Enterprise Architecture Components for Cloud Service Consumers

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Abstract: Enterprise Architecture (EA) and appropriate governance enables cloud computing adoption by consumer organisations. EA is gaining acceptability as an approach for strategic alignment of business and IT and as key enabler for cloud computing. EA practices consist of a range of activities and covers many of the elements necessary for enabling cloud computing. This paper discusses the key architectural components necessary from the perspective of a consumer organization for the adoption of cloud computing and discusses these elements in the context of EA frameworks and governance. The ability to use maturity assessments on these architectural components to determine organizational readiness to achieve cloud benefits is introduced.

1 INTRODUCTION

A number of innovative technology solutions are driving changes in the nature of business and how enterprises are addressing their market opportunity and customer needs. Adapting to and leveraging the opportunities that these new trends and emerging technology capability bring is becoming an important aspect of how business can get ahead of the competition. The cloud paradigm is an amalgamation of a number of proven and emerging enterprise technologies, and enterprises are leveraging the cloud paradigm to varying degrees.

A key aspect of cloud computing is that it has brought about a cost model that leverages economies of scale. By taking aspects of IT out of the enterprise and into large scale utilities, the economies of scale benefits are being accrued to enterprises (NIST, 2013). This has been especially true of IT hardware infrastructure, but the benefits have not been equally achieved for IT processes such as strategy, planning and governance. Enterprises have attempted a trial and error approach to adopting the suitable processes that benefit from cloud computing. A *Cloud Service Consumer* can be defined as an organisation or a user or an IT system that consumes services delivered by a cloud service provider (IBM CCRA, 2014).

Today, most business and IT leaders understand the benefits of cloud computing but they need a pragmatic, effective and transparent approach to cloud adoption. Most existing methods tend to focus on prioritization at a specific solution level and fail to consider wider issues such as alignment of IT strategy with overall business objectives (Feuerlicht, George, 2013). Determining the business value is important because it measures the potential for realization of benefits directly related to the adoption of cloud computing. Enterprise Architecture provides a framework and models to assist IT management with better utilization of IT, and alignment of IT with business. Understanding the challenges and operational constraints that the organization faces helps to identify how cloud computing can benefit the organization and what business and IT capabilities will gain most from cloud adoption. Enterprise architecture is a key enabler for an effective adoption of SOA (Service-Oriented Architecture) and hence cloud computing, and this has been highlighted in the literature (Ibrahim, 2007).

In this paper we firstly discuss the role of Enterprise Architecture with specific focus on cloud computing (section 2), and then consider the problem of EA maturity assessment (section 3). In section 4 we discuss our conclusions.

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2 ROLE OF ENTERPRISE ARCHITECTURE

As discussed in (George, 2013), Enterprise Architecture is being used as an approach to managing both business and IT at a strategic level and forms the basis for achieving agile business-IT environment enabling IT to respond to rapid changes in business requirements as market conditions change. At the same time, the building blocks of IT (i.e. infrastructure components, business applications, etc.) are becoming commoditized, reducing the competitive advantage that organizations gain directly from deploying individual IT components. It is the combination of various IT components and business functions in the context of an EA framework that can deliver business value and competitive advantage. SOA architecture enables organizations to be more agile and cost effective, and cloud computing delivers similar benefits to IT.

2.1 Enterprise Architecture Functions

Enterprise Architecture in an organization is achieved through the means of EA activities that cover management activities and analysis and design approaches. The activities carried out in the context of EA can vary from organization to organization depending on the scale, maturity and objectives of the organization. However, it is possible to identify a number of core activities that typically occur and can be classified as EA activities. For example, in one characterisation eight core activities that include defining IT strategy, modelling EA component architecture, facilitating IT transformation, developing and enforcing standards and managing IT risks have been identified (Bente, 2012).

In any organisation, the EA functions and activities play a major role in the evaluation of new technologies and in ensuring that any new IT capability is delivering the planned business benefits. In the context of cloud computing evaluation and adoption it is possible to identify the following key activities:

1) Creating the essential elements of the Enterprise Architecture – the business architecture, the applications architecture, data architecture and technology architecture and evolving these architectures to meet the changing business needs. In the context of cloud computing adoption, it is critical that all the architecture elements have been adequately defined so that informed evaluation choices can be made. Evolving the IT environment to meet changing needs and adopting new technology and computing models that will deliver competitive advantage for the business is a key activity.

2) Evaluating the business value of new technologies and computing models such as cloud computing.

3) Defining standards and policies for the effective, secure and smooth running of the IT environment.

4) Defining the maturity of the organisation with respect to key skills and organisational capabilities and preparing plans to address gaps.

5) Managing and mitigating risks. In the context of cloud computing adoption, this involves defining an acceptable level of risk for the available cloud options and ensuring that the organisation has the capability to deliver defined mitigation approaches.

IT departments in organisations have grown large and complex providing multiple functions. This has happened as the importance of IT to the business grew which resulted in more IT solutions being adopted and hence requiring a large and complex IT organisation. The advent of cloud computing promises to streamline and reduce IT department growth since major functions that are usually under the management of the IT department are being provided by cloud service providers. Figure 1 is a high-level illustration of key functions that are relevant to cloud IT.

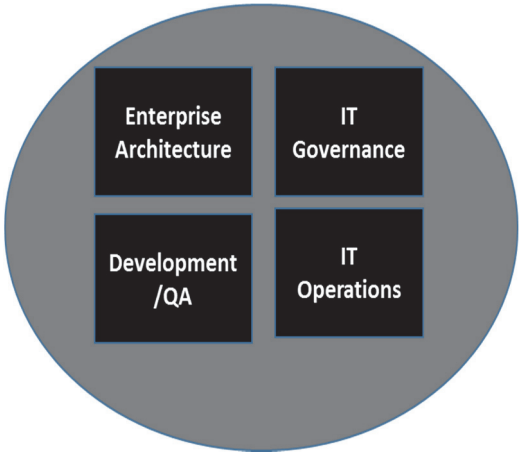

Figure 1: IT Functions for cloud IT.

As previously described Enterprise Architecture covers a broad set of functions. IT Governance incorporates IT Management and ensures that IT structures and performance are supporting the business objectives (ITGI, 2012), (Ross, 2006).

IT Operations focuses on the operational support requirements and works with IT Governance to support the requirements and business goals (ISACA 2012). Development/QA is the solution development function with QA (Quality Assurance) that provides testing and quality assurance.

In this paper we present an approach that covers the following two important elements:

1) Defining the foundational EA that will enable cloud IT to leverage EA frameworks such as TOGAF

2) Defining the governance structures for cloud IT and defining the operations mechanisms leveraging standards such as ITIL (ISACA, 2012).

2.2 Enterprise Architecture Layers

EA deals with all the main and relevant enterprise elements, especially focusing on aligning IT structures with the organisations objectives and vision. As highlighted in (George 2013), an EA helps IT functions to deliver business value indirectly, for example by reducing complexity through standardization of technology platforms, and by improving governance through defining roles and responsibilities.

An EA program in an organisation will deliver intellectual property assets for an organisation that include artefacts such as strategies, models, methodologies, roadmaps and define technology infrastructure and services, best practices and metrics. An EA framework, e.g. TOGAF (TOGAF 2009) provides guidelines, methods and best practices to help an organisation work through an EA program. EA for a given organisation consists of four layers as illustrated in Figure 2.

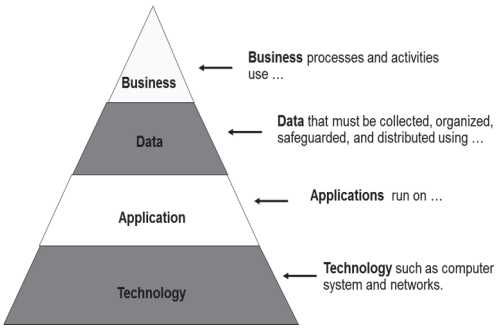

Figure 2: Enterprise Architecture Layers.

This layered approach is considered in the context of cloud computing for the cloud service consumer in the next section.

2.3 Enterprise Architecture Components for Cloud Computing

The service-based paradigm is the approach through which cloud computing is delivering value to organisations. The service-based paradigm is promoting improved agility and adaptability of business process. The service centric business aims to be agile enough to be able to support business, process and technology changes. Business process is the key element of how enterprises organise their work and business processes are supported by software capabilities. This service-based approach when incorporated into the layered enterprise architecture models has the service concept as the main linking capability between the layers (Land 2009). This layered model is illustrated in Figure 3. The way in which these layers exist in the cloud environment is also illustrated in the diagram.

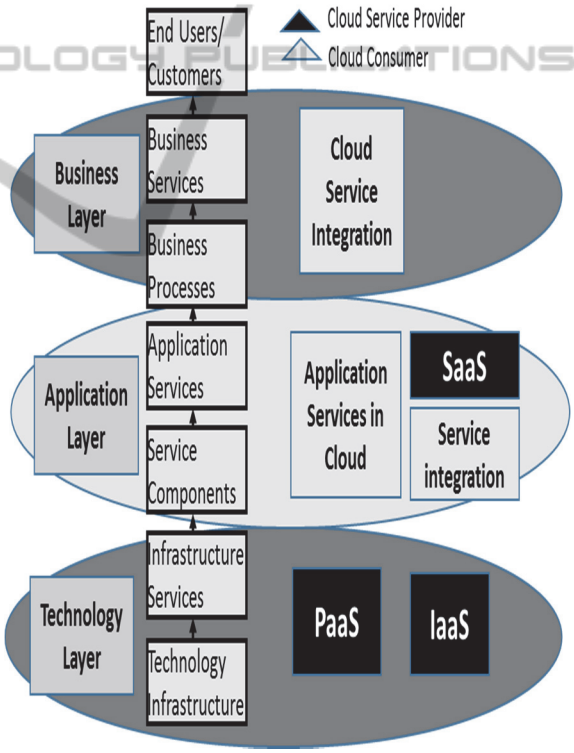

Figure 3: Service-based layered EA model and cloud mapping.

Business Layer

The business layer models the organization structure and the business services it produces, business roles and business processes, and business objects. Business services expose business functionality to the environment and business processes deliver the

business behaviour of the organisation. Two organisations in the same industry delivering the same business service may appear different to the customer if the business processes supporting the business services exhibit different behaviours. Cloud service integration tools provide business processes with integration to application service components in the cloud environment. These tools include cloud brokers and cloud service integration capabilities.

Application Layer

The application layer describes application services and their components and their interactions, logical data entities and their relationships, and the resulting services offered to the Business Layer. Services are the building blocks of the application layer architecture. The application service is available via a web browser or web services API (Application Programming Interfaces). Application components and composite services enable the creation of services dynamically improving business agility. SaaS (Software as a Service) capability hosted by the cloud service provider may be a part of the services and applications portfolio available to service consumers. Service Integration includes Service Meshes and Service Mashups that enable dynamic service assembly and service integration (Raj, 2013). Service Components are a combination of consumer application service components and generic application support service components.

Technology Layer

Technology Layer models hardware, virtual machines, application support software, networks and storage showing how these components translate into services provided to the Application Layer. The Technology Layer in the cloud context consists of: PaaS (Platform as a Service) and IaaS (Infrastructure as a Service). Both PaaS and IaaS are cloud capabilities provided by the cloud service provider and hence the consumer organisation does not need to provide the technology infrastructure. However, governance structures including operational support need to be adapted or enhanced to support the cloud environment.

The EA model described above defines the required elements for delivering cloud computing services for the cloud service consumer.

2.4 Cloud Computing Governance

Cloud computing by divesting hardware and software can reduce the size of the IT organisation. Also, governance and management structures related to hardware, networking and system software can be reduced. However, some governance structures need to be enhanced and new ones created to support cloud computing.

IT governance and service management are critical elements of IT and have been subject of extensive research interest. Oragnizations have used established frameworks such as COBIT (ITGI, 2012) and ITIL (ISACA, 2012) to address their governance and service management requirements.

With respect to cloud computing, COBIT provides support for the following three areas of governance (Feuerlicht, 2012): 1) tools to manage governance compliance, 2) best practice processes to implement governance, and 3) governance maturity model which help to determine the readiness of the organisation for cloud computing adoption. COBIT provides the necessary criteria to ensure that the ITIL processes and functions are performing to agreed to levels of quality. ITIL works closely with COBIT and is responsible for ensuring that ITIL best practices are in place to support and maintain cloud services.

In a service-based environment such as the cloud, SOA Governance and IT Governance aspects are relevant (RAJ, 2013). Additional governance activities for the cloud include activities related to consumption and management of cloud services. This includes IT Service management, Change Management, Security management and Risk management. Service Level Management includes service level contracts and performance monitoring for all entities participating the cloud supply chain. Cloud governance needs to address design time activities to support service development and run-time activities to manage policy enforcement.

3 MATURITY ASSESSMENT

The EA components described as elements of EA for cloud and the governance structures can be evaluated to provide guidelines for organisations to establish their readiness for various stages of cloud computing. Maturity levels provide a mechanism for assessing organisational or technical skill levels for a particular capability (Ross, 2004). (Ross, Weil, 2006) have described a method for assessing maturity levels of EA implementations.

IBM (IBM, 2015) has defined maturity levels for cloud service providers as part of their cloud computing reference architecture (CCRA). Using a similar approach a set of maturity levels for the cloud service consumer under the capability Services Structure and Access can be defined as follows:

Maturity Level 1: basic IaaS capability for hosting applications as services

Maturity Level 2: use of individual cloud services

Maturity Level 3: EA enables catalog of cloud services and static access to the catalog

Maturity Level 4: EA enables a fully capable cloud environment and enables integration

Maturity Level 5: EA design and implementation enable seamless integration of application services transparently regardless of location of the underlying service

The application architecture component of the EA can be assessed to determine the maturity level the current service structure capability for a particular business scenario or business service. The target maturity level to address a specific business need such as agility can be determined for the business scenario. This allows the organisation to determine the gap and the steps that need to be taken to bridge the gap. It is not always necessary to be at the highest maturity level to achieve a particular business outcome. This enables focused allocation of resources based on the business requirements. (George, 2013) has discussed this assessment approach in the context of how EA can be evaluated against business goals and objectives.

4 CONCLUSIONS

Cloud Computing Reference Models (NIST 2013) provide a reference architecture and a reference implementation approach for planning and implementing cloud computing. These reference models give greater detail from the cloud service provider viewpoint than from the cloud consumer organisation viewpoint. The NIST Reference Architecture defines the various cloud services in the context of an overall cloud computing model and provides a reference for cloud consumers to understand, categorise and compare cloud services. The IBM CCRA (IBM 2015) shows at a high level the cloud components from both the consumer and service provider perspective, and describes the cloud management platform in line with ITIL definitions. However a detailed discussion of the architecture and governance from a consumer organisation perspective has not been adequately covered. In this paper the perspective of the consumer organisation and the main architectural elements that are critical for adopting cloud computing in this context have been presented. Details of the architectural elements presented will need to be further studied in ongoing research. Further research into the relationship between the proposed approach in this paper and the cloud computing reference models like the NIST model needs to be conducted. Maturity models have been used to develop understandings of organisational readiness for adoption of new technologies and capabilities. The idea of using maturity models and assessment approaches to gain understanding of organisational ability to achieve planned cloud benefits has been introduced in this paper. Further research defining maturity levels and maturity assessment approaches of capabilities associated with Enterprise Architecture components proposed needs to be conducted.

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