

Toward Cloud Computing Reference Architecture: Cloud Service Management Perspective

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Abstract— Cloud computing architecture is used as a guideline to understand the whole process including actor roles inside a cloud computing environment. Currently, there is only a few cloud computing architecture that can be used as a reference for building a cloud computing infrastructure. As cloud computing technology is being used to minimize the usage cost of computing resources, many enterprises gained interest of migrating their old system to the cloud computing system. This paper describes an overview of the new proposed cloud computing reference architecture but focusing on one of the cloud provider components which is cloud service management. It is required for cloud providers to support them managing their cloud services properly from the planning to delivery and operation process.

Keywords— *Cloud Computing, Cloud Computing Reference Architecture, Cloud Service Management, Cloud Service.*

I. INTRODUCTION

Cloud computing has gained rapid adoption for the last three years as corporate sought more efficient and effective ways in utilizing its IT investment. It provides ability for cloud consumers to use or implement flexible and scalable services without having the computing resources installed directly on consumer's system. However, there is no precise definition of cloud computing because each industry has its own definition [1]. In other word, the definition of cloud computing can be defined based on what people expect from cloud computing. Furthermore, on the base of existing cloud computing architecture, the cloud players or also can be called as cloud actors can apply it for designing and building their cloud computing environment and infrastructure.

This paper provides cloud developers or in general cloud actors with a cloud computing architecture developed by combining two cloud computing reference architectures (CCRA) created by NIST [2] and IBM [3]. The new cloud computing architecture presents more complete explanation including more actors and components that importantly involved in cloud computing environment.

Understanding or just knowing cloud computing architecture is not good enough for building a cloud computing environment or even developing cloud services. Companies should consider having several businesses and IT expertise that are expert and professional on their field to help them

understand what requirements are required to become a successful service provider.

Part of cloud provider in cloud computing architecture which this paper will focus on is cloud service management. Actually, it has similar meaning as IT Service Management (ITSM), it refers to the implementation and management of IT services in terms of quality, business, customer satisfaction, and operation that is performed by IT service providers [4]. But instead of IT services, cloud service management focuses on cloud services, as companies nowadays are turning their old computing system to cloud-based system. Lack of knowledge and experience of cloud providers may affect companies for wasting their available resources and decreasing market share [5]. As cloud providers, they must understand how to manage properly their cloud services from architectural, business and technical perspectives such as design, implementation, SLA, operation, delivery, and quality maintenance.

II. RELATED WORKS

In this section, we will have a brief look at the existing cloud computing architecture and distinguishes the difference between the existing cloud computing architecture and the proposed one. Then we will describe cloud service management once based on the proposed cloud computing architecture.

There are several organizations that have developed a cloud computing architecture and two of them are NIST and IBM. Their well-know cloud reference architecture have been used by IT researchers, industries, or even academia as guidelines and reference for further research or development in cloud computing.

National Institute of Standard and Technology (NIST) has developed and published its research concerning cloud computing architecture in September 2011 [2]. In this research [2], the reference architecture was developed as an actor based model that represents the main or major elements of cloud computing. An actor based model will define components and activities specific and accurate and also easy to understand. Moreover, NIST provides cloud taxonomy to illustrate the actors, roles, and activities clearly with tree-like structure based on categorization or classification methods. However, NIST cloud computing architecture needs more explanation from both technical or business point of view especially in cloud

service management aspect, because cloud computing is used by people with various background and they are also expecting more knowledge of how a cloud computing works.

Another research regarding cloud computing architecture has been developed by IBM research team. In this research [3], they created Cloud Computing Reference Architecture (CC RA) based on their experience and research of IBM's cloud products and services that are applied to their cloud clients. IBM CC RA design covers several important aspects such as operation model, service management process, performance and scalability and many more. These solutions are offered by IBM to support consumers for building their own cloud computing environment. In addition, IBM also provides their clients with specific development and management tools to create and manage their own cloud services. However, the explanation in [3] is quite technical-based, how Mike Buzetti presented is less clear, maybe because his paper is meant to be sort of presentation, so it would be efficient and preferable if people read from the IBM's original documentation.

Cloud Security Alliance (CSA) has developed also a reference architecture called Trusted Cloud Initiative (TCI) [6]. It is created by combining four well-known framework and architecture such as SABSA, ITIL, TOGAF, and Jericho to fulfill the common requirements in terms of security capabilities for enterprises. CSA's TCI architecture is complex and complicated; it will need more study and research to implement it because combining different standards framework and architecture into one requires excellent understanding of each framework.

The architecture proposed in this study is to provide simple but specific cloud architecture by defining actors with their possible activities and components involved in cloud computing environment. As mentioned before, this paper will focus mainly on one of cloud provider components, which is cloud service management.

III. PROPOSED CLOUD COMPUTING ARCHITECTURE

Building a solid cloud computing environment is not easy as most people imagined, it will need a good understanding of which actors are involved, what requirements are required, and how the policies must be followed. Hereby, this study tries to give a solution briefly by proposing a simple, easy, and understandable cloud computing architecture for any cloud actors.

The proposed cloud computing architecture is using the same method as NIST used [2], which is actor-based. It explains the components and activities easily. As shown in figure 1, a cloud computing consists with six major actors and governance.

A. Actors

As mentioned earlier, there are six main actors in cloud computing and each actor has its own activities, requirements, and responsibilities. By knowing and understanding them, it would create a clear picture of what a cloud computing environment looks like and should be.

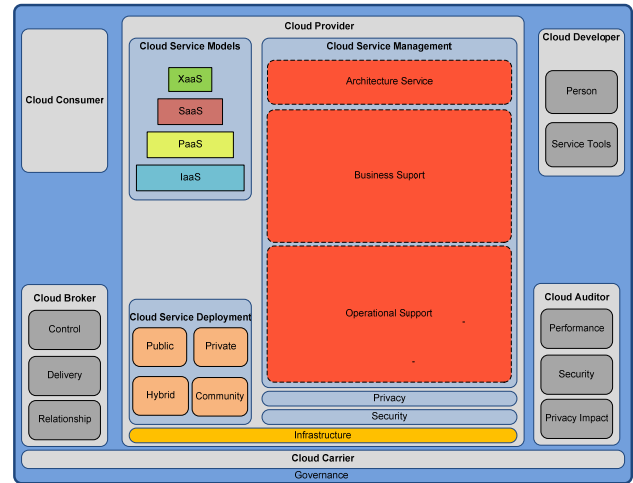


Figure 1: Cloud Computing Architecture: Overview

1) Cloud Consumer

The most prominent entity in any business especially in a cloud market is cloud consumers. It is obvious that they play an important role in business while their demand and expectation are valuable in IT industries. Therefore, by understanding the cloud consumer expectation of cloud computing, it will support continuously the development of cloud services. Based on cloud service model, cloud consumers can be classified to four different groups, they are IaaS (Infrastructure as a Service) consumer, PaaS (Platform as a Service) consumer, SaaS (Software as a Service) consumer, and XaaS (Anything as a Service) consumer. IaaS consumer refers to the customers who need a cloud service concerning infrastructure capabilities such as providing fundamental computing resources. PaaS consumer is a person or organization that is expecting a platform used to develop software or application without even bothering to install the development, programming, and security tools on user's system. SaaS consumer is generally related to all consumers that are using application on internet for their daily activities. XaaS consumer refers to the cloud consumers who have their own service definition and requirement for their business solution and hoping a cloud provider can manage and fulfill their requests.

2) Cloud Provider

Cloud providers have the most complicated components and activities. Clearly, it because they provide cloud services to the cloud consumer and own a cloud infrastructure to sustain the quality, capability, and performance of them. As a cloud provider, it is not only the infrastructure and cloud service should be focused on but the management inside a cloud computing environment should also be taken seriously. Cloud providers must understand the basic requirement of a cloud service, including cloud service model, cloud service deployment, privacy and security. In addition, maintaining, monitoring, operating, and managing are the main activities for cloud providers after their cloud services are delivered and used by the cloud consumers. Security and privacy must be designed appropriately for clouds, because without them,

it will potentially become a huge failure to this revolutionizing computing paradigm [7].

3) Cloud Developer

A person or organization who is responsible for developing cloud services is a cloud developer. It may not always directly connected to other cloud actors, because cloud developers has capabilities and ability to develop and implement services even though they do not have the exact computing resources to become a cloud developer. So, normally a cloud developer offers their cloud services to the cloud provider or deploys it in the cloud provider's system.

4) Cloud Broker

Cloud brokers serve as an agent or a negotiator among cloud actors. When actors do not want to deal or face directly between them, a cloud broker will take place for them.

5) Cloud Auditor

A cloud auditor is responsible for performing evaluation, assessment, and examination in terms of performance, security, and privacy of cloud services. Auditing is used to verify the compatibility to cloud standards and also to improve the quality of cloud services.

6) Cloud Carrier

A cloud carrier represents a physical transportation and connectivity for cloud actors to reach their target. Since internet is the only way to access cloud services, a good internet provider is required. Moreover, for delivering cloud services to the cloud consumer, it may need a transport agent. It is not just a common agent but an expert in cloud computing because while delivering, it possible to configure and set the cloud service in the cloud consumer system as well.

B. Governance

In cloud computing, governance is absolutely required. It refers to the decision making regarding policies, processes, and requirements involved in all activities in cloud computing environments. The best and most effective governance is by defining policies that covering both IT (Technical) and business issues from the organizational relationship to the involved activities and processes [8].

Governance in cloud computing is related to cloud services. These must be managed, controlled, and maintained properly for better quality and performance and therefore processes, procedures, technology are needed. Policies in governance are rules and regulations about how a service should be done and by whom the activities and processes should be performed. By following these, it will lead to a successful cloud computing implementation and management.

IV. CLOUD SERVICE MANAGAMENT

In cloud computing architecture as shown in figure 1, cloud service management is a part of cloud provider major components or requirements. Cloud service management is processes, activities and methods that are generated by cloud providers by taking cloud consumer perspective as a measure of service assurance [9]. A cloud provider has responsibilities

to provide the best quality, control, and performance of cloud services to every cloud consumers. However, they are not easy to implement, it requires good and well-organized management skills and experiences. Therefore, describing a cloud service management in this paper is useful to support cloud providers [11] [12] to achieve their business goal and objective.

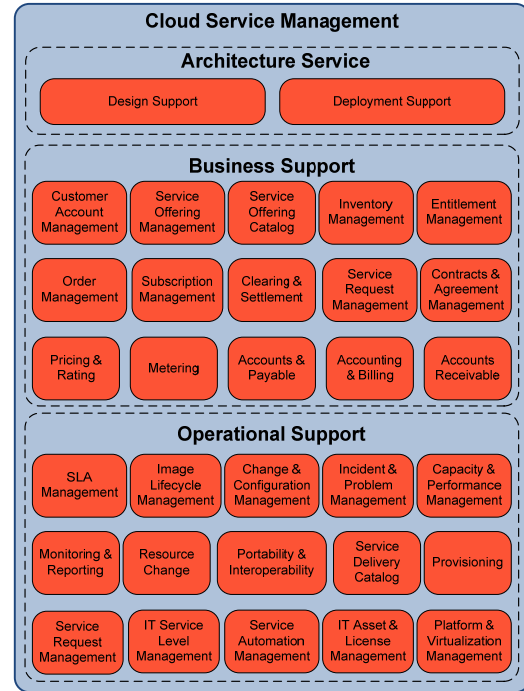


Figure 2: Cloud Service Management: Details

Cloud service management provides necessary functions for managing and operating cloud service for the customers. Cloud service management is supported by three major support services, i.e. architecture service, business support, and operational support, as shown in figure 2.

Architecture service includes architecture design and architecture deployment that supports the consulting process of the cloud architecture integration and alignment to cloud customer business architecture and strategy. It is also supporting the timely integration and alignment to cloud customer internal IT projects/initiative deployment plan. This support is to ensure early integration and alignment of the cloud services to cloud customer business changes.

Business support interacts with business-related services that directly deal with the cloud consumers. It includes components such as contracts, billing and customer account management, which includes the pricing of the services provided to the consumer.

Operational support deals directly with the service level agreement management and the monitoring of the cloud service operations to ensure that the service level agreed can be delivered to the consumer. Service Level Agreements are included in technical support because it covers the quality, performance and accessibility of a cloud service.

V. CONCLUSION AND FUTURE WORK

This paper proposed a cloud computing architecture that provides simple, basic, and clear explanation for building a cloud environment. Describing using actor-based allows people to understand more deeply about several activities involved from every actors in cloud computing. Regarding actors, this research focuses on cloud service management that is one of cloud provider components. It consists of three major support services that include architecture service, business support, and operation support. They are several processes and activities that a cloud provider must know and understand before providing any cloud services to cloud consumers. Essentially, a cloud service management will be more effective when it handled by several expertise in their field. That is why becoming a cloud provider requires both technical and business knowledge and experiences.

As the development of cloud computing is escalating, the demand of cloud services will increase as well. A new service, Security as a Service is also now included as one of the Cloud Service, as described in [13]. The expectation of cloud computing will be higher and more complex. Therefore in future research, we would like to conduct a research about combining different standards and frameworks into one cloud computing architecture. Every specific activity and issues will be run by using specific framework or standard. So at the end, every process will be managed properly based on its field. Another open area that we would like to explore is in the area of Cloud Service Level Agreement Framework that would help many of the cloud service providers guarantee service level that customer demand as more and more complex service is ready in the market.

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