Web Services Enabling Technology
for
Application Integration and Assembly

Commissioned By:

Higher Education Knowledge And Technology Exchange

HEKATE

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I. Introduction

The term "Web Services" is relatively easy to define, but the potential implications concerning Web Services are complex, particularly when applied to higher education.

Web Services are enabling technologies that facilitate the assembly and integration of applications in order to create new, more meaningful and/or more user-specific applications, all at the speed of the Internet. The creation of Web Services occurs within the computing back-end, unbeknownst to the human who happens to be looking at Web-Services-enabled applications on any number of electronic devices/clients.

Web Services have been gaining ground quite rapidly in the corporate world and are already well established in the supply-chain-economics business sectors.

Web Services are only just beginning to take shape in the higher education computing environment. The Higher Education Knowledge and Technology Exchange (HEKATE) sees Web Services as an extremely important key to the future of campus computing on numerous fronts, with enormous implications to enhance teaching, learning and research. Additionally, Web Services are expected to have profound and positive effects on the implementation of enterprise resource planning (ERP) initiatives at colleges and universities.

Nonetheless, before the use of Web Services becomes *de rigueur* of campus computing, at least four extremely important drivers need to be accelerated. First is the technical architecture that will drive Web Services needs to be properly defined and communicated throughout higher education. Second is the whole computing standards movement must reach its promise of effectively facilitating interoperability, reusability and discoverability of applications between disparate systems. Third, in order for the concept of Web Services to reach its fullest potential, a number of security concerns related to network identity management must be solved. Fourth, higher education has to see the value of Web Services and provide the support and funds to further develop this new technology.

This article attempts to broadly define the primary issues and visions for the future of higher education that surround Web Services.

II. Terminology, Standards and Tools

Web Services Defined

Like all computer technology, Web Services come with a can of alphabet soup. The lingo here is primarily XML (Extensible Markup Language), SOAP (Simple Object Access Protocol), WSDL (Web Services Description Language) and UDDI (Universal Description, Discovery and Integration). As noted at Webopedia.com, "XML is used to tag data; SOAP is used to transfer data; WSDL is

The HEKATE Web Services Manifesto

In order to enable customer satisfaction, develop integrated software services, and create value by leveraging existing investments, HEKATE's goals for 2003-05 with respect to Web Services are to ensure that:

1) By the year 2005 most software designed for the higher education space will be compliant with the evolving standards associated with Web Services

2) A range of community source tools and interfaces will be developed for broad adoption in the higher education space upon which proprietary as well as open source solutions will be built.

3) The HEKATE international exchange of vendors and university-based technologists will map a common UDDI schema representing the best thinking of the interrelated work flows and relationships within the University space.

4) HEKATE will seek to create a technical advisory group of major universities to support design specifications and detailed planning for implementation of items 1-3.

5) HEKATE will also support a joint university-industry technical advisory group to accomplish the goals set out in items 1-3

6) HEKATE will collaborate with standards initiatives such as IMS and SCORM with the intent of harmonizing and creating consensus around standards for Web Services.

7) HEKATE will support a joint industry/higher education testing and evaluation lab to support both the assessment of product compatibility and issuing reports to enable valuable integration of Web Services into the higher education space.

8) HEKATE will provide a series of semi-annual updates on the progress of web services in higher education and serve as the major dissemination effort.

9) HEKATE will support sponsored research in the area of Web Services and higher education with financial and technical commitments in the form of grants and collaborative research.

10) HEKATE will seek and consolidate sources of funding to support the activities outlined above.

used for describing the services available; and UDDI is used for listing what services are available."[1]

Basically, in order for Web Services to work, programmers and developers must XML tag existing or soon-to-be-created applications using SOAP definitions. Additionally, the XML-tagged application should have a descriptor created in WSDL that explains the application's capabilities. Finally, depending on the circumstances surrounding the creation of a Web Service, these XML-tagged applications can be listed in a directory, which is the UDDI, also commonly referred to as the electronic yellow pages for Web Services. The WSDL format also enables a UDDI to understand and accept these XML-tagged applications, analogous to the process of placing an ad in the yellow pages.

Toolkits and Interoperability

All of the large software producers, including Microsoft, Sun Microsystems, IBM, BEA and Oracle[2], are developing tools that help to make the process of building Web Services easy; and despite their competitive differences, they are attempting to create a compatible enterprise through a newly formed group called the Web Services Interoperability Organization[3].

As with most programming and developer endeavors, WC3 is the primary organization driving Web Services-related standards and specifications.[4] Microsoft's Global XML Services Architecture (GXA) is also pushing specifications and standards related to the advancement of Web Services.[5]

"Web Services are probably the most important technological step forward since the advent of the Web," says eCollege Chief Technology Officer Mark Resmer. "This is a disruptive technology that is starting to have a real impact on the software industry. It's high time for academia to recognize that this is going on and to understand how to take advantage of it. In particular, Web Services provide for a 'Third Way' of software deployment - combining the best aspects of traditionally licensed software and Application Service Providers (ASPs). In this hybrid model, institutions will be able to assemble customized applications by combining locally hosted software with Web Services provided by companies with a history of hosting ASP services, such as eCollege."

Resmer adds that the introduction of software toolkits available in the standard enterprise-level programming environments makes it relatively easy to create Web Services-enabled applications designed to look for,

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> *Source: Webopedia.com*

understand, consume and interact with other exposed Web Services. In short, to develop such processes involves building in interfaces that know how to generate, receive and parse SOAP-encapsulated XML messages for communicating with each other, using WSDL and UDDI in this process.

The idea is that a Web Service can be written once and accessed across Microsoft, Sun, Linux and other environments, says Fred Benz, founder and principal architect and designer of Context Interactive, an online learning technology and design company. "The promise of Web Services is that it would be interoperable across platforms; it would be reusable because it is sort of broken out. From the standpoint of the developer, it is a more leveraged model for creating applications and services for the Internet because you only have to theoretically create it once and it will work across different platforms."

Today's dialogue concerning the next level of information technology's development, in general, could be changing, Benz adds. Some Chief Information Officers might be moving their focus away from the challenge of understanding which server solution is best for their particular needs, to which is the better development environment to create web-based application services. Proof of this theory may be related to Microsoft's strong push to develop and market its new ".NET Platform" for higher education.

Microsoft's .NET Platform

"The major programming environments are building in native support for Web Services, and you simply need to avail yourself of that native support," says Resmer, adding that "the most well-known toolkit is Microsoft's Visual Studio.NET, which is the leading tool in the marketplace at this point. The eCollege software is almost entirely based on the Microsoft platform already, which makes it very easy for us to include Web Services support in the future."

Blackboard's Senior Vice President of Research and Development Daniel Cane adds that Blackboard's next generation of its Building Blocks Program, which is currently built on a JAVA-based Application Program Interface (API) and uses C#, will also be built on the Microsoft .NET platform. "C# makes it very easy for us to write Web Services," says Cane, adding that "in .NET it is as simple as saying this API is a public Web Service, and it takes care of it for you."

III. The eLearning Vision

The possibility for pervasive creation and use of Web Services among colleges and universities will be a significant catalyst for effectively adding value to an institution's assets. This asset-building process is already taking its first steps inside higher education eLearning environments.

Web Services-Enabled Content Repositories

"That a piece of software can go out and discover what learning resources are available today, find them, retrieve them and then integrate them back into a course - and the person using this never had to do anything - is a very powerful notion," says Resmer. This is the basic proposition driving Web Services in the field of eLearning; it holds an as-yet-to-be-fulfilled promise to greatly enhance teaching, learning and research like never before in the history of education.

For instance, one can imagine a plenitude of standardized Web Services wrapped around XML-tagged, subject-oriented repositories of teaching and learning materials that can be mixed, matched and reinvented dynamically over a Web Services-enabled conduit to ultimately enhance and individualize the eLearning experience. Additionally, the creation of new Web Services can help education providers better manage web-based teaching and learning administrative functions, such as student grading and assessment procedures.

WebCT's Executive Vice President Peter Segall sees how Web Services can benefit eLearning, but he also believes it will take a fair amount of time and effort before the creation of standardized Web Services-enabled content repositories becomes a reality. "What I see today is the first few footsteps toward an integrated environment for students," says Segall. "Web Services is the trend; it is the direction." However, the software standards related to interoperability are "moving targets . . . every six months you get an iterative and evolving picture."

Nonetheless, Segall, and WebCT's two major competitors, eCollege and Blackboard, see a possible future where students and faculty are given the ability to seamlessly and dynamically access the best of the best course materials through their learning management systems (LMS). Segall adds that such course materials may come from Web Services-enabled collaborations between student-learning-centric higher education institutions and developers of external XML-tagged repositories of learning objects and courses from both the private and public sectors, such as Merlot, or the Smithsonian Institute, or any number of companies who happen to build or list online learning materials and courses.

Resmer explains that Web Services make the most sense when the technology provides access to a diverse range of content repositories, to specialized resources provided by major universities, and to services than can be shared between institutions - for example, individual campuses in a university system.

MIT's iCampus

Resmer's reference to accessible content from major universities would have to include MIT, a leader in the development of Web Services to enhance teaching, learning and research. A substantial amount of research and development related to Web Services is happening through MIT's iCampus initiative, a five-year, $25 million research alliance officially launched in October 1999 between MIT and Microsoft Research to enhance education through information technology.[6]

From an initial push that technologically enhanced MIT computer science and engineering courses by incorporating online lectures and automatic homework checking, the iCampus project has quickly changed direction to include "new projects with more of a Web Services flavor to them," says David Mitchell, Microsoft's iCampus program manager.

Much of the iCampus project is being built as a .NET Platform service using C#, adds Randy Hinrichs, group research manager, Learning Science and Technology, Microsoft Research's University Relations

"MIT is asking what happens when you have an infrastructure; you made it wireless; you got federated data services all over the place and access to interesting technologies and data - how do you build collaboration on top of all that?" asks Hinrichs. "How do you build experiences that enable you to bring MIT to the user?"

iCampus Framework Project and Freshmen Essays

One research investigation that may help answer such questions is the iCampus Framework Project, which is under the guidance of Mitchell and well-known MIT Professor of Computer Science and Engineering Hal Abelson[7]. As noted on the iCampus website, the Framework Project "is implementing a collection of Web Services that illustrate the benefits of service architectures for educational computing infrastructure. These benefits include the ability to modularize implementations of educational computing applications to create reusable components and to enable component and resources sharing within the university and across institutions."

Part of the Framework Project supports another iCampus project called Online Essay Evaluation[8], whereby a web-based service currently being utilized this summer administers online essay exams to incoming freshmen from five campuses (MIT, CalTech, University of Cincinnati, LSU and DePaul) and then builds a database of these essays that can be evaluated and assessed by the participating institutions.

Hinrichs and Mitchell explain that students from the five campuses (estimated to grow to ten by 2003 and 30 by 2004) are given the option to include or not to include their writing in the database of essays. The essays that are

opted in are not identified by a student's name, but rather by demographic information related to each student. The actual essay assignment closely matches a true college-level writing assignment, whereby the student must comb through approximately six hours of reading material and then answer one of five essay questions about the readings. Students are given enough time to plan and rewrite their essays before submitting them online. The essays are then graded and put into a ranking system. Individualized feedback is snail mailed to each student.

The Web Services elements of this project come into play in a number of ways. First, all of the participating schools have access to the testing application's functions that are run off of one server at MIT. However, each institution can do its own form of online grading and is able to incorporate its own customized look and feel to the testing interface. Second, those essays that have been opted into the database and housed on the same MIT server are now available to the participating institutions to study.

"Can you imagine as a linguistic researcher if you had a database of 100,000 essays written by people from all over the country and you had demographics and tracking related to their education?" asks Mitchell.

The process of collecting and sharing these essays among institutions that have formed a kind of compact with each other can be referred to as a "federated" data system. In this particular example, such data has the potential of determining what really is the quality of a well-composed college freshman essay from across the United States, adds Hinrichs.

"These are the kinds of emerging Web Services that are bringing schools together," Hinrichs continues. "Hal Abelson calls them commons of the mind. I think it is a good term. So you are now able to look into peoples' work at other universities and share those opportunities for enriching the learner's experience."

IV. Larger Implications

Federated Data and the Elimination of Friction
This notion of sharing federated data relates to the larger issues concerning Web Services technology and implementation on a much broader scale in higher education.

For instance, SCT General Manager, Exeter Solutions, Rob Curtin has a big-picture view that begins with the basic premise that the emerging world of Web Services will be

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the catalyst for "a simpler, easier-defined and more globally inclusive model for bringing together information trading partners." From this standpoint, Curtin sees the application commingling of campus computing environments with disparate systems that can also be considered information trading partners. Some of these partners include the Department of Education's National Student Loan Data System, the College Board's student testing services, Sallie Mae, admissions processing services companies like NCS Pearson, enrollment management services companies like Noel-Levitz, e-commerce systems, other institutions or consortia who may have formed articulation agreements, and many more.

Curtin explains that the manner in which these trading partners exchange information today "is exactly the same as it was 30 years ago despite all the advances made in technology. It's pretty much the same way it was when the mainframe came out and said I will spit you a comma-separated or ASCII file and you will take it, and the automated exchange of information was in the very slow processing of flat files. That has a great deal of cost and time delay associated with it, and it has a great deal of service degradation as well as data degradation along the way."

All this results in what many computer technologists call "friction," meaning a loss of control and slow, error-prone processing. Eliminating friction equals time savings and the facilitation of less degraded data, which in the long haul means cost savings.

Managing the Flow of Information and Applications
However, the process of possibly eliminating friction through the implementation of sophisticated Web Services that can seamlessly and quickly integrate applications and data with Internet speed, and with less degradation, has its challenges. One revolves around moving and exposing data that does not fall under the category of public information and/or is tied to intellectual property rights. Web Services-enabling private data easily brings forth security issues and legalities concerning whether or not global, or even federalized, exchanges of Web Services applications are viable.

"The issue is in network identity management," says Shirish Netke, Sun Microsystems strategic sales director. "Network identity is a very important problem to solve if

Web Services are going to be successful. The reasons why we are doing Web Services is so you can make an application available anywhere in the world, and that part is fine. However, how do you authenticate the person who wants that application? Secondly, how do you authenticate the application itself?"

Netke points to the newly formed Liberty Alliance Project, of which Sun is a member, along with companies such as American Express, AOL Time Warner and United Airlines, as a growing community that is dedicated to helping to develop network identity solutions[9]. As noted on its website, "the vision of the Liberty Alliance is to enable a networked world in which individuals and businesses can more easily conduct transactions while protecting the privacy and security of vital identity information."

Also, Sun Microsystems recently joined Microsoft and IBM in developing what's known as the WS-Security Web Services specification to help organizations build secure, broadly interoperable Web Services applications.

V. Conclusion

Financial Issues

Any change in the campus computing environment typically requires new human resource allocations, new learning curves, new software and, of course, more money to implement.

"The technology guys will tell you it is all about code," says Casey Green, founder/director of The Campus Computing Project. Green believes in the promise of Web Services from a technology point of view but explains that from a campus computing historical perspective, the bottom line is money. Green claims that there's growing evidence of institutions slowing down their allocation of funds for technology projects. The slow down, he says, is partly due to a recession and state cut backs, which could result in the growth and development of Web Services taking a back seat to other higher education priorities.

Green adds that while the focus at many campuses is on the implementation of Enterprise Resource Planning, updating existing databases, and updating and licensing new software - all of which play nicely with Web Services enabling - he sees what he calls an "ERP interruptus" occurring in the immediate future.

So, the issue of how this relatively new technology can save higher education dollars is perhaps what computer technologists need to emphasize much more forcefully, over and above all the great technological potential of Web Services.

"This is the piece that has been kept quiet," says Curtin. "How do you make money? It all sounds exciting and good, but unless we are saving substantial dollars . . .," he trails off.

As Peter Segall says when referring to Web Services, in

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> **- Lev Gonick, Case Western Reserve University and HEKATE**

general, "all the bridges between these various applications are not even built yet. It's almost like you are building the pylons for two ends of a bridge, and some day they will meet in the middle. And it is a multidimensional bridge with many different pieces hoping to connect."

To help put the potential of Web Services into perspective, CIO and Vice President for Information Technology Services at Case Western Reserve University, Lev Gonick, who is also President of HEKATE, says "the key to making money is saving money for the campus. Will we need to continue to invest at the same level in our ERP suite upgrades? Will interoperability and integration between our campus portals and course management systems no longer require the $100,000 plus standard price tag for customized code work? Will our calendaring products talk to our email systems on our handhelds as well as our notebooks? These are all part of the promise. As a campus officer, my job is to analyze and rationalize the allocation of scarce resources. Web Services is the best bet going to that end."

About the Author:
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Notes:

[1] Visit **http://www.webopedia.com** and type "Web Services" inside the search function.

[2] For information about Microsoft's Visual Studio .NET, visit **http://msdn.microsoft.com/vstudio/default.asp**

For information about Sun Microsystem's Java Web Services Developer Pack, visit **http://java.sun.com/webservices/downloads/webservicespack.html**

For information about IBM's Alphaworks, visit **http://www.alphaworks.ibm.com/**

For information about BEA's Web Services support, visit **http://www.bea.com/products/webservices/index.shtml**

For information about Oracle's Web Services support, visit **http://otn.oracle.com/tech/webservices/content.html**

[3] For more information about the Web Services Interoperability Organization, visit **http://www.ws-i.org/**

[4] For information about WC3's "Web Services Activity," visit **http://www.w3.org/2002/ws/**

[5] For information about GXA, visit **http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dngxa/html/gloxmlws500.asp**

[6] For information about iCampus, visit **http://swissnet.ai.mit.edu/projects/i-campus/**

[7] For information about the iCampus Framework Project, visit **http://www.swiss.ai.mit.edu/projects/icampus/projects/framework.html**

[8] For information about the iCampus Online Essay Evaluation Project, visit **http://www.swiss.ai.mit.edu/projects/icampus/projects/framework.html**

[9] For information about the Liberty Alliance Project, visit **http://www.projectliberty.org/**

About HEKATE:

The Higher Education Knowledge and Technology Exchange (HEKATE) is a not-for-profit 501(c)(3) international exchange shaping the next generation of products and services for 21st century learners. Higher education is engaged in finding solutions that meet the rapidly changing needs of 21st century learners. Vendors are anxious to understand education's unique requirements. Closing the gap between needs and technology requires collaboration between leaders in higher education and providers of technology based solutions. HEKATE offers the opportunity to bridge this gap.

http://www.hekate.org

About SCT:

SCT, the global e-education solutions leader with over 34 years of native higher education experience, is the only company to offer higher education a choice in both technology and products that best fit the unique needs of institutions of any size and complexity. The company provides end-to-end solutions that include applications, technology, and services that support higher education's administration of teaching and learning. SCT works collaboratively with clients and partners to provide the e-education framework that enables institutions to serve 21st-century learners. SCT has more than 1,300 higher education clients worldwide, representing more than 8 million learners. SCT also provides leading technology and business solutions for utilities. SCT's global headquarters is located in Malvern, PA and the company has several offices around the world.

http:///www.sct.com