefore currently not supported by BPEL engines and modelling tools.

Approach 3: Spatial Decision Gateways as Web Services

This approach relies on a Web Service which encapsulates the spatial operations. Each spatial operation could be represented by a WSDL-operation which could then be integrated in a BPEL process using the BPEL Activity <invoke>.

The great advantage of this approach is that it keeps up interoperability with existing BPEL tools as the BPEL standard itself is not changed at all.

Depending on the design of the Web Service interface, it is not even required to handle spatial data inside the BPEL process which reduces complexity and increases performance. We define a Web Service which has the capabilities described here as a *"Spatial Decision Service"*.

2.3 A Concept for a Spatial Decision Service

With respect to the SOA paradigm, we assume that both geospatial data and comparison operators for spatial data are provided by Web Services. In case international standards shall be applied, the OGC WFS (Web Feature Service) (OGC, 2002a) interface can be applied both for data access and in combination with Filter Encoding also for providing spatial comparison operators. The OGC WPS (Web Processing Service) (OGC, 2005) interface can also be used for encapsulating spatial operators.

We further distinguish two cases (compare figures 1 and 2): Case 1. The Spatial Decision Service makes use of geospatial data which are part of the BPEL workflow, i.e. the geospatial data is retrieved by the BPEL engine. In this case a WFS is used both for accessing the geospatial data and as a Spatial Decision Service.

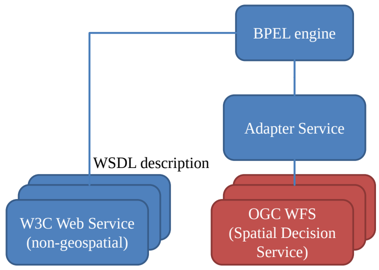

Figure 1. System Architecture Case 1

Case 2. The Spatial Decision Service accesses the geospatial data which then is not part of the BPEL process.

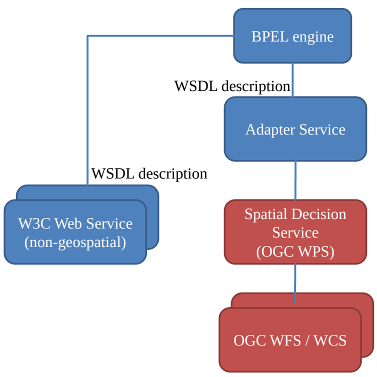

Figure 2. System Architecture Case 2

The advantage of case 1 is that the geospatial data is available within the whole BPEL process and can be manipulated or can alternatively even be produced inside the process. The disadvantage of case 1 is the complexity introduced to the BPEL by the generic nature of the WFS and the use of Filter Encoding (OGC, 2002b) and the Geography Markup Language (GML).

The advantage of case 2 is that the BPEL process need not be able to handle the generic concepts of WFS, Filter Encoding and GML. Case 2 has the following limitation: The Spatial Decision Service only returns a Boolean value (e.g. geometry A touches geometry B = true). Thus the decision is based on the comparison of geospatial data but the geospatial data themselves do not exist within the BPEL process.

Using the WPS standard, creating a Spatial Decision Service means to implement a WPS process. The inputs to this WPS process are references to two spatial data sets in the form of WFS URLs and corresponding Filter Encoding fragments.

3. PROOF OF CONCEPT

3.1 Prototyping a Spatial Decision Service

Below we present a use case showing the relevance of Spatial Decision Gateways to BPEL processes. For accessing geospatial data and as the Spatial Decision Service we used a WFS 1.0 interface provided by GeoServer. As WFS 1.0 does not support SOAP and WSDL, a WFS adapter service had to be developed. For graphically designing the BPEL process, ORACLE BPEL designer was used. We chose ORACLE BPEL process manager as BPEL engine.

3.2 Insurance Use Case

In the last years the number and intensity of natural disasters such as floods, earthquakes or avalanches increased.
Many insurance companies therefore offer an extended insurance against natural hazards in addition to the residential building insurance in order to cover damages caused by natural hazards. However, before a specific customer can take out an insurance policy, the insurance company checks whether the building the customer wants to insure against natural hazards is situated within a natural hazard prone area such as a floodplain (see figure 3). Depending on the result of this check, the insurance company decides whether the building can be insured or not and if so, which is the applicable insurance rate.

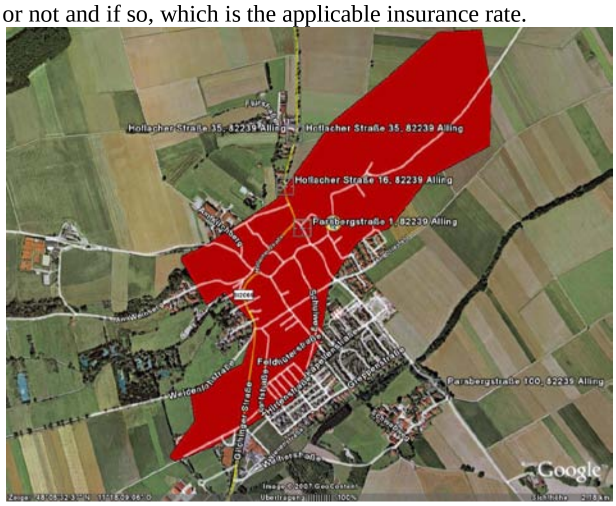

Figure 3. Flood hazard zone feature (fictitious) and address features provided by WFS

From the point of view of the person who is in charge of carrying out this check, the automated business process could be as follows: The person enters into a Web form the insurance policy number of the existing policy the customer wants to extend to cover damages caused by natural hazards. As a response, the person gets the information whether the policy can be extended or not. If the extension of coverage is possible, the response will also contain the insurance rate.
Implementing this business process means modelling a BPEL process which integrates several information systems.
The customer data, in particular the address of the building the customer wants to insure, is stored in an SAP/R3 system which can be accessed by means of a SOAP service. Furthermore, point coordinates are stored for each address in a spatial database which is encapsulated by a Web Service having a WFS interface. This WFS is used as a geocoding service, i.e. it transforms an address provided into coordinates. A second WFS encapsulates a spatial database containing polygon features which represent different types of flood hazard zones. This WFS represents the Spatial Decision Service in our

implementation. It is used in order to determine whether the address of the building to be insured lies within a specific flood hazard zone. The Spatial Decision Service response then determines the specific path of the BPEL process to be followed.

The following BPEL code fragment describes the individual steps of the process according to case 1 of our concept for a Spatial Decision Service (see 2.3). The part of the process representing the Spatial Decision Gateway is printed in bold italics.

```
<process>
  <partnerLinks/><!-- links to the three web services invoked -->
  <variables/><!-- global variables -->
  <sequence>
    <receive/><!-- input from client -->
    <assign/><!-- define inputs for service invocation -->
    <invoke/><!-- get address of building from SAP service -->
    <assign/><!-- define inputs for service invocation -->
    <invoke/><!-- get co-ordinates from address geocoding service -->
    <scope><!-- a scope is a collection of activities having its own local
variables, exception handling and so on -->
      <sequence>
        <assign/><!-- define inputs for service invocation -->
        <invoke/><!-- invoke Spatial Decision Service -->
        <if>
         <condition/>
           <!--Spatial Decision Service returns empty result-->
         <assign/><!-- assign value to output variable of the process -->
         <else>
         <!-- Spatial Decision Service returns flood hazard zone
              features -->
           <assign/><!--assign value to output variable of the proces -->
         </else>
        </if>
       </sequence>
      </scope>
     <reply/><!-- return output variable to client -->
   </sequence>
</process>
```

A significant reduction of complexity can be achieved if case 2 of the architecture concept for a Spatial Decision Service is applied. The BPEL code for the very same use case but applying case 2 of our concept (see paragraph 2.3) will be much more compact since we will just have two partnerLinks, one for the SAP service and one for the Spatial Decision Service which itself connects to the two WFS services. Therefore, geospatial data need not be handled within the BPEL process. Geocoding the address returned by the SAP service is part of the Spatial Decision Service request.

4. CONCLUSIONS AND FUTURE WORK

This paper defines the term Spatial Decision Gateway and describes three possibilities to integrate the concept of Spatial Decision Gateways into the BPEL.

With regard to the research question formulated in paragraph 1.2 it can be stated that the approach we call Spatial Decision Service is the most promising solution.

We further distinguish two cases of Spatial Decision Service architectures. Case 1 is based on geospatial data which is available within the BPEL process and allows for manipulating geospatial data within the process.

In case 2 Geospatial data and spatial operations are encapsulated by the Spatial Decision Service which only returns a Boolean value representing the topologic relation of geometries.

A use case from the insurance domain showed that case 1 results in a more complex implementation than case 2 where geospatial data need not be handled within the BPEL process.

The concept presented here uses BPEL for describing business process workflows which are then implemented on a distributed computing platform based on the Service-Oriented Architecture (SOA) paradigm. The aim of our future research is to not only consider SOA but platform-independently describe geo-processing workflows at the conceptual level using a conceptual schema language like UML. BPEL will in this case be one of several platform-specific models (PSM) which shall according to the model-driven architecture paradigm (MDA) be automatically derived from the platform-independent workflow description (PIM) by means of so called PIM-to-PSM-mappings. Other PIM-to-PSM-mappings could then be defined for proprietary geoprocessing tools like ESRI Model Builder or FME Workbench or even for fundamentally different software architecture paradigms.

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ACKNOWLEDGEMENTS

We thank our former student Johannes Gruber who did the implementation work for this paper in his Master's Thesis at Technische Universität München, Fakultät für Informatik.