Governance Framework for Cloud Computing

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***Abstract*—In the current era of competitive business world and stringent market share and revenue sustenance challenges, organizations tend to focus more on their core competencies rather than the functional areas that support the business. However, traditionally this has not been possible in the IT management area because the technologies and their underlying infrastructures are significantly complex thus requiring dedicated and sustained in house efforts to maintain IT systems that enable core business activities. Senior executives of organisations are forced in many cases to conclude that it is too cumbersome, expensive and time consuming for them to manage internal IT infrastructures. This takes the focus away from their core revenue making activities. This scenario facilitates the need for external infrastructure hosting, external service provision and outsourcing capability. This trend resulted in evolution of IT outsourcing models. The authors attempted to analyse the option of leveraging the cloud computing model to facilitate this common scenario. This paper initially discusses the characteristics of cloud computing focusing on scalability and delivery as a service. The model is evaluated using two case scenarios, one is an enterprise client with 30,000 worldwide customers followed by a small scale subject matter expertise through small to medium enterprise (SME) organisations. The paper evaluates the findings and develops a governance framework to articulate the value proposition of cloud computing.. The model takes into consideration the financial aspects, and the behaviors and IT control structures of an IT organisation.**

***Keywords*—cloud computing, cloud enterprise architecture, value model**

1. INTRODUCTION

There are several studies that analysed the impact of outsourcing IT systems and their correlation to core competencies of an organisation. Yang & Huang (2000) presented the Analytic Hierarchy Process (AHP) in the decision process of outsourcing that requires building of a hierarchy of problems and sub-problems. Then they compute the comparisons, priorities and alternatives. The primary decision criteria for outsourcing presented by the authors are the following:

- Problems and ineffectiveness in the IT function
- Need to focus on the core competencies of the business
- Learn and avail new technologies,
- Reduced cost, leaner IT management and higher reliability and performance of IS, thus leading to higher levels of business service.

In this context, the following factors and attributes of information systems outsourcing were presented by the authors in the following Figure 1.

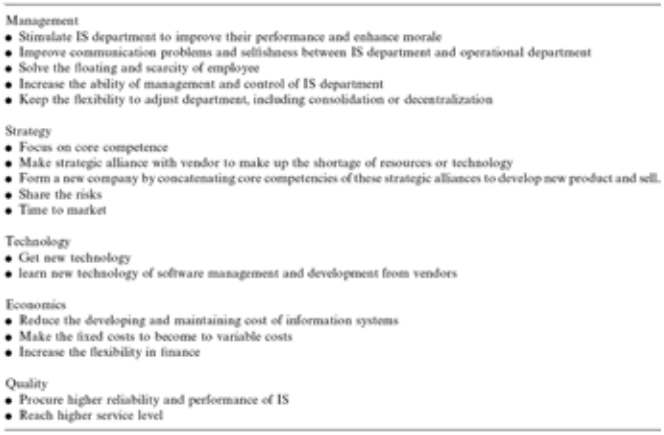

Fig. 1. The Factors and Attributes affecting IS outsourcing (Source Yang & Huang, 2000)

A closer look at Figure 1 suggests that organisations are primarily concentrating to reduce cost of IT services as the highest priority, acquire new knowledge and technologies at the cost of investments made by the outsourcing service provider. Above all, the primary focus of the organization is to concentrate on the core competencies of the organization, not to manage IT systems that enables their core competencies (Yang & Huang 2000).

The IT equipment and software industry was quick to respond to these demands from enterprises. These needs changed the way enterprise IT architectures and the corresponding infrastructures were designed and implemented in the industry. New innovative concepts like grid computing, cloud computing, software as a service, etc. are in the process of replacing the traditional in-house IT computing infrastructures to ensure that the key result areas highlighted in Figure 1 can be achieved (Yang & Huang 2000).

The IT management world is witnessing very rapid developments of two key areas – IT Management (and governance) best practices and the IT computing best practices. However, the new computing models are not totally aligned with the IT enabling models of businesses such as ITIL and COBIT. These computing models are evolving very rapidly. These two areas, computing models and IT support and governance models are two large verticals that are growing very rapidly in the industry. However, the horizontal integration of these two models has still not evolved although attempts are underway by the IT scholars in the industry. Currently, the

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industry urgently requires a number of academic researches that can potentially evolve some empirical generalisations pertaining to such horizontal integration. This research paper is one such attempt presented by the author whereby the attributes of a model that can horizontally integrate both the verticals shall be evolved. We will commence our journey by defining Cloud Computing.

2. WHAT IS CLOUD COMPUTING?

Cloud computing is defined as "a style of computing where massively scalable IT-enabled capabilities are delivered 'as a service to external customers using Internet technologies." (Clearley 2009) If we break down this definition, what we find is a set of mutually supportive concepts. First and foremost is the concept of delivering services (that is, results as opposed to components). Implementation doesn't matter as long as the results of the implementation can be defined and measured in terms of a service with associated service-level requirements. Included in this concept is payment based on usage, not on physical assets. The payment can be subsidized (for example, by advertising) or paid directly by the customer. The second concept is that of massive scalability. Economies of scale reduce the cost of the service. Implicit in the idea of scalability is flexibility and low barriers to entry for customers. Third, delivery using Internet technologies implies that specific standards that are pervasive, accessible and visible in a global sense are used. Finally, these services are provided to multiple external customers, leveraging shared resources to increase the economies of scale (Clearley 2009).

Armburst and Fox et al. (2009) define cloud computing as the applications that are delivered as services over the Internet whereby the servers, system softwares, and databases that serve the applications are hosted in various data centres of the service providers. In this mode the authors define two types of clouds – public clouds sold as utility computing for software as a service (SaaS) and private clouds deployed in internal data centres of the corporations. They proposed that the end users will need to buy a combined framework of "software as a service" and "utility computing" to avail the end to end application service framework. This framework shall ensure three major attributes of services for the end customers – infinite computing resources, no upfront commitment in the form of capital investments and computing resources on demand facility

Oracle Corporation define cloud computing as an elastic, decoupled and flexible infrastructure in which customers can move majority of their IT Capital Expenditures into Operating Expenditures dynamically (Oracle 2009). The capacity and availability is guaranteed as per business requirements and major change management is not required whenever capacity enhancements are required.

They present the following blocks of cloud computing infrastructure that includes different viewpoints from the perspective of component owners of cloud computing – Virtualised Infrastructure, Virtualised Application, Development, Security & Identity Management and Enterprise Management: The enterprise management block is the revenue layer for the cloud service providers that comprises of systems for service provisioning, metering of services and chargeback.

3. CLOUD COMPUTING MOTIVATIONS

The origin of computing started with "centralised computing" infrastructures and a long era of mainframes and mini computers survived in the IT markets (which are fully operational even today). The IBM mainframes run mission critical applications (i.e. banking or engineering control systems) even today. IBM still manages dedicated innovation centres for their mainframes and extends sale and support services of mainframe hardware to their clients. A large community of legacy IT experts still support centralised computing on mainframes as opposed to "distributed computing" on multiple low end hardware platforms. A legacy mainframe expert Kahn claims in light of IBM mainframes has celebrated 45th anniversary, it still delivers much better outcomes than any other computing platforms. Thousands of believers in mainframe systems still vouch for them but have been proved as minority against the huge community supporting distributed computing architectures (Khan 2009). The distributed computing era has led to organisations hosting large number of low cost computers collaborating to deliver applications as per business requirements. However, this architecture resulted in reduced stability, increased cost, faster obsolescence (with poor backward compatibility), increased number of people to manage IT and above all too much of management time spend on IT issues (Khan 2009) . The corporations that have implemented mainframes may still be comfortable to continue with them but the ones owning distributed computing environments are looking forward to new innovative model.

The cluster of servers supporting various needs of enterprise businesses in standalone as well as collaborative mode is called GRID computing. This architecture had wide spread use for almost two decades delivering business value to organisations. Such clusters required multi-platform and multi-vendor management thus requiring people with different skills and multiple SLAs signed with vendors. As a result, single point accountability (the Key Result Area of centralized computing) vanished completely according to Buyya & yeo et al (2009). Post the above analysis, Buyya & Yeo et al. (2009) advocated that Cloud computing is now rapidly replacing GRID computing in the enterprise computing space. Figure 2 presents that the Google search trends from 2008 onwards is more on Cloud Computing than GRID computing.

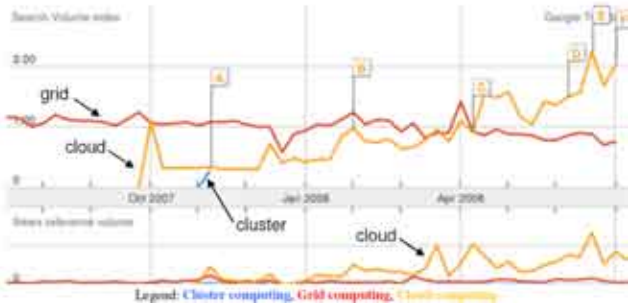

Fig. 2. Google search trends from April 2008 implicating bias towards cloud computing (Source : Buyya & yeo et al, 2009)

IBM has already launched their "Blue Cloud" computing system in 2007 and Google and Salesforce.com have signed cloud computing deal in 2008. The virtualisation solutions by Microsoft, VMware and Red Hat are rapidly being

adopted in the cloud computing environments developed by the hosting service providers. In a nutshell, the hype about cloud computing is getting realized in the form of real world solutions to corporations (Buyya & Yeo et al. 2009).

Current literatures correlate cloud computing with virtual IT infrastructures (Buyya & Yeo et al. 2008). Virtualization is not a new concept in IT computing given that it has been prevailing for a number of years on VMware and Citrix platforms (VMware Inc. 2008; www.vmware.com; www.citrix.com). Technologies like MSTSC (www.microsoft.com), VMware (www.vmware.com) and Citrix Metaframe (www.citrix.com) have been existent in the industry for many years. Such technologies have been deployed in smaller pockets whereby they have proved to be excellent solutions for some business problems but large scale implementations are not commonplace. This is due to the lack of industry's consolidated strategy and approach of implementation of virtualization. There are also conflicting definitions of virtualization itself. However, as analysed by Buyya & Yeo et al. (2008), the spurt of continuous obsolescence of hardware at a high pace is a poor justification of the Return of Investments in IT hardware and software. Therefore, rethinking large scale virtualization implementations has been a catalyst to create cloud computing platforms. These platforms are expected to support a large number of virtual machines on fewer physical machines using an operating system referred to as "Hypervisor".

The hypervisor is a light weight operating system tightly coupled with the core of the hardware. The hypervisor barely applies any load on the hardware and hence opens the entire capacity to other computing needs. Multiple operating systems are loaded on the top of the hypervisor such that they can work in their own independent computing environments without having any integrity conflicts with the hardware. Hence, hardware compatibility issues are significantly reduced by conforming to this architecture. The applications work on the top of the operating systems within the virtual machine (VM) provided to them. All interactions by the Operating Systems with the hardware are managed through the Hypervisor and hence the instructions executed at the machine language level belong to the Hypervisor and not the Operating System. This virtualization architecture is also called "Bare Metal Architecture" in which the Operating System is "not aware" that it is operating in a virtualized environment. The sensitive OS calls are trapped by the Hypervisor using a process called "binary translation".

4. CLOUD COMPUTING KEY CHARACTERISTICS

The Figure 3 illustrates the current cloud computing initiatives in relation to software as a service and platform as a service models. The authors investigated Cloud Computing key characteristics by evaluating the dominant models. The following sections describes these key characteristics.

4.1 Elasticity and Scalability

From the consumers' perspective, elasticity refers to the ability of the system to dynamically and fluidly scale up and down, and reallocate resources across consumers in a granular fashion. Automatic on-demand allocation and non-allocation of resources based on consumer requirements (person as consumer, or program as consumer) is at the heart of elasticity. Elasticity is enhanced where encoded rules, policies and algorithms drive resource allocation. Elasticity is undermined where human intervention or interpretation is required. Elasticity is necessary to support dynamic business models that are based largely on modes of revenue generation focused on rapidly changing interaction models. As needs change for the customers of an elastic service, the service can be scaled up, down, in or out to meet the need of the moment. Ideally, elasticity goes two ways. Scaling up a system to billions of transactions or millions of customers requires the ability to add system resources as you go, but you also need to be able to scale back on those resources should their need be obviated. Raw scalability of the service model is less important than elasticity of the service model.

Fig. 3. Current SaaS landscape (Source - Dickson, 2008)

From a providers' perspective, the response to elasticity demands should be addressed without requiring massive changes to the underlying technology architecture or the economics associated with the system. Failure to have an adequate technology and economic model will make it difficult to profitably deliver elasticity and scale to customers. The economics associated with delivery of a service must be of benefit, regardless of whether a scale up or scale down is needed. "Scalable" and "elastic" do not refer simply to the use of virtual machines and automated provisioning, although these techniques may be used. These terms do not imply a specific technology. Rather, they refer to the qualitative assessment that the service can rapidly scale up or down, just in time and on-demand to users. A cloud computing service provider can choose from a variety of enabling technologies to create a scalable and elastic offering. In subsequent research, we will explore the various approaches used by cloud computing service providers, and will analyse how well they deliver value to consumers (Clearley & Smith 2009).

4.2 Service Model

A separation of concerns between provider and consumer is a fundamental characteristic of any "as a service" model. Separation of concerns is particularly important for cloud computing, because it is an essential ingredient needed to deliver elasticity, support the economic model for cloud computing and encourage greater competition among service providers. The separation of concerns is focused on a service boundary that defines the interface between service provider and consumer. The boundary is defined by the service provider, and consists of a set of IT interfaces, such as menus or programmatic calls (not human interactions) to access, configure, manipulate, consume and/or programmatically extend the service. The provider is responsible for optimizing everything below the service boundary hiding complexity from the consumer. The consumer does not own, control, specify, manage or interface with any enabling technologies or related best practices and methodologies used by the cloud service provider to build, deliver and run the cloud service offering. The consumer does not need any on-premises hardware or software, except what is used to consume/use the cloud service (for example, a browser), and only needs to care what a service does, not how it's implemented. Using the service as a foundation, the consumer is responsible for any additional development that might be necessary above the service boundary to create an application.

By creating the service boundary abstraction, the provider is free to optimize the back-end environment as a whole to drive down cost. Every cloud computing service provider must strive to be better than its competitors at building a highly adaptable, extensible, scalable, elastic and low cost environment. To succeed, providers must implement the service to deal with varied consumers via a common service model (Clearley & Smith 2009).

The authors investigated these key characteristics on enterprise and SME organisation leveraging case studies. The objective of the study is to analyse each organisation to identify attributes of an organisation leveraging cloud computing.

5. CORPORATE ENTERPRISE CASE STUDY

We analysed Valeo Inc. in the context of enterprise case study. Valco Inc is a global supplier of auto spare parts and have recently implemented "Google Apps Suite", the cloud computing services package of Google, for their workforce of 30000 people working in 193 entities and 27 countries. Google has termed this as their largest ever sale of Apps Suite on their cloud platform. As per Andre Gold, the Senior VP – Technical of Valeo, this major move has been carried out to reduce office infrastructure costs by the organization and at the same time improve user collaboration and productivity. Valeo has carried out major re-organization to form four new business groups by integrating existing products & services to enhance their efficiency in the increased globalization of their markets and customers. Switching their fundamental IT systems & services to Google's cloud computing platform has ensured that the information resources are no longer limited by the limitations & bottlenecks of their internal IT infrastructure and all their employees, irrespective of their location, can enjoy same levels of speed, performance and accessibility of information. (Claburn 2009 & Phillips 2009).

This is currently a three year contract supported by Capgemini to ensure that all the 30000 users get access to Google hosted applications from desktops, laptops and handheld PDAs that includes access to Google sites, on-line documents & records, instant messaging, video streaming management, voice services and video conferencing. These services have been enabled in the first phase whereas the second phase will ensure access to enterprise directory services, workflow tools and global administrative processes. In the third phase, the mail, calendar and on-line translations services shall be rolled out to the users. As claimed by Dave Girouard, Google President, the innovations and cost savings as an outcome of deploying cloud computing platforms can help a business to respond to global mobility needs of workforce in much better ways given the low capital cost layout while achieving reduction in recurring expenses as well (Evans 2009).

6. SME CASE STUDY

IBM recently introduced LotusLive, a cloud version of the famous Lotus Notes suite. It is directly targeted to compete with Google Apps which in turn appears to achieve a clean victory in the cloud computing market. LiVE Limited is one of the first customers that implemented this solution. LiVE Limited is a media and entertainment software development company in Japan specialising in Computer Generated Imagery (CGI). IBM established cloud based solutions under various names for LiVE limited – Blue Razor, Collaborative Innovation (using Lotus Notes capabilities on cloud platform), Deep Computing, Capacity on Demand, etc. Although LiVE limited is a small company, the IT demands were very high given that the developers in the company deal with large file sizes. The benefits that they derived from IBM's cloud solution was shorter delivery time lines, higher processing power, large volume handling and lower costs. As per the success story report by IBM, this solution enabled 40000 layers of CG footage over networked IT environment thus improving the productivity because of shared and independent rendering environment allowing capacity and computing power on demand for LiVE limited. (IBM Success Stories 2009)

7. ANALYSIS OF ATTRIBUTES

A closer look at the case study of Valeo Corporation reveals that the decision to acquire Google's cloud computing services was a result of major organizational changes to prepare the company to face global competitive challenges. Valeo carried out major changes in organization structure to consolidate their existing competencies into four groups that

are tasked to face the rapid globalization of their markets and customers such that existing products and services can be extended to them globally without getting trapped into limitations of localization. The new business structure was expected to increase the mobility of their users and hence access to enterprise IT resources was required on the fly irrespective of the devices used by the end users. Further to this, enhancement of IT infrastructure at the global platter in the new business model could have costed Valeo management very dearly which was not justified in the current global economic crisis. As a result, cloud computing was concluded to be the answer and hence Valeo, with the help of Capgemini, decided to lease Google's cloud computing infrastructure for three years to run their business applications which are to be delivered in three phases. The key points that can be understood from this case study are the following:

1. Cloud computing infrastructure can support business globalization of corporations whereby the mobility of employees is expected to increase considerably.
2. Cloud computing infrastructure can help in reducing internal infrastructure costs considerably.
3. Cloud computing infrastructure can ensure improved corporate governance by virtue of better team collaboration, better administrative workflows, better access to information and data and global control on employee performance.
4. Cloud computing infrastructure can ensure simplicity, creativity and innovation in a business framework.
5. Cloud computing will result in improved efficiency by virtue of increased focus on core competencies and competitive advantages because IT has been outsourced to an able agency.
6. Cloud computing transition should be carried out with the help of a business consultant such that effective transition of business needs into IT deliverables can be carried out.
7. Cloud computing can result in significant socialization among corporate employees as they can come closer due to effective collaboration irrespective of their physical location.
8. Cloud computing is an ideal choice when the financials are not going well in the corporation as well as in the global markets.

The case study of LiVE limited offers another dimension of cloud computing for small and mid-sized companies. SME companies that have large demands from an IT infrastructure may end up investing huge amounts if they invest in in-house IT infrastructures and may still end up not getting the value that they wish to demand. Hence, cloud computing with computing power and capacity on demand may be the ideal solution for such companies given that they can invest heavily when projects are at peak implementation phase and almost nothing when the projects are in dormant mode. In this way the companies can optimize their investments and eliminate wastes completely while they are able to exceed customer expectations by delivering high quality products on time.

8. VALUE MODEL

Concluding from the case study of Valeo Corporation, the following adaptation of cloud computing has been derived with an underlying an effective governance framework that can bring together business and technology architectural requirements.

Collectively, when we analyse the findings, the research on case studies and evaluations have led to the creation of the following model illustrated in Figure 4.

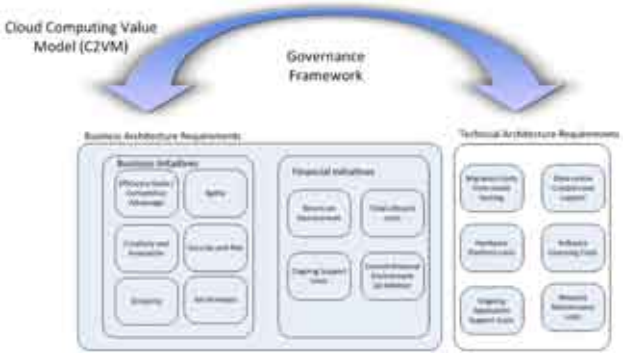

Fig. 4. Proposed Cloud Computing Value Model

Transition to cloud computing cannot be a decision taken in Silo without clearly mapping the business requirements and the benefits that it can acquire from the cloud platforms. The business architectural requirements have been divided into two objectives – business objectives and financial objectives. The business objectives comprise of:

1. Efficiency Gains and resulting increase in Competitive Advantages
2. Improved agility
3. Better creativity and innovation in products & customer services
4. Better security and risk management
5. Simplicity of IT systems
6. Better socialization among employees

The financial objectives comprise of:

1. Better return on investment in IT
2. Improvement in total lifecycle costs of IT deliverables
3. Reduction in ongoing recurring costs – like support expenses
4. Better response to financial distress or economic slowdown conditions.

The IT needs to respond to these business and financial objectives by ensuring that is a reduction in costs of:

1. Data centres creation, running and maintenance
2. Hardware platforms
3. Software licensing
4. Application support
5. Network management

These cost reductions can be achieved by transition of IT infrastructure from on-site to virtualized hosting which will have its own costs but mitigated. Hence, the ROI needs to be worked out very clearly that shall trade-off the one time transition costs.

8.1 Cloud Computing Value Model Attributes

The authors are exploring whether they could use COBIT as a model to define the attributes for the Cloud Computing Value model. The authors believe due to the high usage of COBIT in the industry and proven control structures will assist to build a solid foundation for their value model.

COBIT (Control Objectives for Information and related Technology) is a much larger framework compared to ITIL given that it is designed to implement the entire IT governance and not only the services. The COBIT framework provides the control objectives and controls in a logically organised structure comprising of best practices designed by a panel of experts. The primary objective of this framework is to link IT objectives with business requirements such that a process model for IT activities can be designed to ensure optimum utilisation of the major IT resources with respect to IT management control objectives.

The authors believe the outcome of this paper shall be a COBIT enabled cloud computing model clearly indicating the various roles contributing to the maturity of the model. The primary attributes planned for the model are:

1. Shorter implementation life cycles of IT systems & applications
2. Enhanced service levels
3. Higher uptime
4. Better business continuity
5. Excellent capacity & availability management
6. Low cost operations
7. Better risk management & information security
8. Better software development life cycle management

The authors have investigated the COBIT control objectives in detail to extract the most relevant control objectives that related to cloud computing. They have concluded the following control objectives stands out from the rest. They are Acquire and Maintain Application Software, Procure IT Resources, Acquire and Maintain Technology Infrastructure, Install and Accredit Solutions and Changes, Manage Performance and Capacity, Define and Manage Service Level, Ensure Continuous Service

The authors also categorized COBIT control structures to quantitative financial attributes and qualitative attributes. The quantitative information could be gathered by investigating past and present financial information (i.e. Return on Investment, Total Cost of Ownership etc..). The qualitative information needs to be captured by a specialized tool created as a result of this exercise.

9. CONCLUSIONS AND FURTHER WORK

We are currently enhancing the Cloud Computing Value model from the research conducted on two case studies. The proposed Value Model will not only take the financial implications of the Cloud Computing initiatives, but also attempts to address the behavior and IT control structures of organisations. The research is continuing to conduct a survey to validate the model. The eventual artefact is expected to be realised as a service adopting the model for organisations that wish to gauge the value proposition of cloud computing as opposed to traditional, in-house hosting options.

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