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Abstract

This paper addresses real challenges and ensuing issues facing the Singapore government in their endeavour to enhance global economic competitiveness through the adoption of innovative technologies development and usage; in this case, the acceleration of SOA. Key stakeholders have spearheaded a strategic and systematic project (called SOA1) to ensure that SOA is inculcated into the mainstream of businesses and industries. Outcomes, insights and lessons learned are presented along with a glimpse of the next phase of the SOA1 project (called Enterprise 2.0). IT Management complexities not accounted for in SOA1 and Enterprise 2.0 are examined with a call for empirical academic research in the areas of people and organisational behaviour within the context of SOA adoption and implementation.

Keywords

SOA, web services, IT adoption, IS strategic planning, Technology trends

CHALLENGING ISSUES

All developed countries would realise the need to cultivate a vibrant and competitive infocomm industry that attracts foreign investment and sustains long-term GDP growth through innovative infocomm technology development, deployment and usage in order to enhance its global economic competitiveness. Singapore is no different. In fact Singapore strives on *kiasu* competitiveness and consistently scores high marks in global and regional rankings. *Kiasu* is a term that literally means 'fear of losing'.

The task of cultivating and sustaining this competitive infocomm industry and environment falls on the Infocomm Development Authority (IDA) of Singapore, a government agency which seeks to achieve this objective in its roles as the infocomm industry champion, the national infocomm master-planner (iN2015 Masterplan) and developer, and the Government CIO.

The general concept of "services" is well-known and widely used in business organizations to make their processes more efficient and adaptable. The same principles can also be applied at a software level in application design. Service Oriented Architecture (SOA) is an architectural style which designs "services" which are modular, reusable, clearly defined, sharable, and loosely coupled. It is rapidly emerging as a prominent integration and architectural approach in providing a flexible, adaptive and yet reliable software architecture. SOA purports to increase code reuse, reduced integration expense, better security, and — the big payoff — greater business agility (Moore 2006). According to Gartner, by 2010, at least 65% of large organisations will have more than 35% of their application portfolios SOA-based, which is up from fewer then 5 percent of organisations in 2005 (Malinverno 2006).

IDA was one of the earliest government agencies to realise the potentials and benefits of SOA especially in a global competitive playing field. Back in May 2003, they launched the WEAVE (Web services Add Value to Enterprises) program, a jumpstart initiative, with the aim of promoting the development of web services over a period of three years, as a key engine of growth for the ICT sector. In early 2005, IDA was challenged with a two-prong but related question of "how they can kick-start and sustain an active SOA community at a national level?" and "how they can help accelerate the adoption of SOA for locally-based companies with minimal risk and funding?"

First Challenge – How to Kick-Start and Sustain an Active SOA Community at National Level?

Although there are numerous numbers of online and non-online communities, building a SOA community or any other technologically based communities at a *national* level can be challenging. IDA was seeking an active and sustaining SOA community consisting of key stakeholders like SOA vendors, Independent Software Vendors (ISVs), System Integrators (SI) and academic institutions. This community would have to be managed by a neutral third-party. Most if not all the key stakeholders are competitors and getting them to share and discuss SOA issues in the same room can be a challenge in itself.

Second Challenge – How to Accelerate the Adoption of SOA with Minimal Government Funding?

This is a bigger challenge compared to the first. The impetus is to assist locally-based companies that have started developing web services. IDA has identified interoperability testing of web services as a focus of SOA then due to the fact that half of the developed web services from the WEAVE program were exposed to external parties such as partners and suppliers, as reported by IDA in their WEAVE 2005 Report. Interoperability testing ensures the communication between web services across several platforms. The test itself is an expensive investment simply because SOA is an emerging field which usually implies the testing tools are immature and expensive. In addition, setting up such a testing environment with the various testing tools, different hardware, on the various platforms is very costly for any IT organisation especially for ISVs and SIs.

The sub-challenges faced in the area of interoperability testing are:

- Although web services technology has assisted in making interoperability more possible with open standards, there is an issue with interoperability across multiple platforms;

- Absence of neutral party who can objectively advise locally-based companies on various issues related to integration and interoperability; and

- Lack of a neutral testing environment for multiple platforms with multiple testing tools and solutions from different vendors. This will be a costly and time-consuming exercise to setup such an infrastructure. In addition, there is a high Total Cost of Ownership (TOC).

BACKGROUND

The three strategic thrusts of the WEAVE program are, to seed intellectual capital, leverage Singapore as a living lab and to ensure the development of enabling infrastructure. The key targets under this program are: Firstly, to drive S$120 million investments in the development of Web Services; secondly, to train and certify 600 professionals in Web Services; and last but not least, to encourage at least 20% of locally-based organisations in Singapore to adopt Web Services. This was the beginning of a rich and evolving history of SOA in Singapore.

In October 2005, IDA reported that they are well on track to achieving these targets with a total of S$70 million invested in 52 Web Services projects spanning different economic sectors from finance and transport, to leisure and entertainment. In terms of capability development, they have far exceeded their target with more than 2,800 professionals trained in Web Services know-how. More than 20% of these have attained certification through formal IDA-endorsed courses. In addition, at least 290 new jobs have been created as a direct result of the WEAVE programme.

The success of the WEAVE program prompted IDA to pursue the acceleration of SOA adoption in Singapore. Shekhar and Anderson (2007) reported in a Springboard Research's Executive Brief how Singapore and Hong Kong are looking at SOA as an engine of growth and have taken active interest in promoting SOA through public-private partnerships.

Solution to the Challenges

In order to address the two SOA-related challenges introduces in the earlier 'Challenging Issues' section of this paper, IDA collaborated with SiTF (Singapore infocomm Technology Federation) and NYP (Nanyang Polytechnic) to set up the SOA Centre in October 2005. SiTF is Singapore's premier infocomm industry association and brings together 400+ corporate members from multinationals and local companies. The main charter of the federation is to assist its members in business development, market intelligence, overseas trade missions, networking and alliances. NYP's School of Information Technology's Centre for IT Innovation (CITI) is a platform for collaboration with leading IT companies, with staff and students working on projects to provide solutions and services to the industry. As part of its capability developments, NYP partners with technology leaders such as IBM, Microsoft, Cisco Systems, Oracle, SAP and ILOG to spearhead the development of technologies in the areas of web services, enterprise solutions, RFID integration, mobility solutions, business rules solutions, IP convergence and grid computing.

This vendor-neutral SOA Centre was and still is a first in the region and the world and it provided web services interoperability testing for locally-based organisations. The Centre pooled together eighteen SOA vendors, ISVs and SIs under one roof to highlight the leading SOA activities that Singapore is doing in the area of web services and SOA. They have also contributed in a unified effort, hardware, software and expertise to the Centre. These eighteen SOA partners of the SOA Centre are Accenture, BEA Systems, Cisco Systems, Crannog Software, Ecquaria Technologies, Hewlett-Packard, IBM, Mercury Interactive, Microsoft, NCS, Novell, Oracle, Parasoft, SAP, Singapore Computer Systems, ILOG, SQL View and Sun Microsystems. IDA would provide funding for locally-based organisations to engage the SOA Centre for their web services interoperability testing. IDA would also fund SOA activities organised by the Centre and associated marketing expenses.

At the same time a new chapter, the SOA Chapter was structured within SiTF with SOA industry leaders forming the SOA Chapter Executive Council (Exco). The SOA Chapter Exco serves as the SOA Centre's steering committee and provides the necessary and essential stewardship to oversee the Centre's operations. The Exco meets once a month and provides the check-and-balance mechanism to facilitate governance and due diligence in matters related to the Centre.

This 2.5 years project commencing October 2005 was codename 'SOA1'.

SOA CENTRE DELIVERABLES AND KPI

The objective and goals of the SOA Centre are aligned to address the presented challenges. The objective is to provide a single point of contact to address key issues in moving SOA to the next level of adoption by the industry and businesses in Singapore.

The goals are:

- To actively accelerate SOA adoption to create business value and innovation

- To encourage organizations to be part of SiTF's SOA Chapter

- To provide regular networking events and activities to bring about a collaborative and knowledgeable community and environment

In general, the SOA Centre has achieved its goals by engaging with the industry via a number of events and a significant membership increase within the SOA Chapter. During the October 2005 till April 2008 timeframe, the SOA Centre under the direction of the SiTF's SOA Chapter was the most active SiTF chapter in terms of activities and received the most funding from IDA.

Recruitment of Director, SOA Business Development

IDA has provided funds to pay the salary of a senior position within SiTF but physically based at the SOA Centre based at NYP. The budget line was available from October 2005 till April 2008. The Director, SOA Business Development oversees the overall operations which include:

- putting in place marketing activities to promote the business propositions of the centre to industry,

- work with the various industry partners to ensure a healthy pipeline of interoperability testing projects that will flow through the centre,

- coordinating and working with the appropriate NYP's testing specialists on the administrative aspect of individual test cases,

- reporting and clearing with the SOA Chapter Exco on operational matters, and

- compiling appropriate documentations and perform the necessary administration for claims submission to IDA.

Interoperability Testing Projects

IDA has provided a $220,000 SGD funding for 60 interoperability testing projects based on a tiered 100%, 70% and 50% subsidization scheme. IDA will subsidize 100% ($5,000 SGD) for the first 20 projects. Subsequently, clients will pay $1,500 SGD each for the next 20 projects and $2,500 SGD each for the final 20 projects. The Key Performance Indicator (KPI) of 60 interoperability testing projects was agreed and signed by all relevant stakeholders during the SOA Centre's MOU signing in October 2005 with the assumption that each SOA Centre's partner would contribute a number of interoperability testing projects.

Knowledge Transfer and Skills Preparation

The multi-platform and vendor-neutral SOA Centre focuses on Web Services interoperability testing targeting ISVs and SIs who have developed and/or implemented web services across multiple platforms.

The planning for the resource pool in preparation for the interoperability testing projects and SOA-related activities was done months prior to the MOU signing.

SOA Centre Activities

The SOA Centre was accountable for SOA-related activities that IDA would approve and fund. The impetus to plan, organize and run such activities is because of the need for awareness and education due to the overall lack of SOA awareness in Singapore.

Marketing-related Deliverables

Marketing-related deliverables are encouraged by the SiTF's SOA Chapter and IDA. These include funding for the production and delivery of marketing collateral and other media-related deliverables.

OUTCOMES OF DELIVERABLES AND KPI

This section describes the outcomes of the deliverables and KPI introduced in the prior section.

Recruitment of Director, SOA Business Development

SiTF had a difficult time recruiting the Director, SOA Business Development due to stringent position requirements. Eventually a person was recruited from overseas and he commenced the employment contract on October 2006.

Interoperability Testing Projects

As of June 2007, the SOA Centre has secured 24 projects or 40% of target. As of April 2008, the Centre has secured 38 projects or 63% of target. The Centre targeted the following market segments for projects:

- Companies of SOA Chapter Exco members
- 18 partners of the SOA Chapter
- Repeat project clients of School of IT, NYP
- WEAVE participants
- SOA Chapter members
- Leads from conferences/seminars/workshops
- Leads from IDA

The totality of the above market segments is quite exhaustive in terms of companies with web services. All possible means were attempted to derive leads from the above sources. The Director also presented at events and conferences focusing on SOA and indirectly selling the SOA Centre and interoperability testing. This included presentations to ISVs, SIs and partner organisations.

The majority of the completed 38 interoperability testing projects are from the ISVs/SIs (37%). This is followed by the Financial Services industry (21%), the Government sector (16%) and Manufacturing & Logistics (10%). The majority of the web services undergoing the interoperability testing are new services which indicate the trend in adopting a SOA approach in software development.

Knowledge Transfer and Skills Preparation

The multi-platform and vendor-neutral SOA Centre focuses on web services interoperability testing targeting organisations which have developed and/or implemented web services across multiple platforms.

SOA testing specialists from NYP are drawn from a pool of existing resources within NYP based on their technical expertise. Through the course of conducting interoperability testing, there is knowledge transfer from the SOA vendors to the testing specialists and subsequently to NYP students via improved and updated course curriculum. The SOA testing specialists roles are:

- be the technical contact to liaise with client companies on technical specific issues,

- assess the projects that come through the Centre and work out the various test scenarios,

- size each project and its individual test scenarios, and work out the estimated time to conduct the tests,

- liaise with the Centre Director on administrative matters, including doing the necessary reporting and getting the approvals prior to commencement of each test,

- perform the actual technical testing,

- consult/liaise with IT specialists from the SOA Centre partners on platform domain specific issues,

- produce a comprehensive test report and provide the necessary recommendations based on the test results to the client companies, and

- update information repository of the tests that are conducted, which would form the basis of identifying and formulating agility patterns and architectures.

SOA Centre Activities

The SOA Centre was directly involved in the planning and organizing of a few SOA-related talks and several speaking engagements. These included:

- The Director speaking engagement in SOA Middle East Conference in Dubai and another SOA conference in Singapore. Both topics were on SOA Governance.

- SOA Developers' Day a flagship event championed by the SiTF's SOA Chapter to provide knowledge and to skill the developers' community in Singapore. The event was organised twice and attended by about 200 participants on each occasion.

- The SOA Chapter Members' Networking cum Seminar was held at Microsoft Singapore; it was attended by close to 80 people.

- SOA-related case studies were presented to IT Management Association (ITMA) members; good feedback by 20+ IT Directors and IT decision makers who attended the half-day talks hosted by Accenture. The case studies were presented by Microsoft, ILOG, Accenture and BEA.

- The SOA Chapter was offered a booth and a speaking slot at Microsoft's Regional Architect Forum 2007 and 2008, an annual regional event attended by 150+ participants. The Director spoke on the current and future status of SOA, role of the SOA Centre, and best practices in web services interoperability testing.

- SiTF was one of the sponsors at the Avaya Communications Summit 2007; an annual event organized by Avaya and was attended by 300+ participants. The Director presented on SiTF and specifics of the SOA Centre.

- The Vertical Industry Networking Day (financial services industry) was successfully held and was attended by bankers, SOA adopters and vendors. Computer Associates sponsored the event and a representative from Citibank presented on their SOA journey.

- The Director was an invited special guest speaker at Marcus Evan's 'Service-Oriented Architecture' workshop attended by 25+ paying workshop participants.

Marketing-related Deliverables

The SOA Centre produced a couple of marketing collateral. A case study on Citibank was written describing the motivation behind SOA, the implementation approach, challenges faced and lessons learned. Interesting web services interoperability tests were also written up as reference case studies.

The Centre also initiated the SOA@Singapore wiki at soasingapore.wikia.com. The purpose of the wiki is to create and grow the SOA community in Singapore.

ISSUES

As of April 2008, the SOA Centre managed to secure only 38 out of the targeted 60 interoperability testing projects. There was considerable pressure within the SiTF's SOA Chapter Exco to encourage the Exco members to contribute projects in order to meet IDA's KPI.

The failure to reach the 60 interoperability testing target is investigated and based on several primary factors:

- The most significant factor is that the majority of the web services are consumed internally and as such companies did not see the value of interoperability testing as the web services are mainly developed on a single platform and the very fact that they are consumed internally. Companies with externally exposed web services tend to place a higher value on interoperability testing especially those with web services that interacts with other services,

- Interoperability testing is an after thought during SOA implementation; similar to SOA governance ie. not considered to be critical, and

- Organisations with existing web services are not convinced interoperability testing will return a ROI especially when their existing applications are working.

Other secondary failure factors include:

- Lack of awareness and familiarity with SOA is the number one barrier to adoption of SOA in Asia. Only 23% of the 2711 CIOs and IT managers that Springboard Research (Aggarwal and Anderson 2007) approached for interviews said they were aware of SOA. However, even among those aware of SOA, there is wide disparity in their understanding of what exactly SOA means and does,

- Many organizations have not deployed SOA because they are not sure of the benefits which usually are a result of not understanding their own needs, and

- IT teams often fail to convince business managers on the benefits SOA offers their businesses. This leads to a disinterest in the business groups and therefore funding limitations. In many cases, even though the organization's long term IT strategy is built around SOA; funding support is not forthcoming because business leaders are not convinced of its benefits.

INSIGHTS & LESSONS LEARNED

Lessons learned are categorized into technical and non-technical aspects.

Non-technical Aspects

- Building a SOA Centre back in October 2005 without the 18 industry partners would have been a fairly expensive exercise. The industry partners have sponsored and contributed hardware, software and professional services such as training and support. The partners have also got together under one roof on a monthly basis to accelerate the adoption of SOA at the national level with the SOA Chapter Exco playing the steward role.

The lesson learned here is that this is a good working model involving all relevant stakeholders with each contributing equitably. Other SiTF chapters and groups within IDA have examined and adapted the model to their respective projects.

- The number of interoperability testing projects is the only KPI during the October 2005 till April 2008 timeframe.

The lesson learned is that for future initiatives several KPIs as opposed to a single KPI should be considered to measure the effectiveness of the individual initiatives/projects.

- The majority of the completed projects are from the ISVs/SIs (37%). This is followed by the Financial Services industry (21%), the Government sector (16%) and Manufacturing & Logistics (10%).

These percentages concur with what's happening globally.

Technical Aspects

- In conducting the Web Services Interoperability tests, the Centre has accumulated 'best practices' knowledge pertaining to the issues determining web services interoperability. This knowledge repository is documented and is available to members of the SOA community.

- Staff and students seconded to the SOA Centre are trained in a broad range of SOA-related software from the many partners.

- The Centre has made available the knowledge repository to the members of the SOA Chapter, as well as participating in various events such as XMLOne and the Microsoft Regional Architect Forum 2008 to share and discuss the knowledge gained.

WHAT'S NEXT: ENTERPRISE 2.0

The focus of the next phase (beyond April 2008) would extent beyond SOA1 interoperability testing projects. Although interoperability testing would still play a critical role, it is timely to look beyond the fundamentals of SOA ie. beyond the architecture aspects of SOA. The next phase would focus on real locally-based SOA projects and more into "advanced" SOA areas like SOA governance and testing with the view to helping industry move further towards the industrialisation of SOA within their respective organisations. Duggan et al. (2007) research has indicated that SOA testing and SOA governance will take 2-5 years before mainstream adoption.

In addition, the emergence of Web 2.0 technologies cannot be discounted. Progressively, Web 2.0, Rich Internet Applications (RIA) and mashups would be inculcated into businesses along with new business models which are expected to change the business landscape as companies need to be more agile. With SOA as an architecture and Web 2.0 enriching the front end, the SiTF's SOA Chapter Exco coined "Enterprise 2.0" as the next phase which is expected to commence during the latter part of 2008 and ends in 2011. Enterprise 2.0 is an extension of SOA1, the technical focus of SOA1 is interoperability testing and establishing the SOA Centre, while the focus of the former is to develop real SOA solutions with industry partners.

The impetus for Enterprise 2.0 is still driven by ICT market forces. However, it is important that the objectives of the second phase still align with IDA's goals and objectives. In summary, the impetus to continue with the SOA Centre is based on challenges and issues to be faced in the 2008-2011 period. They are:

- Reluctance by companies/agencies within vertical domains (e.g. financial services and government) to share web services;

- Recognition for locally-based companies in their efforts to deploy SOA in their companies. Deploying SOA is a complex exercise in itself for any company; local success stories are few and a national recognition scheme would definitely assist in "bringing-out-the-best" in SOA planning and implementation; and

- Continuing effort to educate locally-based companies on SOA with emphasis on the various soft facets of SOA such as SOA governance, SOA testing, maturity levels and service lifecycle.

Scope of Enterprise 2.0 Proposal: Interoperability, SOA Security and Governance Testing

SiTF is proposing to continue to site the existing SOA Centre at NYP to provide for web services interoperability testing to locally-based companies. The Centre will continue to provide interoperability testing services which comprise of the following activities:

- WS-I Basic Profile Testing,

- Platform testing (across multiple platforms), and

- Reporting based on testing outcomes with recommendations and best practices.

The Centre envisages other testings demanded by the industry, in particular SOA Security and Governance testing, as web services interoperability issue becomes mature.

SOA Security testing activities would include:

- WSDL Analysis on the use of WS-Security elements, including WS-Security protocol specifications, including WS-Username, WS-X509, WS-Kerberos, WS-SAML, WS-Encryption and WS-Signature,

- Build clients in platforms for testing on the web service. This assumes that the client platforms identified are already enabled with WS-Security features. This largely eliminates older versions of some platforms, and

- Analysis of the design and implementation of security features with respect to effectiveness, efficiency and usability.

 SOA Governance testing activities would include:

- To help in either the design of web services or create a registry for web services that can be subject to proper governance through tools/services, and

- SOA design time and run-time governance testing to ensure that design of various aspects of SOA governance are built into the planning and implementation of SOA projects and in particular testing supporting service discovery, service delivery, security, service levels, service validation, auditing and logging.

Consortium-led SOA Vertical Solutions

Consortium-led SOA vertical solutioning is a significant initiative that is aligned to IDA's iN2015 masterplan to develop a globally competitive infocomm industry. Vertical solutioning is about designing and developing sharable web services within a particular vertical domain. Each consortium may consist of local IT companies and multinationals; lead by a local company, the consortium will determine the vertical domain they intend to design, develop and market their domain services. Potential vertical domains as defined within iN2015 are: manufacturing & logistics, healthcare, tourism & hospitality, education and learning, financial services, government, digital media & entertainment, SME and Transport.

Vertical solutioning is crucial in moving local companies from system integration, marketing, distribution and support to higher value-added activities such as solutioning. It enables the creation, exploitation and export of intellectual property (IP) and thus build a "made-by-Singapore" brand.

MANAGEMENT COMPLEXITIES OF SOA1 AND ENTERPRISE 2.0

Despite the innovativeness and opportunities presented by both SOA1 and Enterprise 2.0, the rapid adoption of distributed cross-platform web services and SOA can result in a multitude of complexities for IT management. Due to the inherent nature of SOA, managing SOA projects viewed through the lenses of change management and project management can be both challenging and complex.

Often "it's human habit – not technical difficulty" that slows the adoption of a promising new technology. Such is the case with SOA, where issues of governance pose significant obstacles (McKean 2005). Manes, Vice President and Research Director at Burton Group, suggests that SOA is about people behaviour and that the organisational behaviour needs to change to make it effective (as cited in Windley 2006).

Current literature indicates SOA requires more organizational discipline than previous development models. SOA is inherently complex and will require strong governance. Malinverno (2006) purports that the lack of working governance mechanisms in midsize to large (fewer than 50 services) SOA projects will be the most common reason for SOA failure. Kontogiannis et al. (2007) present a set of cross-cutting SOA issues: governance, social and legal, people skills/capital, application domains, enabling factors, stakeholder management, and training and education. Most if not all of these issues are people-related. This is not surprising as SOA should always be business-driven and not technology-driven.

Correspondingly, as SOA is a new way to design systems, it is more about organisational culture than it is about technology. SOA will impact many aspects of an organization—from software development and operations to accounting, incentive systems, and governance (Moore 2005). Accordingly, Cournoyer (2006) points that SOA initiatives must be supported with organisational and project governance, software development methodologies, and staffing.

There should therefore be a call for more empirical research work in the areas of people and organisational behaviour within the context of SOA adoption and implementation. SOA governance and SOA management should also be target research topics. The lack of such research from the academic community is apparent.

CONCLUSION

Were the challenges addressed in SOA1? Yes, they are. The Singapore government has accomplished what other countries are just beginning to envisage – enhancing global economic competitiveness through the adoption of innovative technologies development and usage; in this case, the acceleration of SOA. IDA along with SiTF and NYP has spearheaded a strategic and systematic approach to ensure that SOA is in the mainstream of businesses and industries. Research especially from Springboard Research has clearly shown that the Asia Pacific is poised for strong SOA growth. However, there were issues from SOA1 although the insights and lessons learned outweighed these issues.

Enterprise 2.0, the next phase beyond SOA1 would raise the bar higher and with the drive for vertical solutioning, IDA and the associated stakeholders will attempt to heighten the export of locally developed IP and the "made-by-Singapore" brand. Singapore is creating her own future.

However, there are management complexities which are not accounted for in SOA1 and Enterprise 2.0. There must be an increased realisation of the fact that the adoption and implementation of SOA should be more about people rather than the technology. An apparent lack of empirical academic research with this focus demands a call for more academic research.

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