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SERVICE ORIENTED ARCHITECTURE (SOA): IMPLICATIONS FOR AUSTRALIAN UNIVERSITY INFORMATION SYSTEMS CURRICULUM

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Abstract

Service Oriented Architecture (SOA) is emerging as a popular approach and paradigm for organizations to gain competitive advantage via managing their software applications and IT infrastructure as a set of interacting services. As the SOA market value is posed to increase to 10.3USD billion (WinterGreen-Research, 2009) by 2015, it is crucial that IS schools in Australia are providing the relevant industries with competent IS professionals that possess the necessary skills and are capable of understanding the impacts/implications of SOA deployments in order for them to design and create services of value. This paper examines the organizational and technological impacts/implications on organizations and discusses the skills and knowledge required by SOA-IS professionals and compares these with the requirements with the Australian Computer Society's (ACS) common body of knowledge created for accreditation of Australia university curricula.

Keywords: Service Oriented Architecture, SOA Implications, IS Curriculum, IS Education

SERVICE ORIENTED ARCHITECTURE (SOA): IMPLICATIONS FOR AUSTRALIAN UNIVERSITY INFORMATION SYSTEMS CURRICULUM

1 INTRODUCTION

This paper evaluates, in relation to the applicability of service oriented architecture, the recently revised body of knowledge in Information Systems created for accreditation of Australian university curricula by the Australian Computer Society (ACS). In these dynamic and competitive, yet emerging global markets, organisations must be agile and flexible to respond to the shifting needs and unpredictable business climate (Papazoglou and van den Heuvel, 2007, Baskerville et al., 2005, Bieberstein et al., 2005, Cherbakov et al., 2005, Jammes and Smit, 2005). Organisations are constantly exploring to identify various alternatives to reduce information technology investment; meanwhile offering sophisticated products and services to their customers with more cost-effectiveness (Feuerlicht and Govardhan, 2009, Shum and Dhillon, 2005). Thus, it is important that organisations streamline their business process and enforce strong IT services integration in order to achieve this (Papazoglou and van den Heuvel, 2007).

Service Oriented Computing (SOC) or the use of Service Oriented Architecture (SOA) is the IT industry's solution to help organizations manage their existing diverse and heterogeneous infrastructure into a set of interacting services (Papazoglou, 2003). With an increasing demand for SOA implementations with market value expected to reach 10.3 USD billion by 2015 (WinterGreen-Research, 2009), a much broader vision and multi-disciplinary perspective is required in order to fully understand how the business process can be aligned with the IT, then to exploit the eminent potential of SOA (Bieberstein et al., 2005, Sidorova, 2009). As a result, this paper attempts to examine the impact of SOA in organizations and discuss whether the current Australian information system (IS) curriculum is sufficient for meeting industry' demands for quality IS professionals proficient in SOA implementations.

2 SERVICE-ORIENTED ARCHITECTURE

Channabasavaiah et al. (2004) state that an architectural definition of Service-Oriented Architecture (SOA) is "an application architecture within which all functions are defined as independent services with well-defined invocable interfaces which can be called in defined sequences to form business processes" (p. 9). Channabasavaiah et al.'s definition contains the underlying components:

- All organizational functions are defined as services that include business functions, business transactions, and system service functions.
- All services work like independent "black-boxes" – external components do not understand how the services work and are only concerned with outputs from the services.
- The interfaces are invocable regardless i) whether they are local or remote based; ii) type of connection scheme, protocols or infrastructure used for the connection; iii) where the service exists within the system such as corporate intranet or within an application in a partner system.

Service-Oriented Architecture (SOA) is the architecture with special properties, comprising of various components for building independent and interoperable systems to improve business process flexibility, adaptability, and provide better IT alignment that stress on location transparency (Jammes and Smit, 2005, Channabasavaiah et al., 2004, Maurizio et al., 2008). SOA possess the same basis and key concepts underlying SOC that utilizes services as fundamental elements for developing application to support the development of rapid, low cost and easy composition of dispersed

applications (Papazoglou et al., 2007, Papazoglou and Georgakopoulos, 2003, Huhns and Singh, 2005, Papazoglou, 2003). SOA is constituted by SOC's basic services, descriptions and basic operations (publication, discovery, selection and binding)(Papazoglou and Georgakopoulos, 2003, Bichler and Lin, 2006).

Despite having heterogeneous platform with various applications, access devices and protocols, a robust SOA can be employed to design a software system which provides services to end-user applications, connectivity to different publishable and discoverable services via a distributed network utilizing the Internet (Papazoglou, 2003, Papazoglou et al., 2006, Tsai, 2005, Papazoglou and van den Heuvel, 2007, Channabasavaiah et al., 2004). The integration of IT infrastructure and services are the key elements for SOA or on demand IT environment because integration that seamlessly interlink the people, processes and information within an organisation can increase resource allocations efficiency and flexibility, and optimize business performance (Channabasavaiah et al., 2004).

SOA addresses the requirements of loosely coupled, standards-based, and protocol independent distributed computing, mapping enterprise information systems isomorphically to business process flow (Papazoglou and van den Heuvel, 2007, Brown et al., 2006) by removing redundancies, generating unified collaboration tools, restructuring and streamlining IT processes, IT support infrastructure, software applications and systems to achieve end-to-end enterprise connectivity to enable each service to communicate through a standardized platform, interface and governed by one set of protocol (Papazoglou, 2003). This architecture is critical when different applications are running on various technologies and platforms that need to communicate with each other (Papazoglou, 2003).

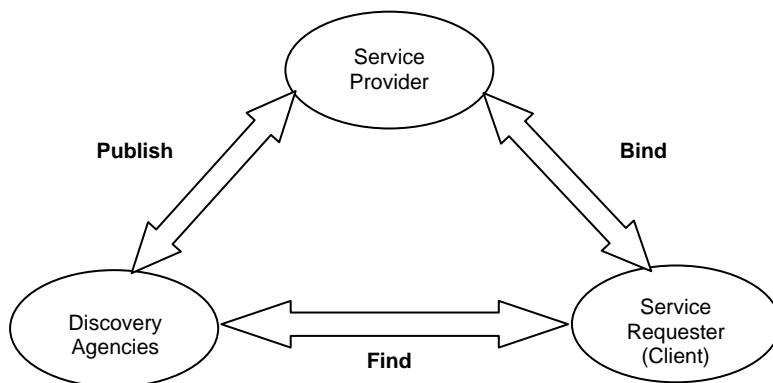


Figure 1. Basic Service Oriented Architecture

The basic architecture of SOA involves the relationship of three members: *service provider*, *service discovery*, and *service requester (client)*, which engage in three operations: publish, find, and bind (Papazoglou, 2003, Papazoglou and van den Heuvel, 2007). The interaction occurs between software agents as an exchange of messages, service requesters (clients) and service providers, these software agents can act simultaneously as clients and providers. Providers are software agents which are responsible for publishing a description of the service when clients request for the service execution. The clients must be able to find the description of the service they request and must be able to bind them (Papazoglou, 2003).

2.1 SOA Migration Technicalities

As demonstrated in the previous section, the use of SOA in organizations is a fundamental change in the paradigm of how IT infrastructure and applications are developed, deployed and managed (Channabasavaiah et al., 2004). This section highlights the technicalities associated with SOA migration.

2.1.1 Enterprise Service Bus and Inter-operability

Enterprise Service Bus (ESB) has been designed by many large vendors e.g. IBM (Bieberstein et al., 2005) to simplify service integration in large-scale enterprise software. The ESB is an “open-standards based message backbone designed to enable the implementation, deployment and management of SOA-based solutions” (Papazoglou et al., 2006, p8). An ESB contains tools and architectures that allow communication among component applications using web services standards along with middleware control functions (Bichler and Lin, 2006) that solve disparity problems between applications running on different platforms and using incompatible data formats (Papazoglou et al., 2006).

ESB provides support for service, message and event-based interactions with appropriate standardisation (Papazoglou et al., 2006), integration via the management of the control, flow and translations of all messages between services, utilising any possible message protocols (Papazoglou and van den Heuvel, 2007). Applications and discrete integration components are brought together to create services to form composite business processes that automate business functions in an enterprise (Papazoglou and van den Heuvel, 2007). Figure 2 adapted from Papazoglou and van den Heuvel (2007) shows a simplified architecture of an ESB that integrates various organisational applications such as legacy systems, JAVA and .NET.

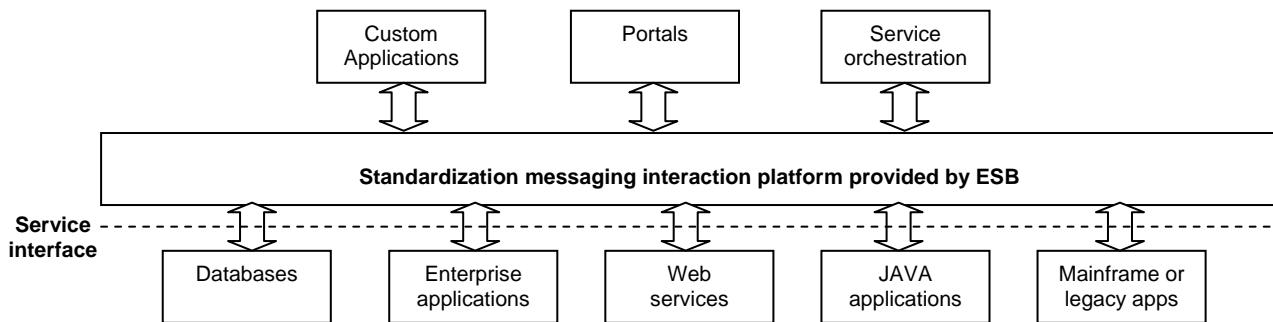


Figure 2. ESB's Role in SOA

The interface between the various existing applications which ESB provides is the key to inter-operability. It defines the parameters and the output (Channabasavaiah et al., 2004) and hence addressing the needs of security, policy, reliability and accounting required for SOA (Papazoglou et al., 2006).

2.1.2 Business Process Management and Modelling

Business Process Management (BPM) (Maurizio et al., 2008) or process integration (Channabasavaiah et al., 2004) are essential for companies to align their process to fully benefit from the opportunities brought about by SOA. BPM contains the set of software tools necessary to optimize organizational performance, set realistic performance goals which are linked to process data, automation and monitoring of processes and allows for a platform for agility (Maurizio et al., 2008).

Process integration is related to the development of computing processes that map to and provide solutions for business process, integration of applications and business processes (Channabasavaiah et al., 2004). Integration of processes may involve not just services but the integration of whole processes from external sources relating to Supply Chain Management (SCM) or financial services that includes different institutions. It is important that adopting organizations choose the right process for an SOA effort based on its potential contribution to add business value (Maurizio et al., 2008).

Despite process modelling history, the concept of combining process modelling and SOA is still relatively young which led to analysts and consultants having differing ideas and opinions and best practices (Maurizio et al., 2008). Cherbakov et al. (2005) suggest that the change in process design

will require new approaches to process modelling. The new concepts and modelling constructs ideally must be able to capture processes with flexible sequences that are results driven rather sequential decision based.

2.1.3 *Service Providers and Requirements*

Services are offered by organizations that implement the service (Brown et al., 2006), supply their service descriptions and provide related technical and business support to the adopting organizations. Services may be offered by different organizations and operate via the Internet which allows for a distributed computing infrastructure for both intra and inter organizational integration and collaboration (Papazoglou, 2003). Clients of services can be an end user application or another service (Brown et al., 2006) that can exist within or external to an organization as applications, process or customers. To facilitate the exchange of the services, the services should be designed to be (Papazoglou, 2003):

1. Technology neutral – service applications should be invoked with the possible ease that implies that delivery mechanism such as protocols for retrieval, description, and search must comply with widely accepted standards.
2. Loosely coupled – services need not possess knowledge or any internal structures conventions at the client or service side
3. Support location transparency – services should have their structural information stored in standardized repository e.g. Universal Description, Discovery and Integration (UDDI) and which enables a variety of clients to locate, access and call up the services.

2.1.4 *Web Services and Standards*

Web services is the deployment of SOA via the Web (Papazoglou and Georgakopoulos, 2003) that involves a specific kind of service that is identified by a Uniform Resource Identifier (URI) that has its service description and transport build on Internet standards. Exchanges between Web services are conducted through SOAP (Simple Access Object Protocols) that contains XML (Extensible Markup Language) data content that provides context and structure (Fremantle et al., 2002, Papazoglou and Georgakopoulos, 2003). According to Fremantle et al (2002), Web services should possess the following attributes:

- Web-based protocols – Use of SOAP over HTTP (Hypertext Transfer Protocol) in the design of web services allows passage through firewalls and will work in a heterogeneous environment.
- Interoperability – Use of SOAP provides for a common standard for various differing applications to interoperate.
- XML-based – Use of XML contributes to interoperability via the creation of machine readable documents.
- Modular – Service Components are reusable and composite hence allowing for the composition of larger components.
- Descriptive – Services must be embedded with machine-readable description to allow identification of the interface of the service.
- Implementation independent – The service interface is available in a way that is independent of the final implementation.
- Publishable – Service descriptions publishable and available in a repository where clients can find and use the service.

2.2 Implications of SOA on Organizations and Vendors

Bieberstein et al. (2005) and Channabasavaiah et al. (2004) claim that deployment of SOA within an organization will bring about benefits such as agility and business process improvement and better utilization of existing infrastructure. However, the adoption of SOA does have other implications for organizations which are summarized in table 1.

Impact	Implications	Sources
IT Governance	The adoption of SOA gives rise to unique situations and the governance of SOA should be considered an extension of existing IT governance framework that includes a review board, development of an interoperability board, improvement in communications and effective policies. Common enterprise services should have defined owners with established ownership and governance responsibilities.	Bieberstein et al.(2005); Maurizio et al.(2008)
IT Transformation	Business initiatives and policies are often essential to encourage the required culture to successfully support an enterprise-wide SOA. Such initiatives include i) establishment of IT directives for creating business transformation; ii) creation of executive councils and architecture boards; iii) formalization of governance policies and models; iv) allocation of funds for such directives.	Bieberstein et al.(2005); Maurizio et al.(2008)
Role of IT in Business	SOA enterprise utilizes IT strategically to transform the business and create new sources of business revenue. IT systems inherit the attributes of the businesses created. Business value is created through the exchange of information across the value net among cooperating businesses that allow the dynamic relationships between partners. Business need of an SOA enterprise can be fulfilled by multiple providers which allow enterprises to change providers based on performance.	Cherbakov et al.(2005);
Change in organizational structure & roles	Transition of to SOA enterprise requires loosely coupled organizations that are based on the role definitions of service consumers and service providers and the understanding of their relationships. The new organizational structure needs to be optimized to cater for business agility needs, streamline process and communication, minimize bureaucracy and provide results-driven output. Negotiation and change of service providers may be accelerated with the use of service intermediaries that act as liaison between providers and clients.	Bieberstein et al.(2005); Cherbakov et al.(2005)
Technology Adoption	SOA technology and implementation requires guidance to provide a consistent and interoperable system of available services. Guidance includes i) use of standards and methodologies to provide templates for projects to create standardized services that can readily used by other clients; ii) risk management required for managing the benefits and potential costs associated with emerging technologies	Bieberstein et al.(2005); Papazoglou et al.(2006)
Business Process Management	SOA enterprise has the option of assembling its processes by using the services provided by others and business processes can be created by using a composition of existing services in an new enhanced service. The creation of a new service is dynamic and may involve the modification or enhancement or existing services.	Cherbakov et al.(2005); Papazoglou et al.(2006); Maurizio et al. (2008)

Table 1. *Implications of SOA on the Adopting Organizations*

From Table 1, it is clear that the adoption of SOA for any organization has wide ranging implications that varies from change in organizational structure to IT transformation. This also demonstrates the complexity and difficulty that any adopting organization faces in their SOA implementation and the need for proficient and SOA knowledgeable IT/IS professionals in the industry to help assist organizations with their SOA projects.

With the current web based environment, SOA is focusing towards object-oriented environments, which also require potentially high demand of calibre graduates who have the right skills, knowledge and competence in SOA in order to meet industry needs (Kohun et al., 2009, Foster, 2005). As a

consequence, IS curriculum should be revised and developed by integrating with other courses that can help to cultivate potential graduates, such as IT students to use their IT skills in a business environment (Polack, 2009). As part of the learning process, students should be trained and developed to view, understand, and analyse the business processes from a holistic view, recognise the available technologies, use their full knowledge about SOA design and implementation, and be vigilant about the challenges that underlie the SOA implementation (Luthria and Rabhi, 2009).

An effectively implemented SOA should offer the flexibility and robustness (Bieberstein et al., 2005, Luthria and Rabhi, 2009) that allows better process design and knowledge, monitoring and rapid transformation to deliver valued-added services to the organization in the short-term or longer-term (Channabasavaiah et al., 2004, Papazoglou and Heuvel, 2006, Sidorova, 2009). IS curriculum should also incorporate industry placement to raise graduate knowledge in this area with some real experience based project (Iyengar, 2009), to bridge the gap between the business world and classroom learning.

3 BODY OF KNOWLEDGE (KEY SKILLS) FOR SOA-IS PROFESSIONALS

Graduates from Information Systems (IS) programs are general able to find employment in various ICT positions but their primary role is seen as that of a business analyst (ACPHIS, 2009). To determine if Australian varsities are producing IS professionals with the right skill sets to meet the demands of SOA market, a set of key competencies are identified from the literature analysis which will compared to the Common Body of Knowledge (CBOK) provided by the Australian Computer Society (ACS, 2008) .

3.1 Key Knowledge or Skills Identified from Literature

3.1.1 Business Process Knowledge and Modelling (BPKM)

SOA-IS professionals should be capable of modelling business process or possess knowledge pertaining to business process management in assisting adopting organizations identify and streamline key businesses processes. However, the combination of SOA and process modelling is still in a relatively new stage and hence new concepts and modelling constructs are required to help capture processes with flexible sequences.

3.1.2 Knowledge of Enterprise Applications Integration – Supply Chain Management (EAI)

As discussed previously, integration of processes plays a crucial role for the development of streamlined solutions that may involve not only services but the integration of sources from the supply chain. As such, SOA-IS professions should have knowledge of how traditional supply chain management works to assist them in the creation and optimization of relevant services.

3.1.3 Understanding of technologies, interoperability and system development (TSD)

The deployment of SOA and use of ESB provide the support for the integration of heterogeneous and disparate applications possessing different data formats and systems built from different technologies. An understanding of different technologies, programming languages and their limitations and interoperability will be critical for SOA-IS professionals to determine the extent of integration possible.

3.1.4 Understanding of Standards and Protocols (SP)

Web services utilize the Internet and exchange of information is conducted via the use web-based protocols e.g. SOAP and HTTP that contains XML data content. SOA-IS professionals should be have background knowledge on the use of web protocols and standards to allow them to design and create services that are interoperable in a heterogeneous environment.

3.1.5 Governance and Risk Management Knowledge (GRM)

SOA deployment allows for unique situations and business processes catered by composite services and hence the governance of SOA should be carefully considered. Awareness of issues pertaining to communication, inter-operability, policy making, strategies for the encouragement and adoption is essential. Risk management knowledge required for managing the benefits and potential costs associated with emerging technologies.

3.1.6 Change Management Knowledge (CM)

IT is utilized strategically in SOA for business transformation and allows for the creation of new business revenue sources. Value is created via the use of services provided by participants in the value chain. The transformation requires organizational change which the new structure needs to be optimized for agility having streamlined processes and communication and give results-driven output. SOA-IS graduates will need to understand the implications of the organizational changes and come up with effective change management strategy.

3.2 Comparing current IS curriculum based on CBOK with the key skills identified from section 3.1.

ACS Common Body of Knowledge			SOA Relevant Areas					
Key Area	Description	Sub-Areas	3.1.1. BPKM	3.1.2. EAI	3.1.3. TSD	3.1.4. SP	3.1.5. GRM	3.1.6. CM
ICT Problem Solving (PS)	Knowledge to use modelling methods and processes to understand problems, handle abstraction and design solutions. Emphasis on developing artefacts that are abstract and complex where modelling tools and methods are essential.	<ul style="list-style-type: none"> Problem solving using modelling and abstraction 	✓	✓				
Professional Knowledge (PK)	ICT professionals require a level of 'professionalism', which means exhibiting a degree of autonomy and responsibility, behaving in an ethical manner and demonstrating high-level communication and interpersonal skills.	<ul style="list-style-type: none"> Ethics 						
		<ul style="list-style-type: none"> Professionalism 						
		<ul style="list-style-type: none"> Teamwork concepts & issues (leadership) 					✓	✓
		<ul style="list-style-type: none"> Interpersonal communication 					✓	✓
		<ul style="list-style-type: none"> Societal, environmental, legal issues; privacy; regulatory compliance 		✓		✓	✓	
Technology Building (TB)	Specialised programming and engineering roles involved in building systems from the ground up.	<ul style="list-style-type: none"> History and status of discipline 						
		<ul style="list-style-type: none"> Programming 			✓	✓		
		<ul style="list-style-type: none"> Usability (Human-computer interaction) 						✓
		<ul style="list-style-type: none"> Systems development (configuration management, change management, release management) 			✓	✓		✓
Technology Resources (TR)	Possess basic technical knowledge to underpin other professional activities: i) implementing IT; ii) acquiring IT; iii) managing IT; iv) or engaging in higher-level specialized technical roles.	<ul style="list-style-type: none"> Systems acquisition 				✓	✓	✓
		<ul style="list-style-type: none"> IT infrastructure and platforms (hardware and software, ICT architecture) 			✓	✓		
		<ul style="list-style-type: none"> Data and information management 			✓	✓	✓	
Outcomes Management (OM)	Understanding of how ICT is used and managed to gain benefits in organizational and societal contexts.	<ul style="list-style-type: none"> Networking (data communications, web services) 			✓	✓	✓	
		<ul style="list-style-type: none"> IT Governance – IT management, business cases, ROI, value realization 		✓			✓	
		<ul style="list-style-type: none"> Project management (risk management, quality assurance) (as a team member) 					✓	
		<ul style="list-style-type: none"> Change management 						✓
		<ul style="list-style-type: none"> Security 					✓	

Table 2. Comparison of current IS curriculum and the skills identified from literature

It is obvious from the table 2, that current Australian IS curriculum manages to fulfil most of the skills identified critical for IS-graduates to work on a SOA deployment. However, one key skill was not found in the CBOK which was enterprise application integration – supply chain management. It can be argued that with SOA deployment, the supply chain is becoming less conventional with boundaries becoming less explicit. Organizations find themselves in a position to be more creative and innovative which allows them to collaborate with different partners in the supply chain via the services offered by the partners in the chain.

4 DISCUSSION AND CONCLUSION

The concept of SOA is redefining the boundaries of business units and IT as organizations need to consider them in terms of services. This has implications on traditional IS schools and business schools as services can be seen as a hybrid of both schools. IS schools need to recognize the implications of SOA and its impact on IT/IS development and projects.

Maurizio et al.(2008) suggest that one of the major academic challenges facing IS schools is to train existing faculty to teach the various technologies and concepts that support SOA. As with ERP systems, many universities opt for industry partners and standardize their curriculum on an SOA backbone and the tools provided by major vendor such as SAP (Maurizio et al., 2008). This paper agrees with Maurizio et al.(2008) that regardless what toolset taught, the basics of XML web service standards need to be introduced into current IS curriculum to allow the demonstration of processes designed and developed from services. While technical skills such as programming remain valued skills, most of the technical developments are likely to be handled by third parties or vendors.

Business process management and modelling will become a key area of interest for IS schools as industry vendors will likely to come up with new methodologies and templates for the modelling and managing business process in the context of SOA. This will challenge existing curricula and should stimulate further development and extension of that curriculum to incorporate alternative perspectives that derive from SOA. This not only will challenge IS concepts and content but the applicability of business models usually incorporated into an IS curriculum.

The above discussion also showed that current IS curriculum does not adequately address the business needs of SOA-IS graduates particularly in the area of supply chain management. IT/IS systems built on SOA in the future may involve multiple technologies, programming languages, platforms and systems and uncertain different number of service providers in the supply chain. The traditional system development and management concepts embedded in the current curriculum need to be revised to take into consideration the dynamics of SOA deployment.

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