Web Services and Next Generation Workforce *

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Abstract: Over the course of the past 15 years there has been an increasing trend towards the provision of service based functionality by Information Systems (IS). This has been due to a number of driving forces, however the main impetus of this tendency has been the development and implementation of Web Services technology. Web Services offer a solution to deliver a dynamic, task-driven computing environment and shared business processes, while also reducing costs. Web Services have overturned many traditional assumptions about Information Systems. They have enabled innovation and afforded a degree of flexibility not available previously from an Information System. This paper will give a brief overview of Web Services and corresponding technologies. It will then examine the required skills of graduates and identify the roles where these proficiencies will be required. Finally, it will propose that the flexibility afforded by the use of Web Services must be emulated in the teaching of Web Services.

Key words: Web service; workforce training; software teaching
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1 Introduction

WEB Services are a set of innovative and continually emerging technologies which have significantly expanded the role of automated communication and data sharing between software applications on remote computers. Web Services achieves this by integrating a system of distributed computing with the existing infrastructure of the internet[1].

For the purposes of this paper, Web Services are described within the context of a Service Orientated Architecture (SOA), where Web Services technologies are utilised. SOA is a conceptual style of achieving a 'loosely coupled' or flexible Information System architecture. It involves merging a service provider and a service consumer to achieve an end-goal. SOA reorganises Information Systems as independent and reusable services that can create a flexible IS environment by offering these services over the Internet[2].

Web Services are now a ubiquitous technology and therefore the technology is currently spanning across all sections of industry. Major vendors such as Microsoft, Sun Microsystems, IBM, HP and IBM are all promoting Web Services by developing technologies and also by incorporating support for existing Web Services technologies into their current platforms. Indeed Web Services are so widely available that organisations are currently using them without actually realising it. "Web services that are externally available are increasingly common and attractive, and enterprises will explore them, almost without knowing it, at a global level. By year-end 2007, 25 percent of the Global 2000 will employ an external Web service in a strategic application"[3].

To successfully implement an SOA utilising Web Services requires a number of different skills and proficiencies. Educational institutions have always been required to provide students with marketable skills, however as Web Services and SOA continue to progress, employment patterns have changed[4]. Within Web Services, there is overlap of skills required and no clearly determinable or complete segregation of duties. This development has created an opportunity for the educational sector to provide graduates with a varied skill-set required for these roles. It also offers an opportunity for students to fulfil these roles required by industry.

Section 2 of this paper gives an overview of Web Services technologies and current developments in the area. Section 3 describes the skills and roles required to implement and utilise Web Services. Section 4 of the paper proposes an approach to teaching Web Services in order for students to attain the required skill-set to fulfil Web Services roles. Section 5 presents conclusions.

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2 WEB Services

2.1 Technology overview

The World Wide Web Consortium (W3C) is a grouping of organizations which defines Web Services standards. Encompassed within the W3C, the Web Services Architecture Working Group defines a Web Service as "... a software system designed to support interoperable machine-to-machine interaction over a network... systems interact with the Web Service in a manner prescribed by its description using SOAP-messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards."[5].

One of the most distinguishing features of Web Services is that they allow programs rather than humans to exchange information and commands in the form of eXtensible Markup Language (XML) messages. Web Services allow people to do things differently and it is within this context that Web Services have become important as well as continuing to be a key technology for the future. It is important to recognise that the use of information systems alone does not derive benefits, benefits flow from how information systems are actually utilised to benefit an organisation[7].

To fully understand the benefits offered by Web Services, it is beneficial to examine the underlying protocols and standards which Web Services rely on to communicate. These are typically set and maintained by independent, not-for-profit organisations composed of a diverse membership.

The underlying protocols and standards are① eXtensible Markup Language, ② Web Services Description Language, ③ Simple Object Access Protocol and ④ Universal Description, Discovery and Integration.

(1) eXtensible Mark-up Language. Web Services can communicate because they all speak the same language, called eXtensible Mark-up Language (XML). XML provides a standard way to describe information sent between two separate systems[8-9].

(2) Web Services Description Language. WSDL is an XML document that defines both the inputs and outputs of a Web Service, describes what functionality a Web Service offers and acts as an interface for other applications[5, 10].

(3) Simple Object Access Protocol. SOAP is an XML based protocol and it offers a simple and light weight mechanism for creating structured data packages to be sent between network applications[10-11].

(4) Universal Description, Discovery and Integration. The UDDI specification creates a common place for storing and accessing information like what services are available, what their interfaces look like and where they can be found[12].

Figure 1 shows a graphical representation of a typical Web Services deployment. It shows the interaction between client, server, interfaces and a directory. All of these interactions require protocols or rules to exist. Web Services now incorporates much more that the basic setup as displayed in Figure 1. Terms like 'Web 2.0' and 'Mashups' can be incorporated into the domain of Web Services technologies and paradigms. Web 2.0 refers to a perception of a next-generation utilisation of the Web as a platform by developers and end-users and not a change in the technical specification of the World Wide Web[13]. A further development of the Web 2.0 concept is the idea of mashups, which is the development of an application or service by combining two or more distinct Web Services into a hybrid application[14]. One of the most well known mashups

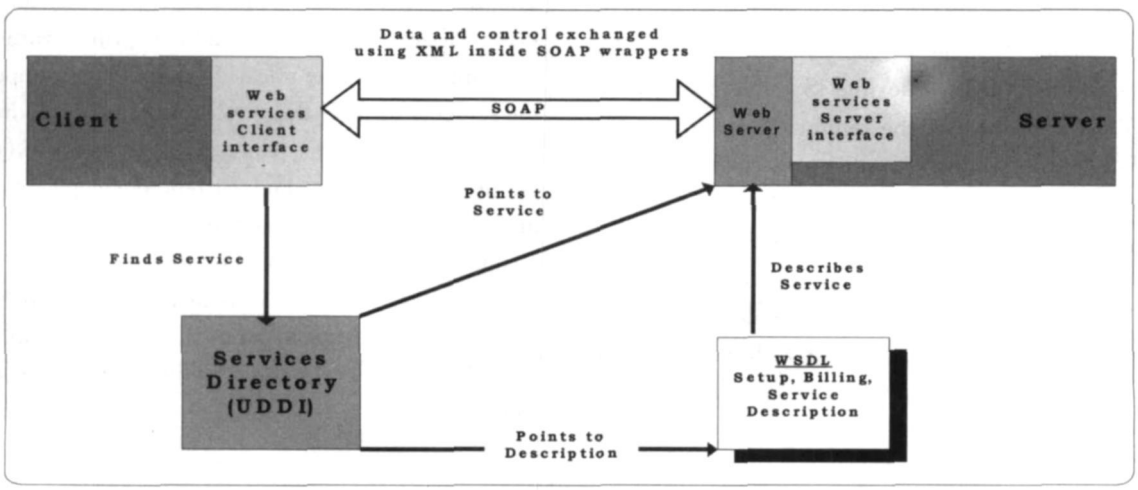

Fig. 1 Web Services Setup, Adapted[6]

can be observed when accessing Google Maps where ‘layers’ of data from separate sources are displayed within the mapping of an area, as requested by the user[15].

2.2 Roles and Skills

The successful implementation of an SOA utilising Web Services technologies requires employees with a diverse skill-set to undertake various positions. The labelling of the technology as ‘Web Services’ offers a flawed description of what exactly Web Services technology involves. Despite having the term ‘Web’, the technology does not implicitly require any web pages to be designed or displayed[16], however most common user Web Services entail information to be accessed or displayed on the Web, these are referred to as ‘Consumer Mashups’[14, 17]. ‘Enterprise Mashups’ are generated at a ‘back-end’ level focusing on functionality and data presentation, proving an organisation with an end-product suitable for its business requirements[14, 18].

While positions such as Web Services Architect, Web Services Developer and Web Services System Management are identifiable[19], the skills required for these positions are increasingly overlapping. The evolution from a traditional structured based ‘job’ to a more innovative, unstructured ‘role’ has been more prevalent with the increased use of Web Services and SOA.

The nature and flexibility of Web Services expands the effect of boundary shifting and a certain amount of distortion of employee roles[20]. Therefore it is even more essential to clearly identify the set of skills that are required to devise, create and manage an SOA which utilises Web Services technologies.

Table 1 displays the positions of Web Services Architect, Web Services Developer and Web Services System Management and the corresponding roles required for each position. It also lists skills that are related to two specific development environments, namely IBM's WebSphere and Microsoft's .Net platform. It can be inferred from Table 1 that the skills required for each role identified can and do overlap. The core technologies of XML, SOAP, WSDL and UDDI are easily identifiable as required across all position. Other skills such as ASP.Net, J2EE and related technologies are also required across two of the identified positions. For skills such as UML, OO Programming and WS-Security these are required only in a limited context for the positions identified.

Table 1 is limited to roles and skills for two development environments, many other development platforms exist which require differing technologies such as BEA WebLogic and Novell's exteNd5. This is not an extensive list of the various technologies and skills that are available for each of the two stated development environments. The skills list can be expanded further to include continuingly developing technologies relating to business processes and management. This has an affect on the skill-set required for each role or position involved in Web Services design, implementation or management. Research has stated that “By 2015, more than 60% of jobs will be unique to a company. That is, fluid, customised and without comparison.”[20], and this statement is reflected by the proliferation of required skill-set for Web Services.

Web Services as a technology is driving ‘boundary-spanning’ roles in the employment market. A key finding by a Gartner Research report suggests that “Boundary-spanning roles will become pivotal... the roles themselves defy traditional job assumptions and demand new approaches”[20]. There are a number of

Tab. 1　Web Services Roles and Skills, Adapted[19]

	WS Architect	WS Developer	WS Systems Management
Roles	Architecture Design	OO Programming	Application Server Administration
	Environment Selection	Java Development	Web Services Administration
	Application Server Design	Web Application Development	Application Security
	Security Design	Enterprise Application Development	Packaging and Deployment
	OO Analysis and Design		
Skills	UML	Web Servlets / JSP	WebSphere
	Web Servlets / JSP	ASP.net pages	.net
	ASP.net pages	J2EE / EJB	WS-Security
	J2EE / EJB	.netManaged Components	WSDL
	.netManaged Components	ADO.net	UDDI
	JDBC	SOAP	XML
	XML	XML	SOAP
	SOAP	UDDI	
	WSDL	WSDL	

implications for the Education Sector arising from this notably the requirement to provide graduates with the varied skill-set required to fill these ‘boundary-spanning’ roles and this will be discussed further in Section 4.

2.3 Education Requirements

One of an educator’s primary responsibilities is to teach students principals that will outlast any specific technology and this principal must be incorporated into the teaching of Web Services[21]. This must be balanced however, against the requirement to develop graduates with marketable skill-set to fill boundary spanning roles in the area of Web Services and this is crucial for 3rd level institutions.

Due to rapidly emerging standards, traditional teaching methods are struggling to keep up-to-date with developments with regard to Web Services. One example being paper based textbooks becoming outdated almost immediately after publication[16]. The proliferation of roles and skills involved with Web Services provides another difficulty encountered by educators, namely the various competing platforms available to develop Web Services, each platform requiring different skills and support tools to teach[22]. One on the most common issues faced by educators it that of how to fit problems of sufficient complexity into a single college educational program in order to provide industry with desirable graduates. Table 1 displays the skills required for two development environments, this illustrates the extensive choice and therefore complexity available in relation to Web Services. Finally, there are a number of implications for Educational institutions regarding the shift from a traditional ‘job’ based position to a ‘role’ based position, as discussed in Section 3 of this paper.

We propose the Web Services Next Generation Workforce (WS-NGW) which will require graduates with a varied skill-set and real world experience with a high degree of complexity involved. We contend that a hybrid of online teaching methods and real world project teams can provide graduates with the required skill-set, knowledge and experience to satisfy the requirements of the WS-NGW.

Figure 2 graphically represents how skills and roles, real world experience and a degree of complexity are all contributing factors to the WS-NGW. By combining online teaching and real world project teams, educators can offer students the structure to achieve all of these requirements.

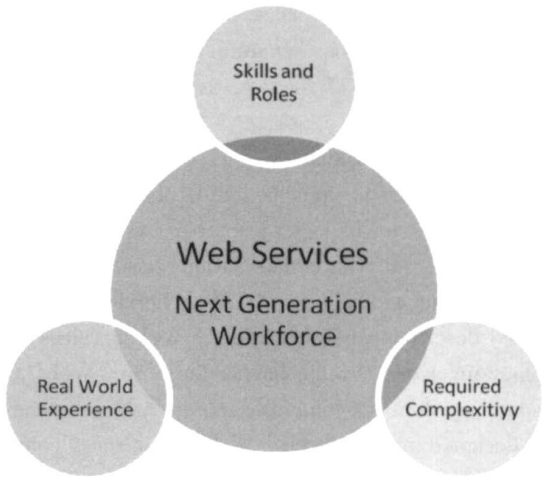

Fig. 2 Components of Web Services Next Generation Workforce

A project team environment will address the issues in relation to skills and roles as ‘boundary-spanning’ roles will naturally evolve in a team environment. The experience of selecting a development environment is beneficial in itself, however this selection will also address another issue as it will automatically limit the skills required to that specific development environment. After selection of the development environment, an online course in the required technologies can be utilised by students to learn the required skills for that environment.

Real world experience can be gained by having a real life purpose for the project team. An example of this is the Microsoft and BT sponsored Imagine Cup competition, which has been described as “The World’s Premier Student Technology Competition”[23]. In this competition, project teams are invited to compete against other development teams from universities around the world.

In the 2007 competition, Red Dawn, a team of students from the DIT School of Computing came second in their category in the Imagine Cup (from 160 teams worldwide) by developing a mashup that facilitated geographically separated student teams to collaborate on software projects. Their application consisted of online IDE, project management system, source code repository, instant messaging and online help sub-systems. In addition to providing each of these sub-systems as Web Services, the application used Web Services from Facebook, Google, Microsoft and Yahoo. The application was built on the Microsoft .Net framework. Red Dawn team member Mohammed Al-Thas stated “this competition offered us the opportunity to develop a complete application from analysis and design to implementation with the added advantage of

having a real world environment, this experience simply would not have been possible to replicate in a classroom environment.

This also offers a level of complexity not available in traditional teaching methods. A team assembled with a tangible goal set will face complexities such as the proliferation of Web Services standards and requiring a varied skill-set. Boundary-spanning roles and a project team's dynamic will also be encountered by a project team. This competition gives students a tangible goal and this then reflects the real world nature of the project.

3 Conclusion

Web Services in consumer terms or in business terms affords the ability to be flexible and dynamic. This benefit is one of the reasons why the technology has evolved so quickly and has been developed and supported by the major information technology vendors. However, we conclude that the flexibility offered by the technology must also be emulated in the teaching of the technology to student in computing disciplines.

From the evolution of unstructured roles to developing technologies the Web Services domain is dynamic, fluid and constantly changing. We further conclude that for 3rd level institutions to provide suitable graduates to this expanding discipline they must also be dynamic in their approach to teaching.

Traditional teaching models are static and as such cannot provide students with the required skill-set, complexity or real world experience required to successfully fulfil the WS-NGW. We conclude that the proposed hybrid of a real world project team and online teaching tools offers the ability to develop graduates with this required skill-set.

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