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Geospatial Services Chaining with Web Processing Service

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***Abstract*—Web Processing Service is aimed to define a standardized interface that facilitates the publishing of geospatial processes, and also acts as middleware service for data, by obtaining data from an external resource in order to run a process on the local implementation. Owing to the generic nature of Web Processing Service, it can be used to wrap other existing geospatial services. This paper demonstrates three approaches to do geospatial services chaining with this new standard.**

***Index Terms*—Geospatial Service, Web Processing Service, Services Chain**

I. INTRODUCTION

The extraction of information from Geospatial data has been used through Geospatial Information Systems (GIS) in order to deal with spatial questions. Traditionally, because every system has its own proprietary data format, GIS doesn't seem like open and interoperable. These days, as enterprise information systems evolve toward Service Oriented Architecture (SOA), geospatial technologies also evolve along the same lines [1]. The open and interoperable SOA is taking place of the traditional monolithic GIS.

Services, which are the atomic elements of the SOA paradigm [2], can be considered as the functions together with some service standards and protocols which describing the pre- and post-conditions. Web services' nativity provides a new mechanism for achieving interoperability between distributed data and applications.

Many geospatial services were born due to the transmission, such as Web Map Service (WMS), Web Feature Service (WFS), Web Coverage Service (WCS) and the latest Web Processing Service (WPS). Today, these Open Geospatial Consortium (OGC) web services become the standardized interfaces which are used to publish geospatial processes including the capture, modeling, manipulation and analysis of geospatial data [3].

In this study, we discuss how to use WPS in establishing geospatial services chain and present some approaches. The remainder of the paper is organized as follows: Section 2 gives an overview of WPS and the related natures, while in Section 3 we describe the proposed three approaches to do geospatial services chaining with WPS. And finally, Section 4 concludes the paper and presents future work.

II. WEB PROCESSING SERVICE

Open Geospatial Consortium (OGC) launched Version 1.0 of the Web Processing Service (WPS) Interface Standard on February 22, 2008, which was first released in September 2005. This new standard aims to define a standardized interface that facilitates the publishing of geospatial processes and the discovery of and binding to those processes by clients [4]. This WPS interface standard allows executing geospatial processes on the web on the basis of XML/GML communication encoding.

A "geospatial process" means an algorithm, a model or a calculation that is made available at a service instance operating on spatially referenced raster or vector data. This process is not a chain unless it is created as an opaque chain. This point of view can be described as [5]:

$$\text{Process } P^1 \text{ produces results } R^1\text{-}R^N \text{ from input } I^1\text{-}I^i$$

There are three mandatory operations specified by WPS interface, namely GetCapabilities, DescribeProcess and Execute [4]. The response to a GetCapabilities request generally describes the names and abilities of the processes in the form of XML-based metadata. The response to a DescribeProcess request returns the detailed information about the processes containing input and output parameters as well as their available formats. An Execute operation is used to run specified processes, which are also based on XML/GML.

Figure 1 shows a simple class diagram summarizing the WPS interface. The WPS interface class inherits the getCapabilities operation from the OGCWebService interface class [4]. Because WPS offers a generic interface, it does not limit itself to certain specific processes that are supported. Instead, each implementation of WPS defines a process it supports, as well as the associated inputs and outputs. WPS allows for the provision of input data in two different methods. Data can either be embedded in an Execute request, or referenced as a web accessible resource. In the former approach, WPS acts as a stand-alone service. In the latter method, WPS acts as middleware service by obtaining data from an external resource in order to run a process

on the local implementation. Owing to this generic nature, WPS can be used to wrap other existing OGC geospatial standards (such as WMS, WFS and WCS) that are designed to provide geospatial services.

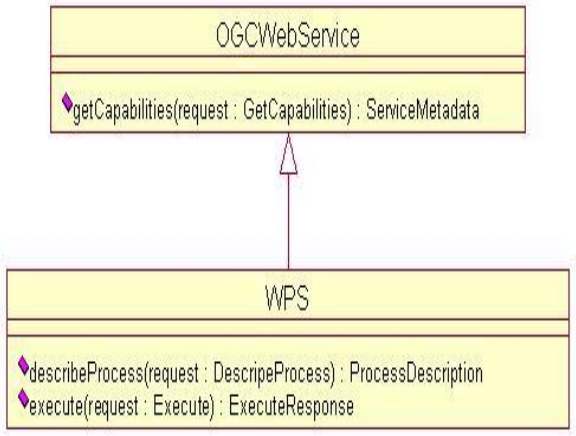

Figure 1. WPS Interface Class Diagram

III. APPROACHES TO DO GEOSPATIAL SERVICES CHAINING WITH WPS

A service chain is a sequence of services where, for each adjacent pair of services, occurrences of the first action are necessary for the occurrence of the second action [5, 6]. When no single service can be used for the requirement, we should combine several services together to do the work. As the central concept of SOA framework, compositing services chain can solve complex problems. This possibility is also perceived as the solution to deal with geospatial data accessing and processing tasks by compositing and reusing several simple geospatial web services [7].

A WPS process normally performs a specific geospatial service. Chaining of WPS processes facilitates the creation of repeatable workflows. And existing geospatial services (such as WMS, WFS and WCS) including WPS itself can be incorporated into services chains in the following ways:

A. Using BPEL to orchestrate a service chain that includes one or more WPS processes

WPS is compatible with Simple Object Access Protocol (SOAP) and Web Service Description Language (WSDL) [4], which is used by Business Process Execution Language (BPEL) for the purpose of describing web services. WPS can offers more sophisticated services chaining capabilities since it uses BPEL to orchestrate the chain including other services and WPS services themselves.

BPEL is an XML-based standard for defining process flows. This open standard makes it interoperable and portable across many environments. Today, IBM and Microsoft work jointly on making the BPEL and its supporting tools popular and standard [8].

BPEL is widely used in addressing automation and orchestration business processes in business networks. And it also can be used for describing a key aspect for the geospatial web services chain. It provides a core of process description concepts needed for the definition of interactions among distributed geospatial processes [9]. This core of concepts is used both for defining the internal processes of a participant to an interaction and for publishing the external protocol that defines the interaction behavior of a participant among several distributed servers without revealing its internal behavior.

Figure 2 shows the collaboration diagram of using BPEL to orchestrate a services chain, and uses data reduction process as the example. Client requests geospatial data process by starting the BPEL to describe it. WPS executes the request with the scripts calling geospatial data process with reference to other web services as input parameters. Response from WPS process should only contain references to the results. And the results which are GML document are stored on the WPS server that performed the process. This reference could then be forwarded to other WPS processes. BPEL script also could send request to other WPS processes. It passes the reference to the results from the former WPS process. Response from BPEL scrip tells client where to get the processed results. And then client retrieves GML document from the WPS service.

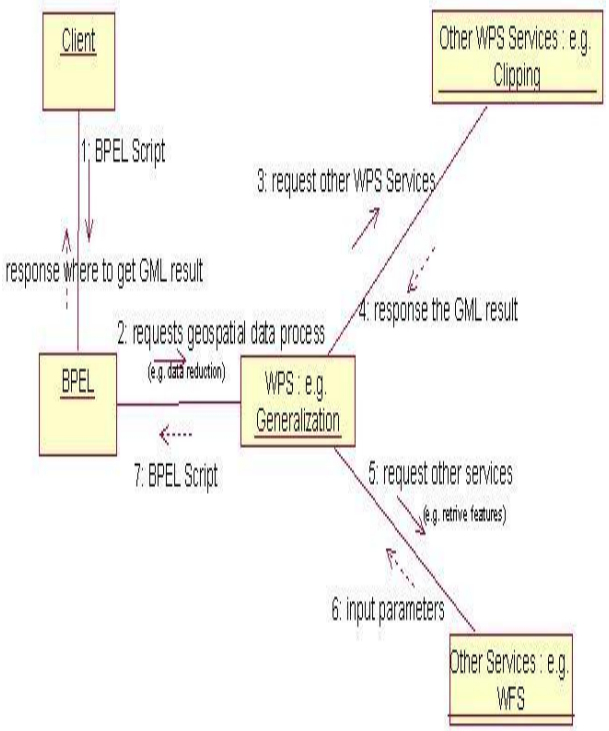

Figure 2. collaboration diagram of using BPEL and WPS to orchestrate a services chain

B. Using WPS Interface to design a sequence of web services

There is also a problem with the transfer of binary data which is served in response to a WMS GetMap or WCS GetCoverage request which cannot for this reason be orchestrated using the BPEL approach [10]. The

difficulties make us use WPS interface itself to design the chain of geospatial services complied with WSDL interface.

WPS supports to use WSDL when it is required to help and support discovery and binding. It can be used in orchestrating services chain, for the reason that a WPS service can be constructed to call other geospatial web services and also other WPS services, acting as the services chaining engine.

Figure 3 shows the collaboration diagram of using WPS interface to orchestrate a services chain, and uses buffer process as the example. Client requests the process by calling WPS GetCapabilities operation, and these requests are based on HTTP Get and Post. WPS Interface executes the request with reference from other WPS services as input parameters. This response from other WPS process only contains GML document as the references to the result. And WPS Interface also can requests other geospatial web services, such as WFS, WMS and etc., by calling GET operations of these services. Response from WPS interface tells client to retrieves GML document as the result.

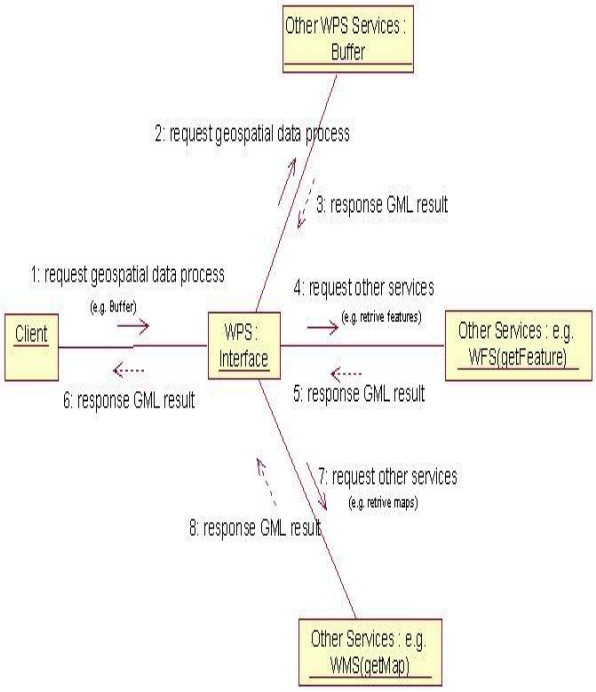

Figure 3. collaboration diagram of using WPS interface to orchestrate a services chain

C. Simple cascading service chains created via WPS GET operation

The former method we use can be count as centralized chaining using WPS service as the central service to invoke other geospatial services. Furthermore, simple services chains can be orchestrated even via the WPS GET operation, since WPS also offers a service discovery mechanism which can be used without the overhead and complexity of WSDL [11]. That is, the WPS interface also supports cascading chaining. And this method make geospatial services exchange data directly because each service communicates with one another individual service.

Figure 4 shows the collaboration diagram of a simple cascading services chain orchestrated via WPS GET operation, and uses feature fusion process as the example. As same as the former method, client requests the process by calling WPS Get operation. This WPS service aims at aggregating more than one heterogeneous GML feature collections into one homogeneous feature collection by communicating with other geospatial services, such as WFS, for fusing GML features.

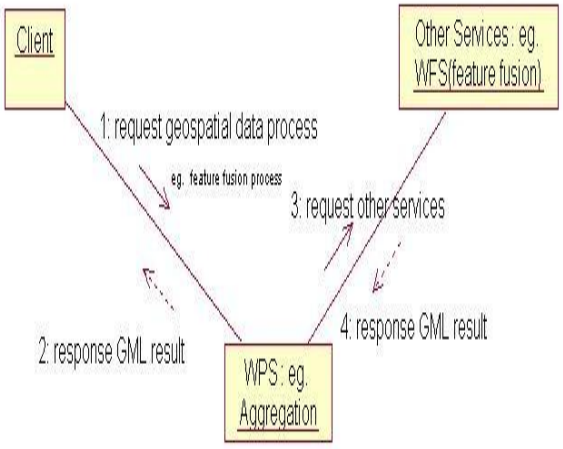

Figure 4. collaboration diagram of a simple cascading service chain orchestrated via WPS GET operation

IV. CONCLUSIONS AND FUTURE WORK

This paper looks into how to make geospatial services chain using WPS. Using BPEL accompany with WPS is depended on WSDL documents. Although a WSDL document seems redundant for the reason that the WPS DescribeProcess operation response contains some same information as a WSDL description, reusing services can be better supported by applications like BPEL designer which make it possible to orchestrate single services using graphical tools. The use of WPS interface to orchestrate a services chain can cover the shortage when facing the problem with the transfer of binary data which cannot be orchestrated using the BPEL approach. And some simple process can be also use cascading services chain via WPS GET operation. The geospatial services chain architecture could be centralized or cascaded depending on which process the geospatial services deal with. The future work of our study will concentrate on realizing more sophisticated geospatial analysis through the methods above.

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