Selection of Minerals properties using service oriented architecture

Pavel Horovčák[1]

Continually and impressive amplification of internet technologies development and implementation enables the creation of productive, efficient, useful and interactive web applications. The contribution briefly characterizes SOA (Service Oriented Architecture), WS (Web Service) and AJAX (Asynchronous JavaScript And XML) technology and illustrates advantages of AJAX and WS integration on application example for interactive selection of one or more minerals according to actually chosen selection criteria. Contribution presents three created web services (service for creating of web page's select list based on given database table content, service for selection of one or a group of minerals according to specified criteria from the group of database tables, and service for correct depiction of chemical formulas on web page). The application makes use of two web services on the server side and one web service plus Ajax technology on the client's side. Application's client's side presents integration of these web services in a dynamic way by means of Ajax technology and at the same time it is a mashup demonstration.

Key words*: SOA, Web Services, Ajax, minerals, integration*

Introduction

SOA is currently very frequently used term supported probably by all significant development firms and explained by huge amounts of web pages, articles, books, contributions and definitions. One of service's realization possibilities in SOA architecture is the web service – WS [1]. WS enables the interoperability between applications running on various platforms. They are specified by means of WSDL (Web Services Description Language) and message exchange between service server and client is performed with SOAP (Simple Object Access Protocol) utilization. The Ajax represents a composition of standard technologies JavaScript, XML, CSS (Cascading Style Sheets), DOM (Document Object Model) and XSLT (Extensible StyleSheet Language Transformation). The integration of these technologies multiplies their advantages and brings the new possibilities of effective web applications creation. The contribution illustrates this approach on example of minerals properties selection in application developed in the sense of service oriented architecture rules (policy). The application uses integration of Ajax technology and web services technology.

SOA

Since 2007, service oriented industry professionals view architecture as an underlying structure that supports communications among different services. In such a context, a service can be thought of as a unit of work that is performed on behalf of some form of computer entity, which might be a human user or another program. Service Oriented Architecture is now viewed as a method for two separate computer entities, such as programs, to interact in a way that enables one of those entities to perform a unit of work on behalf of the other entity it is connected to. Service interactions are viewed through the utilization of a description language. Every interaction is self contained and coupled loosely, enabling every interaction to be independent of any other interaction. [2]

Services as repeatedly usable elements are considered to be software building blocks that run specific functions. According to [2] there is no universally agreed definition of SOA except that SOA is an architecture, which is based on orientation on services as main construct principle. In truth, there is not a universally agreed upon definition of Service Oriented Architecture, other than the fact that it is an architecture that literally relies upon service orientation as its main principle of design. SOA is in many aspects evolution of client – server architecture, at which application logic is distributed to services (unlike monolithic application server in client-server architecture). System based on SOA can clearly and simply unify services running at various different software platforms. SOA considers user requirements as well as service consumers. Provider of service offers its functionality in form of interface to handle the given service. A consumer of this service is using then this interface. Consumer of service can be application or even provider of another service. Essential characteristic of quality services is possibility to share them, to save resources during development and also to simplify maintenance.

Beside indisputable positives of SOA there are areas and situations that are not suitable for application of SOA. Deployment of service oriented architecture is not recommended [3] in scenarios where independent

[1] *doc. Ing. Pavel Horovčák, CSc.,* TU of Košice, F BERG, Institute of Control and Informatization of Production Processes, Boženy Němcovej 3, 040 00 Košice Tel. (421 55) 602 5176, Slovak Republic Pavel.Horovcak@tuke.sk
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undistributed applications don't require integrations with other applications or components, - where homogenous application environment is build upon unified architecture (e.g. J2EE), - where is no need to set up communication with the aid of XML through HTTP, because existing Java RMI protocol is more suitable and hence sufficient, - where we dealing with prototypes on short-term basis, demos or utilities without need for extension or reusing them in future, - where applications with graphical user interface require quick response in short intervals.

Among most frequent mistakes at SOA deployment according to Gartner [4] belongs:

a. deployment of SOA before finishing executive units leads to huge amount of services in discrepancy with business model and requesting frequent changes in specification,
b. omission of data layer may lead to inconsistency and problems with model integrity,
c. abandon SOA concept only to technical staff may lead to technically perfect, but business requirements fail to satisfy product,
d. by using components we meet with distrust to foreign (developed outside development team) units that lead to duplicate work and waste of resources,
e. jump to SOA without preceding planning and preparation is often critical,
f. SOA is differently understood by various professions (programmers, architects, technical staff and executives) that often lead to communication problems,
g. in company that uses SOA should exist coordination centre for collaboration of services,
h. centralization of services in whole company is often worse solution than decentralization to departments, branches or to utilization areas,
i. is dangerous and organizationally not suitable to design conversion to SOA sooner than company is ready.

WS and AJAX

Web service is one possible realization of service in SOA architecture. WS provides standardized description of its interface in form of WSDL (Web Services Description Language) that allows client to use the service. In principle this description is deployed on different server as service itself and represents thereby some kind of connection (binding) between provider (server) and consumer (client) of service. However, SOA is not (only) equal to WS, because each WS is indeed in compliance with SOA, but not each service within the frame of SOA has to be WS. Currently, new extending specifications were added (e.g. WS-ReliableMessaging, WS-Addressing, WS-Notification, WS-Security, WS-Policy and WS-Choreography) to the existing WS standards (XML, SOAP, WSDL and HTTP). This new specifications complement the usage of WS and extend further syntax of WSDL.

AJAX is a web development technology (representing group of technologies - XHTML, CSS, DOM, XML, XSLT, XMLHttpRequest and JavaScript) meant to make interactive web applications. It represents next logical step in SOA evolution. With help of AJAX, user interfaces through web browser can use web services as data sources to store and refresh data [5]. Important part of AJAX - object *XMLHttpRequest* (XHR) - is part of Internet Explorer 5 (since 1999) as ActiveX component. Implementation of XHR in other browsers (Mozilla, Safari), its classification in DOM Level 3 (Document Object Model) and primarily massive use in popular applications (Google Maps, Google Suggest, Gmail etc.) XHR becomes practically a standard. As the first Jesse James Garrett (from Adaptive Paths) made use of term AJAX in work Ajax: A new Approach to Web Application [6] in February 2005. AJAX covers today all technologies supporting asynchronous communication of browser with server without necessity to refresh actual web page.

Application for mineral properties selection using SOA

Mineral for needs of SOA illustration is represented by selection of his four characteristic properties - hardness, category, crystallography and chemical formula. Data model of application is composed of one table with five columns (four mineral properties plus mineral name) and three code lists with names of minerals, names of classes and crystallography pattern. Functions for selection are defined as single-parameter (name, hardness, category and crystallography), two-parameter (hardness and category, hardness and crystallography, category and crystallography) or three-parameter (hardness, category and crystallography). Selected mineral or group of minerals is presented by all properties listed above in selected language mutation.

Description of web services used in application

The application is composed using directly or indirectly three web services WS1, WS2 a WS3 that provide partial functions (fig. 3).

Web service WS1 (with name ServiceTable) is a service assigned to realization of database table's given items selection. The service's purpose is creation of select list in web application's data-entry form also with possibility of setting parameters for more detailed specification of the <select> element. Primary it is intended for selection from tables those primary key consists of two columns. It also enables selection from table with one primary key. The service provides two functions in form:

```
array(2) {
[0]=> string(72)
"string getTable(string $Table, string $Col1, string $Col2, string $Col3)" [1]=> string(120)
"string getSelectTable(string $Table, string $Col1, string $Col2, string $Col3, string $Par1, string $Par2, string $Par3)"
}
```

Function getTable() has four parameters with denotation Table - database table name, Col1 (primary key) and Col2 are the names of table columns, the values of which will be returned as key/value pairs (and they will be used in the element <select> creation for items <option> in the form <option value="key"> value </ option>). Parameter (column) Col3 defines the second primary keys (out of two). In the application there is a second primary key used to the specification of table's content language version. In the case that the table has only one primary key, there is entered a value Col3 = 0. If it's necessary to select from the table only one column, there is entered its name (value) for Col1 as well as for Col2, whereby is Col3 = 0.

Function getSelectTable() has seven parameters. It returns to client a completely built-up element <select> filled with pair of values of key/value of specified table. The meaning of the first four parameters is the same as in function getTable(). Meaning of next parameters is following: Par1 –element identification id, Par2 – function's name (in JavaScript) called on item selection (change), Par3 - the first item text of element <select> without value. The function result has following form

<select id="Par1" onchange="Par2"> <option value=""> Par3 </option> <option value="key">value</option> ... </select>.

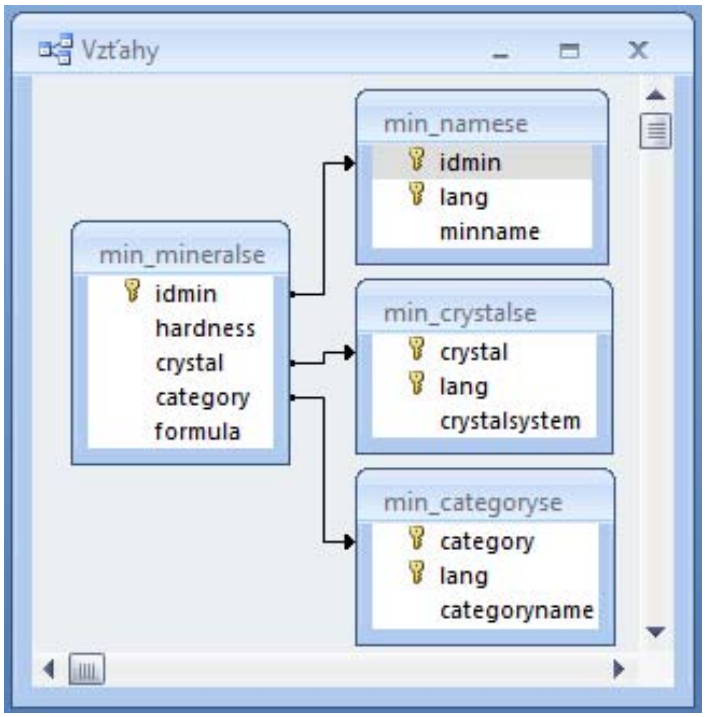

Fig. 1. Data model of ServiceMineral web service.

Web Service WS2 (ServiceMineral) is a service intended to selection of one or a group of minerals according to specified criteria from the group of four database tables illustrated on fig. 1. The main table (min_mineralse) has for the purposes of the application only five columns (mineral, hardness, crystal, category and formula). It is complemented by a group of three multilanguage code lists – tables of keys (currently there are two languages SK and EN) for the names of mineral, crystallography and category.

The service has one function getMineral() in form:

```
array(1) {
[0]=> string(99)
"string getMineral(string $Regime, string $Param1, string $Param2, string $Param3, string $Language)"
}
```

Function getMineral () has five parameters with denotation Regime – selection mode, Param1, Param2 and Param3 are selection parameters, Language – defines language version of selection. The fig. 2. illustrates the possible selection regimes. The service provides three single-variable selections (for entered hardness, crystallography and category), three two-parameter selections (hardness + crystallography, hardness + category, category + crystallography) and one three-parameter selection (hardness + crystallography + category). In the case of mineral selection (regime 1) the values of the other three parameters are not considered regardless their values. If the value of all four parameters is zero the function returns a complete selection of all main table items. Function returns all five columns from main table for one mineral or more minerals fulfilling the selection's conditions or all table lines (in the case of regime 0). If the result of selection's conditions is the empty set, this fact is indicated in all columns of returned structure by text „Empty set!". Function uses another web service as a client (SluzbaChemForm) to correct interpretation of mineral's chemical formula.

Function	Regime	Par1	Par2	Par3	
All table values	0	0	0	0	
Mineral 1	x	y	z		
Hardness	2	x	0	0	
Crystallography	3	x	0	0	
Category	4	x	0	0	
Hardness + Crystallography		5	x	y	0
Hardness + Category	6		x	y	0
Category + Crystallography		7	x	y	0
Hardness + Crystallography + Category	8		x	v	z

Fig. 2. Functions of ServiceMineral service.

Web Service WS3 (ServiceChemForm) is a service intended to chemical formulas representation [7]. The service implements a chemical formula transformation from the standard ASCII format in HTML format, which displays a number of atoms or ions valence in form of inferior or superior indexes (by elements <sup> and <sub>). The algorithmic solution of standard formula's entry transfer determines the type of the corresponding index. The service provides two functions in form:

```
array(2) {
[0]=> string(35)
"string getChemForm(string $Formula)"
[1]=> string(38)
"string getChemFormStr(string $Formula)"
}
```

Function getChemForm () has one parameter - the chemical formula. After transfer realization the function returns result to client in the standard XML form. For the result insertion in the HTML code on the client's side, it is appropriate in the PHP environment to use the standard function html_entity_decode.

Function getChemFormStr () has just one parameter - the chemical formula. It differs from foregoing function by returning result to client not in XML form, but in string form. In some cases it enables to simplify the processing on the client side.

Application structure

Application is built-up using the principles of service oriented architecture. The application structure consists of client and server side. The server part contents a group of web services which calling performs the client side through their interface files - WSDL files. The applications client side (on fig. 3. marked by the symbol of HTML) consists of two parts - static and dynamic. Static part is created by four *select* lists, using which the user formulates the criteria required for selection of one or a group of minerals. These select lists (<select> elements) are created by web service WS1 respecting the language setting. Source code illustrates figure 4. Creating of select lists is realized by submitting the language selected (button Jazyk/Language). The application dynamic part is implemented by mutual cooperation of HTML (selected criterion), JavaScript and connecting script (Proxy). Connecting script (via interface file WSDL2) links the web service WS2. The service WS2 supplies following the selected criteria required minerals' data. This entire functionality is presented on HTML page using HTML element .

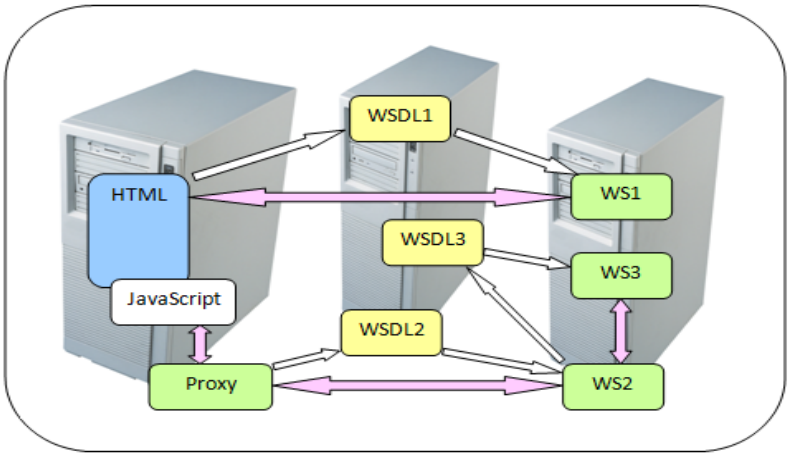

Fig. 3. The structure of service oriented application.

```
<body >
<form action="<?php echo "".$self.""; ?>?act=prevod" method="post">
<select id="lang" name="lang" onchange="process();">
<option value="2" <?php echo ($lang==2)?"selected":"";?>>english</option>
<option value="1" <?php echo ($lang==1)?"selected":"";?>>slovensky</option>
</select>
<input type="submit" name="zmena" value="Jazyk/Language" >
&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;&amp;nbsp;<b>(AJAX&amp;amp;WS)</b><br>
</form>
<?php
if ($act=="prevod"){
$head3=($lang==1)?"Výber minerálu(ov) klient":"Mineral(s) Selection Client";
print("<h3>$head3</h3>");
$pros=($lang==1)?"Zadajte prosím":"Select please";
$h=($lang==1)?"Minerál</td><td>Tvrdosť</td><td>Sústava</td><td>Trieda":
"Mineral</td><td>Hardness</td><td>Crystallography</td><td>Category";
$urlwsdl='http:// lipko.tuke.sk/~horovcak /php_ws/wsdl/select.wsdl';
$Service = new SoapClient ($urlwsdl);
print("<table><tr style=\"font-weight:bold;\"><td>$h</td></tr>");
print("<tr><td>".html_entity_decode($Service->getSelectTable("min_namese",
"idmin","minname",$lang,"param4","process();",$pros))."</td><td>".
html_entity_decode($Service->getSelectTable("min_mineralse","hardness",
"hardness","0","param1","process();",$pros))."</td><td>".
html_entity_decode($Service->getSelectTable("min_crystalse","crystal",
"crystalsystem",$lang,"param2","process();",$pros))."</td><td>".
html_entity_decode($Service->getSelectTable("min_categoryse","category",
"categoryname",$lang,"param3","process();",$pros))."</td></tr></table>");
}
?>
<div id="myDivElement">  </div>
</body>
```

Fig. 4. Source code of application client side.

Application functions

Application offers to user one select list for language choice (now two languages - Slovak and English). After language selection there are available four select lists containing mineral name and further three minerals'parameters (hardness, crystallography, and category). Selecting mineral name there will be displayed corresponding properties of the entered mineral (irrespective of the value of the other three parameters). Selecting one, two or three minerals' parameters there will be displayed characteristics of selected minerals' set. In the case that this set is empty there will be displayed text "Empty set!". View of screen applications for concrete selection parameters illustrates fig. 5.

Application design allows easy widening of possibilities of language options. Adding another language (language mutation) to the application requires several steps. On server side it is addition of three language-dependent database tables (min_namese, min_crystalse, min_categoryse) and completion of text specifying empty selection in web service WS2 (variable $emp). On client side it is completion of the language name in the language select list in HTML (additional <option> line) and corresponding texts in variables $head3, $pros and $h (fig. 4) as well as completion of JavaScript file by the output table header (variable var html for a particular language).

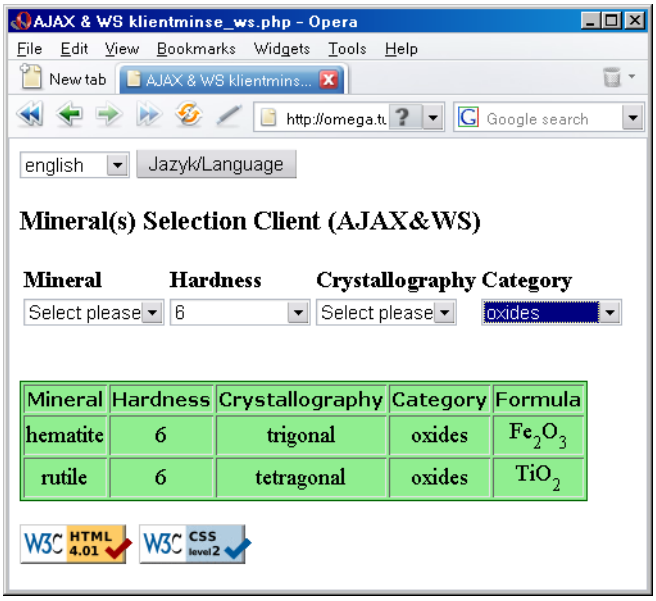

Fig. 5. Illustration of application output screen.

The application design represents a join of Ajax and web services technologies using service oriented architecture. In this way we obtain possibility to interactive work with various data resources gathered by means of web services. Such approach illustrates a possibility of SOA's practical utilization. The application structure results from interconnection of both WS and Ajax approaches.

Conclusion

Employing SOA approaches and tactics can bring a lot of benefits and rewards to a company as to application designer. These benefits fit typically into one of the following categories: standardized interfaces and data models, re-use and composability.

Service oriented architecture by means of consolidation and repeated using of application services enables enterprise infrastructure rebuilding, redundancy elimination and individual projects acceleration. It also enables simpler and more quickly to accommodate oneself to enterprise needs change as well as a faster and more effectively realization of new projects.

Integration of asynchronous communication between client and server and web services utilization brings several new possibilities into the application design, first of all various input screens of form type, as it leads to decomposition frequently complicated server applications on several simpler relative autonomous functions – services. Significant and important role have several another at the first glance invisible aspects of such approach, e.g. considerable reduction data rate transferred over the net, possible application operation acceleration resulting from reduction data rate transferred (by some results [8] till about 33 %), relative independence of „interface" WSDL files, as well as, certain modification and transformation

of standard practices [9] of web application design and development. In many cases it is possible and advisable to complement the components of web services, Ajax or their combination into the legacy (already existing) applications or projects (incremental approach). An essential advantage is also web services accessibility from various languages, development environments, as well as, operating systems.

In presented demo application for selections of minerals properties using SOA were created three web services (service for creating of web page's select list based on given database table content, service for selection of one or a group of minerals according to specified criteria from the group of database tables, and service for correct depiction of chemical formulas on web page). Application's clients side presents integration of these web services in a dynamic way by means of Ajax technology and at the same time it is a mashup demonstration which is already becoming a mainstay of Web 2.0 [10].According definition [11] a mashup is a set of services, websites or applications that combine content from multiple resources into a new integrated user experience. Web services' added value is given by its definition (WS is software system identified by unified resource identifier URI whose public interfaces and bindings are defined by XML and definition of this system can be discovered by other systems [12]), assignment and possibility of its exploitation by a number of clients or client's applications. The application use is in area of minerals' evidence, sorting and selection by chosen criterions, as well as, in area of education and instruction of SOA and Ajax practical use.

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