Technologies for integration of e-learning content

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ABSTRACT
The technological solutions for integration of e-learning content are presented. The integration concerns information resources in the global network applying the web service paradigm. Concepts for the integration of resources and tools in Web are considered. Web service integration is addressed by the application of emerging standards and technologies. Examples of programming codes for web service integration and their invocation are presented. Examples of good practice for virtual learning platforms are discussed.

General Terms
E-learning, Technologies, Integration, Internet

Keywords
Web services, E-learning, workflow technology

1. INTRODUCTION
Under the term e-learning it is noted the process of **education via Internet, network, or standalone computer**. E-learning applications and processes include Web-based learning, computer-based learning, virtual classrooms, and digital collaboration. Content is delivered via Internet, intranet/extranet, audio or video tape, satellite TV, and CD-ROM. Generally, the infrastructure of the e-learning system can be divided into a Learning Content Management System (LCMS) and a Learning Management System (LMS) [16,17,18].

E-learning encompasses content as well as educational tools and applications. The e-learning has its peculiarities, fields of applications, and covers specialised topics. E-learning is a method that makes educational content available on electronic media: CD-ROM, Internet, intranet, extranet, interactive TV, etc. content, and deserve to be treated as different domains and technologies of learning.

General problem in e-learning are the different educational standards and their interoperability on the different levels for usability and reusability. The different technological solutions, operating systems, network technologies, developing environments raise problems about the e-content creation and usability [5,20]. Thus an important problem in the e-learning content design and e-learning courses implementation is the integration of data, taken from the virtual environment [8,13].

To perform the integration two requirements have to be satisfied [4,15,21]:

- common presentation of the content;
- implementation of multi-search technology in virtual environment, which can retrieve appropriate information from different source of data.

The paper presents the standardization approaches for the development and technological solutions for integrating e-content from various sources. The integration is performed according to the deployment of appropriate technological and information solutions. Here are presented the common paradigm of integration of info services. Appropriate technological solutions are explained. The integration of info services and data is regarded as the technological background for the implementation of reusable e-learning content in virtual labs and virtual education.

2. WEB SERVICE PARADIGM
Web services are new phenomenon in the computer industry. The concept of a Web service is based on service based computing performed from different dispersed hosts in the global network. A definition of a service is given in [1]: "..a service is an active program or software component in a given environment that provides and manages access to a resource that is essential for the function of other entities in the environment". The resource could be a piece of hardware (hard disk) or software (math library). But in the global network the resource and service concern only program entities, which interact with other entities. Thus, the web service refers to a service over a computer network that resides in a specific environment. The web service as a programmable application logic is accessible using standard Internet protocols [7]. Web services combine the best aspects of component-based development and the web. Like components, web services represent functionalities that can be easily reused without knowing how the service is implemented. Unlike current component technologies (DCOM, CORBA, RMI), which are accessed via proprietary protocols, web services are accessed via ubiquitous web protocols (HTTP) using universally accepted formats (XML) [4]. Practically, Web Services have emerged as a powerful mechanism for integrating information resources. From a historical perspective, web services represent the convergence between service-oriented architecture and the Web. The service is an application that can be accessed through a programmable interface. In the past clients accessed these services using a tightly coupled, distributed computing protocol, such as DCOM, CORBA or RMI. While these protocols are effective for building applications, they limit the flexibility of the system [6].

The web services paradigm takes all the best features of the service-oriented architecture and combines it with the web. The web supports universal communication, using loosely coupled connections. The resulting technology eliminates the usual constraint of DCOM, CORBA or RMI. Thus, the web services

support web-based access, easy integration and service reusability.

3. FINDING INFORMATION IN INTERNET

The main reason in developing web services and applying them in e-learning domain is to implement automatic functionality's in data retrieval and search services. The drawbacks in finding information in web origin from [21]:

- The large and disparate volumes of available information;
- The existence of multiple but isolated source of information;
- These sources are not shared or integrated;
- There is a large variety of media formats used for the open source of information;
- The volume of data available is too overwhelming to be used appropriately;
- Now manual methods are applied for the aggregation of data, which result in lack of the "complete picture" of the retrieve information set;

This set of problems can be resolved by software solutions allowing [25]:

- Integration of data from disparate sources;
- Provision of near real-time reliable information for intelligent applications.

Hence the key stone in the automation of data retrieval system is the integration of data resources. Till now three concepts have been applied for the integration of data from disparate/distributed sources: hypertext; application of meta tags and web services.

4. THE CONCEPT OF THE HYPERTEXT

First appearance of the concept off distributed source of information and its integration is found in [2]. The "hypertext" concept is made as a common phenomenon by Tim Berners Lee in 1989 according to the World Wide Web [19].

The major effect of WWW is that it is given immediate access to huge amount of data, information and info services. The openness and wideness is the quintessence of the WWW. The WWW emerged the outputs of hypertexts from the world digital production. Hence a publishing revolution is occurred. To benefit from this revolution, several problems have to be solved.

A. The resource discovery problem. Before the users can exploit the info-services, offered by the web community, they must be aware of the existence of the service and the host on which it is available. Hence the resource discovery problem has to find the resources, qualify them, rank them and identify the resources that provide the "best fit" for the user needs. Firstly the problem has been formulated by Alan Emtage and Peter Deutsch in [10]. Before the user can effectively exploit any of the services offered by the Internet community or access any information provided by such services, the user must be aware of both the existence of the service and the hosts on which it is available. The resource discovery problem encompasses also the cases:

- If the discovery process yields pointers to several alternative resources, some means must qualify and identify the resources that provides the "best fit" for the problem;
- The problem means also that the user can assess the quality, relevance, topicality, significance and suitability of a given resource.

B. The fallacy of abundance. This is a mistake, which a searcher makes when he uses a large information retrieval system and when it has to find some useful documents. On a sufficiently large informational system as Internet almost any query will retrieve some useful documents. However, this will be a mistake to think that just because the searcher got some useful documents, the information retrieval has been performed well. The real case is that it is not known how many or at least relevant documents of the system missed.

C. Presentation problem. Most web pages that exist today are aimed at presentation for human readers only. Browsers and search engines are not in general able to distinguish advertising from scientific paper or they can't distinguish the difference between a porn site and one offering medical advice. Computers are limited to transmit and present information on the web and cannot really process it.

The well known solution for the resource discovery problem is the Internet Search Engine [22].

5. INTERNET SEARCH ENGINE

With the current size and growth of WWW human indexing of the info resources is no longer practical. Special programs, known as "robots" have been developed and implemented in the search and retrieval process. They explore the Internet and extract data about the resources it owes across. The data, extracted by the robot is stored in a data set on the search engine host computer and it is refined to make it suitable for searches. The data set is queried through a client/user interface and the results of queries are presented as an ordered set. The typical search data is captured by a robot prior, sometimes weeks before. The search is defined by two sets of expressions: one is a search expression (additive) and the other is a filter expression (subtractive). Ranking and presentation are perceived as a vital for the success of the search engine services. The search engines use the Meta tags concept, which is a part of the HTML document, to identify informational resources and services.

The Meta tags are sections of HTML pages, which describe the content of the Web pages that visitors will find. Web site owners use this resource to control their descriptions in the search engines. The Meta tags precede the opening <HTML> tag. It is the first element to be used on any page. The applicable Meta tags are:

<meta http_equiv="expires", content="24 May 2004"> - describing that the service will no longer be valid

<meta http_equiv="refresh", content="min;url=http://telenetcentre.org"> - to redirect or refresh the actual service location;

<meta name="description" content="This is an e-learning system"> – this tag will lead the user in searching for appropriate service domains.

The meta tags technology accumulates two generic functionality for the search engine and the server content.

Search engine: it provides the searches, according to the customer's parameters. A list of the Uniform Resource

Identifications (URI) of the service providers is stored. The intelligence of the Search engine is achieved by ranking of the search set. Thus the content is automatically divided by domains.

Server content: the content of the search machine is continuously updated by domains. Thus, the data is classified semantically and it can support the thematically integration of the information.

6. WEB SERVICE INTEGRATION

Now the web services are located and published in the web as program applications. The lasts are invoked across the Web from customers to integrate the application result set for the customer service. The services can perform functions ranging from simple requests to complicated business processes. Thus, the goal of the web service integration is to enable systematic application – to – application interaction on the web. The web service now is an effort also to build a distributed computing platform for the web and addresses three general questions:

- What goes "on the wire", which concern the formats and protocols, used for the web service implementation;
- What describes what goes on the wire? This answer concerns the manner of description of the web services.
- What allows the consumer to find the service description? This concerns the technology of discovering the services.

These three general pillars of the web service deployment have its development and achievements

Formats and protocols: The XML formats of data presentation is assumed as natural extension of HTML coding [9]. Due to its inner free tag definition structure, XML technology is widely applied in the Web for data presentation and data serialization. The communication and messaging between XML result sets is performed by the new protocol SOAP [18]. Now practically SOAP1.1 is a standard, applied for web service messaging [15]. The XML messaging is performed according to XML envelope, consisting Header and body, Figure 1.

```
<SOAP-ENV:Envelope
xmlns="http://schemas.xmlsoap.org/soap/envelope/">
  < SOAP-ENV:Header>
   ...
  </ SOAP-ENV:Header>
  < SOAP-ENV:Body>
   ...
  </ SOAP-ENV:Body>
...
    </ SOAP-ENV: Envelope>
```

Figure 1. The SOAP Envelope

The prerequisites for the web servicing are:

– Common language: XML messaging protocol over HTTP, named SOAP;

– Component integration, developed as CORBA, DCOM, RMI technologies.

7. WEB SERVICE DESCRIPTION LANGUAGE (WSDL)

The WSDL language rises as a standard to describe the networked web services. It origins from 9/2000 when WSDL v1.0 has been lunched. The version WSDL v.1.1 has been submitted to the standardization committee W3C on 3/2001 [32]. De facto WSDL now is an industry standard, which provides functional description of the network services, Figure 2, and applies several definitions:

– portType – for the abstract definition of the service as a set of operations;
– multiple bindings per portType for the descriptions of how to access the service and the communication peculiarities, performed under SOAP protocol;
– ports, giving inputs where to access the service.

The web service framework is defined, standardized and supported by the industry. It is widely applicable [14,15,23]. Thus, a very high level of interoperability of the web applications is achieved.

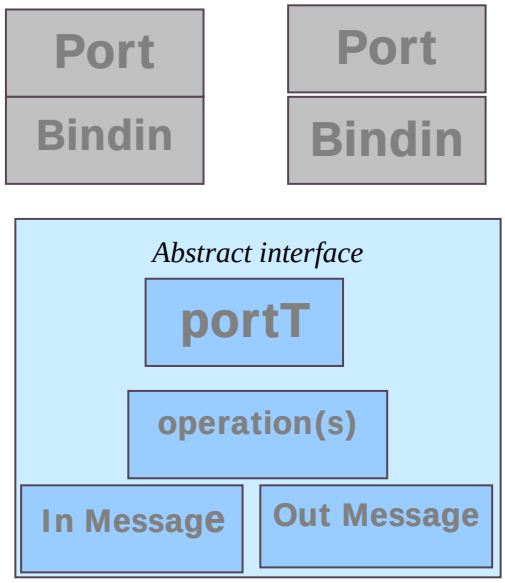

Figure 2. WSDL architecture

8. SERVICE REGISTRATION: UNIVERSAL DESCRIPTION DISCOVERY AND INTEGRATION (UDDI)

The UDDI standard is developed to design a structured public registry consisting information about the info services and their functionalities [7]. The UDDI Framework speeds the interoperability and the adaptation of the web services by establishing standard-based specifications for service description and discovery and to allow shared operation of service requests in the registry.

Thus, the architecture of the web services and service negotiations consist relations between three general players: service requester, service provider and service broker. The requestor queries the broker for appropriate service and the broker performs functionalities in identification the service as an UDDI service register. After selecting an appropriate service, the service

requestor addresses the service provider by the URI, found into the registry, Figure 3.

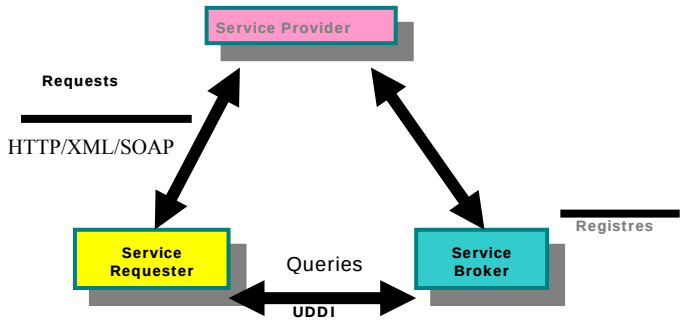

Figure 3. Negotiations between web service players

9. TECHNOLOGY IMPLEMENTATION OF WEB SERVICES

An example of the web service design is provided. It is based on php server side programming. A toolkit NUSOAP is applied, using the extension of the php interpretator, named nusoap.php. This toolkit is available for downloading from [31]. A client-server framework is implemented. For example the server provides the service of evaluating tax adding by the function taxCalc(). The negotiations between the client and server are performed by SOAP protocol [7, 25]. For example the client sends a service request to the server, asking the invocation of taxCalc() function with the value 856. The web service provider accepts the SOAP request, parses the message, prepares the incoming data and passes them to the function. Having the results from the function invocation it responds in XML format to the client.

The server responses through SOAP messages, having the evaluation of 856+7%(856) = 915,92, where 7% tax is used by the function taxCalc(),Figure 4.

```
HTTP/1.1 200 OK
Date: Mon, 12 Aug 2002 01:31:10 GMT
Server: Apache/1.3.14 (Unix)
X-Powered-By: PHP/4.0.6
Status: 200 OK
Connection: Close
Content-Length: 510
Content-Type: text/xml; charset=UTF-8
<?xml version="1.0"?>
<SOAP-ENV:Envelope SOAP-
ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"
  xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
  xmlns:si="http://soapinterop.org/xsd">
<SOAP-ENV:Body>
<taxCalcResponse>
<noname xsi:type="xsd:float">915.92</noname>
</taxCalcResponse>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

Figure 4. SOAP response of taxCalc() function

The server side code, supporting the service, is:

- Definition of the service function which returns the generated total for the purchase.
  function taxCalc ($rate=0, $sub=0){ return (($rate / 100) * $sub) + $sub; }
- The function is turn into web service by declaration
  require_once('nusoap.php');
  $server = new soap_server;
  $server->register('taxCalc');
- The service is registered into the server

$server->service($_SERVER['HTTP_RAW_POST_DATA']); exit();

- A fault generation is produced if the service falls

return new soap_fault('Client', '', 'Must supply a positive, non-zero tax rate.','');

- The client side code, invoking the web service by call to the nusoap.php library is

Require_once 'nusoap.php'

- Building a parameter list **$param = array('rate'=>$_GET ['rate'],'sub'=>$_GET['sub']);**

$client = new soapclient('http://www.whytewolf.ca/ws/taxCalc.php');

- Invokation of the service

$response = $client->call('taxCalc', $param);

- If fault has occurred, fault property will be set

```
if($client->fault){
   echo "FAULT:  <p>Code: {$client->faultcode} <br />";
   echo "String: {$client->faultstring} </p>";                    }
```

This implementation of the web service paradigm is quite simple. It illustrates that only few program codes can support the web service integration and web operability.

10. GRID ARCHITECTURE: THE TECHNOLOGICAL ENVIRONMENT FOR VIRTUAL E-LEARNING DESIGN

Grid computing is a form of distributed computing in which the use of disparate resources such as compute nodes, storage, applications and data, often spread across different physical locations and administrative domains, is optimized through virtualization and collective management [24]. Grids are often classified as either *compute* grids, which emphasize the shared use of computational resources, or *data* grids, which support federation, integration and mining of data resources. These distinctions mostly dictate the type of hardware infrastructure needed to support the grid—for example nodes on a data grid may need to provide high-bandwidth network access, while a grid whose primary use is for long-running parallel applications is more in need of high-performance computational nodes.

GRID computing can be considered as a method for integrating a variety of systems connected together in the large network. The main advantage of GRID is that it can aggregate the computing power of computers distributed over many institutions at different cities or countries.

Web services allow GRIDs to be specified as services that can interoperate with each other. Wide range of GRID services, particularly those focused on information services (queries) and on control can be developed as Web services.

The Web services paradigm takes all the best features of the Service-Oriented Architecture (SOA) and combines it with the Web. The Web supports universal communication, using loosely coupled connections. The resulting technology eliminates the usual constraint of DCOM, CORBA or RMI. Thus the Web services support web-based access, easy integration and service reusability.

11. EXAMPLES OF E-LEARNING LABS

Biology Labs On-Line - [27,30]. Biology Labs On-Line (BLOL) offers a series of interactive, inquiry-based biology simulations and exercises designed for college and AP high school students. These labs allow students to conduct virtual experiments that would not be feasible in a school wet lab due to cost, time-constraints, or safety concerns. Designed to reinforce scientific methodology, the labs let students focus on their experimental design and the science behind the experiments. Appropriate for introductory biology, genetics, cell biology, and ecology, BLOL activities are web-based and easily accessible. The labs are vertically scalable, modular and self-contained.

Web based teleoperated Virtual Laboratories (Web Labs) - Figure 5, [27]. It primarily consists of two different parts. The client computer runs a web browser only, which opens a web page loaded from the server. On the front end is incorporated a user friendly, high-level block diagrammatic, web interface which can be accessed at any internet enabled computer with a supported browser which gives user access to simulation, testing and refinement of the experiment systems with a virtual model. The remote user also views the virtual representation (the avatar) of the experiment in her/his VRML browser window.

The server runs the interface scripts, which communicate with MATLAB and which in turn generate the VRML (MATLAB's Virtual Reality Toolbox) world.

For designing of such an environment, following aspects were considered from the user point of view:

- On the client's side which is the user with a web browser, only standard software independent of the operating system is necessary to use Web Labs.
- The web pages are standard html only with Java components and VRML plug in for the interactive features. Via these web pages, complex simulations with remote access to simulation software on our servers can be undertaken.

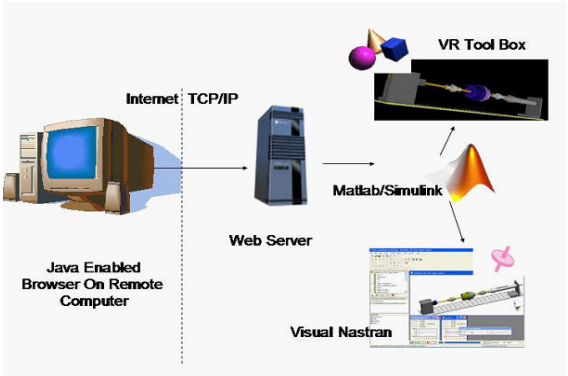

Figure 5. Teleoperated Web Lab

Virtual Chemistry Laboratory, Chemistry Department, University of Oxford [28]. The ASTER Project has produced a set of resources to assist staff who want to introduce or develop the use of C&IT to support and enhance their small-group teaching. The following resources are available:

- **Case** studies - examples of the use of C&IT to support small-group teaching.
- **Online** bibliography - information on articles describing the use of C&IT.
- **Reflective Tools** - questionnaires for you to work through individually or with colleagues, to help you in identifying those areas of teaching and learning that you wish to enhance, and to consider the impact of any changes to you and your students.
- **Publications** - more information on C&IT use and current practice.
- **"Ask ASTER"** - questions on C&IT use in small-group teaching answered.

All the resources are freely available from the Resources page of the ASTER web site [29] .

A list with good practices in deployment of e-learning systems and tools are available at:

- Universitat Konstanz, Advanaced Virtual Laboratory
- John Hopkins University, Virtual laboratory
- Universitat Bochum, Virtual Control Lab;
- University of Oregon, Physics applets
- Carnegie Mellon Universitat, Virtual Chemistry Laboratory
- MGTU"Baumann", Automatic Virtual Distance Practicum
- TU –Sofia,Virtual Laboratory for Measurement
- TU –Rousse, Virtual Platform for e-learning ELSE [11,12].

11. CONCLUSIONS

The concept of web service is powerful for the integration of e-learning content. It develops an open space of info services in the global network. Thus, integration of informational resources is achieved. The most important achievement is the automation of many info services and data retrievals by searches, performed in independent way from human interaction. The technology stack for such kind of automation in global web systems is quite restricted: SOAP communications and XML data presentation; WSDL description of the web services; UDDI for the repositories definition and implementation.

The concept of GRID computing provides the ideal framework for developing virtual collaborative e-learning environments. Web services allow GRIDs to be specified as integrated services that can interoperate with each other. Thus, variety information resources are put together into a virtual supercomputing system.

Web services and a service-oriented style of architecture are widely seen as a basis for a new generation of distributed e-learning applications and e-learning system management. The paper performs an overview of available technological solutions, which can be applied in the development and the deployment of e-learning facilities, systems and virtual laboratories. The technological solutions are based on Web service paradigm, Grid computing and the implementation of standards. Few examples of good practice and e-learning applications are discussed.

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