A Common Factors Analysis on cloud computing models

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Abstract

From previous advancements in technology and from the likes of parallel computing, distributed computing and grid computing, a new technology has emerged, called cloud computing. In this paper, at first we discuss about eight models in cloud computing, which are built upon three major services namely IaaS, PaaS, SaaS and including other minor services such as, Hardware-as-a-Service (HaaS), Virtual Cluster-as-a-Service (ViteraaS). Then, paper tries to presents a solid comparison of these models according to a set of most common factors that any cloud models should have, identified from thoroughly researched multiple cloud-based articles. Finally, an evaluation of the comparison and exposes all the possible future works or implementation that can be considered, has proposed. The paper discusses factors that must be considered to choose the most suitable model for implementing certain functionality in cloud computing.

Keywords: ***Grid computing, Cloud computing, Infrastructure-as-a-Service, Software-as-service, Platform-as-service, virtual Cluster, High performance-as-a-service***

1. Introduction

Stand-alone computers paradigm did not support much connectivity; the evolving need for collaboration led to a division in architecture between clients and service providers. Mainframes now depended on connectivity for various functionalities and not as stand-alone entities. Grid computing enables aggregation of distributed resources and transparently access to them. Most production grids such as "TeraGrid" and "EGEE" seek to share computer and storage resources distributed across different administrative domains, with their main focus being speeding up a broad range of scientific applications, such as climate modeling, drug design, and protein analysis. There are many types of cloud functionality provisioning, which include: platform, software, and infrastructure. Clouds are pools of easily usable and accessible virtualized resources, which can be dynamically reconfigured to a variable load, allowing optimum resource utilization. The cloud has many participants:

- **The end user / client**: this is the person that is least concerned with the technicalities of the system. They simply use the system without knowledge of what is happening in the background.
- **The business management:** these are the people that govern how the system works, they make sure the system is running and providing acceptable standard services to the clients. The management must aim at providing top-notch services in order to satisfy the growing base.
- **The cloud service provider**: this is the part of the cloud that is responsible for maintenance and the assets of the business. They are the technical team of the cloud system [9].

2. Related works

Now, we will discuss about eight major and complete cloud computing models from 2009 to 2011.

2.1. Compostable Services Architecture (CSA):

In' s research he proposes CSA architecture to handle some of the pressing issues in the economy today such as, functional interoperability, basic language support and usage, deployment management services request execution management and virtual machine creation. He uses an infrastructure that combines grid and cloud concepts such as storage resources and others to design an architecture services virtualization based on abstraction of physical component services and their dynamic composition (figure 1).

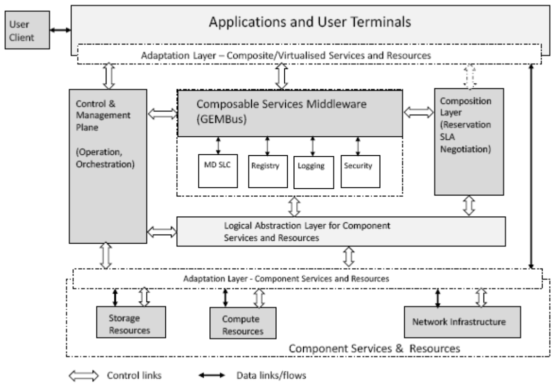

Fig. 1: Composable Services Architecture

2.2. High level market-oriented cloud architecture

Rajkumar et al present a market oriented cloud architecture which details concepts on management strategies for both customer –driven service management and computational risk management to sustain SLA. Apart from covering the basic characteristics and benefits of cloud, Rajkumar et al discus further issues like autonomic resource management, leverage VM technology for dynamic resource assigning, and derive appropriate market-based resource management strategies. In they believe in cloud concepts that enable client communication, increase access and approachability and encourage trust confidence through security (figure 2).

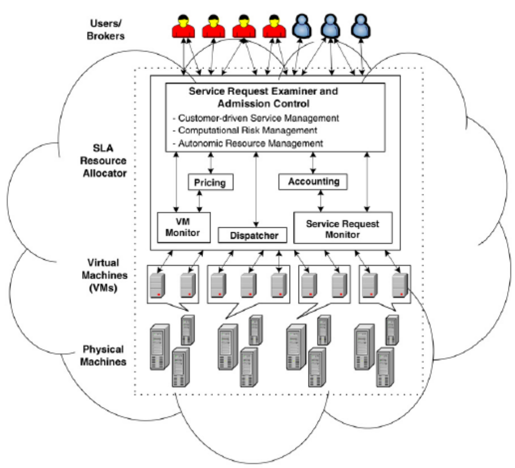

Fig. 2: High level market-oriented cloud architecture

2.3. Computer music as-a-Service Architecture

J. L, Alvaro and B. Barros present the first service –oriented music architecture for music composition. The CMaaS layer is intricately placed in between the Platform as a service layer and the Infrastructure as a Service layer; to provide functional and specialized computer music services for assembling music. The research also provides particular insight on reusability of certain functionality, which is useful in research such as rapid prototyping that is required frequently and also avails tools for building web applications (figure 3).

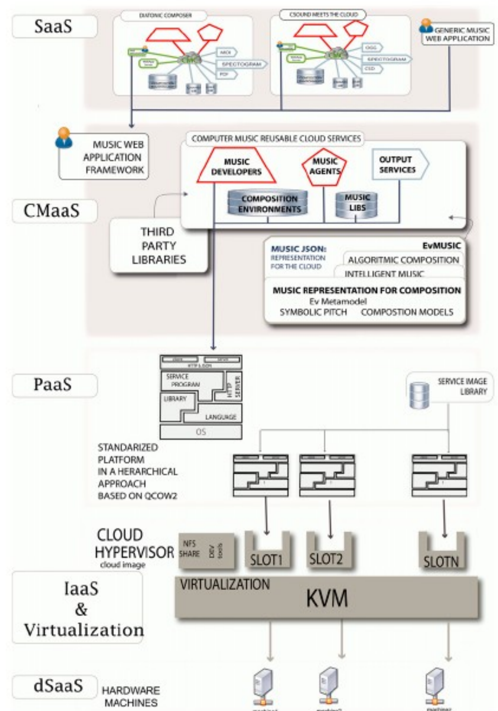

Fig. 3: Computer music as a Service Architecture

2.4. Cloud Computing Open Architecture (CCOA)

Liang-Jie Zhang and Qun Zhou present a Cloud Computing Open Architecture (CCOA), the architecture was modeled based on seven principles and two strategically thought of technologies, namely, virtualization technology and Service-Oriented-Architecture (SOA). The virtualization controls how the images of the OS, middleware and application are created allocated and destroyed all on-demand. SOA is the growth of a system, which involves addressing, reusability, extensibility and flexibility. This model can be used for high-level strategic planning, for an inter-connected scenario and it can be used as architectural foundation to guide the lifecycle of the cloud. This architecture is offered to help create and explore the business value of cloud computing (figure 4).

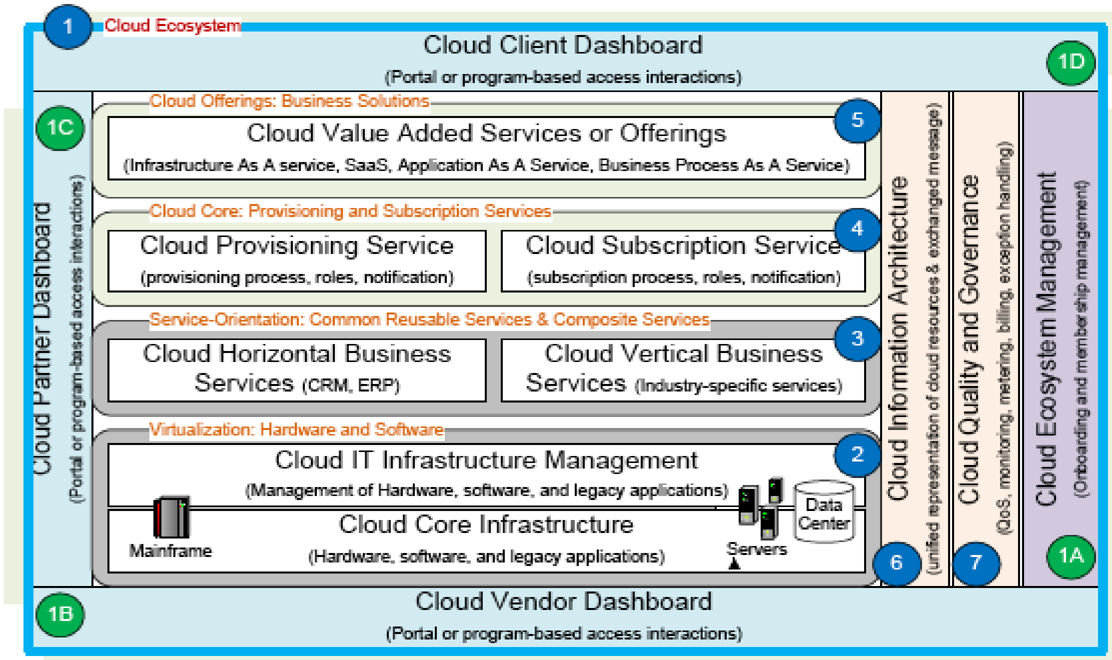

Fig. 4: CCOA: Cloud Computing Open Architecture.

2.5. Virtual Cluster as a Service (ViteraaS)

F. Doelitzscher, M. Held, C. Reich, and A. Sulistio, proposed a service model ViteeraS, which makes use of OpenNebula (a virtual infrastructure manager), in which users can create dynamic clusters of VMs on idle resources. The user defines the size of each cluster and it is created on-demand. After the task has finished, the cluster is "demolished" and the resources are released for newer clusters. ViteraaS is helpful for students and professors, to conduct high performance computing tasks. The objective of ViteraaS is to shorten the creation/deletion of HPC tasks; it also provides stringent security using single-sign-on method and also provides monitoring of the virtual clusters (figure 5).

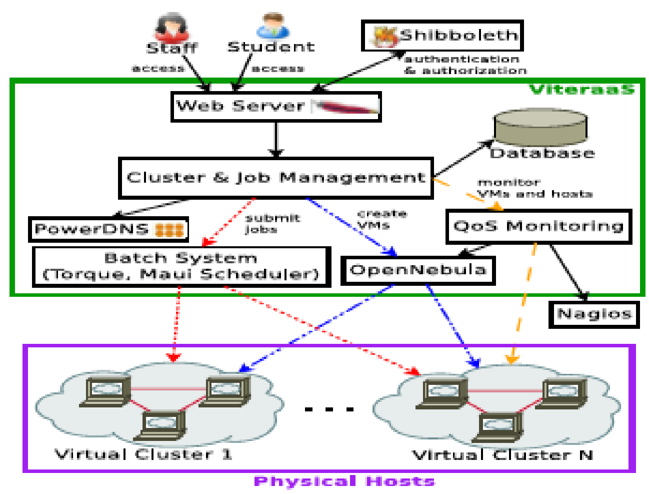

Fig. 5: ViteraaS: Virtual Cluster as a Service

2.6. Designing Flexible Resource Rental Models for Implementing HPC-as-a-Service in Cloud

Han Zhao and Xiaolin Li insinuate a resource rental model , owing to the growth of cloud computing, many scientific communities would like to conduct large-scale high resource experiments, planning resource rental is not easy in a cloud environment, because different communities have different interests, this being the main issue. The CloudBay architecture provides abstraction and flexibility, also providing enriched features for scalable and autonomic resource management through an incentive-compatible payment method (Vickrey). The objective of CloudBay is to provide a suite of tools, which help ease resource sharing and enhance application-to-infrastructure mapping (figure 6).

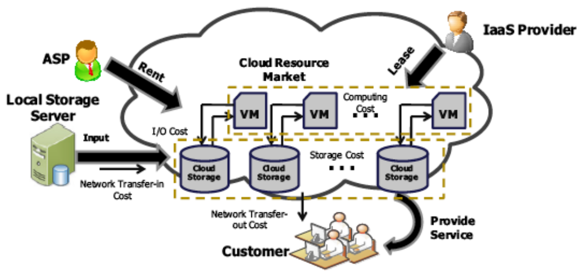

Fig. 6: System model for deterministic resource rental planning

2.7. NIST Cloud Computing Reference Architecture

NIST reference architecture was the first version of a neutral conceptual model that consists of five major components which are the cloud broker, cloud service consumer, cloud carrier, cloud auditor and cloud service provider. It was designed to help the United States government in understanding the cloud computing components for federal IT executives, program managers and IT procurement employees. The cloud service provider is responsible for providing services, management of resource allocation, control and the physical resource layers. IT is also responsible for the management of the cloud in overall. The cloud carrier is the middleware between the consumers and the providers through network, telecommunication or other access devices. Cloud broker enhances and eases the cloud consumer to handle the complexity of cloud services integration. The cloud auditor evaluates the services provided by the cloud provider in terms of security, privacy and performance. The cloud service consumer is the federal agency that is interested in moving to cloud-based solution such as PaaS, and Microsoft azure (figure 7).

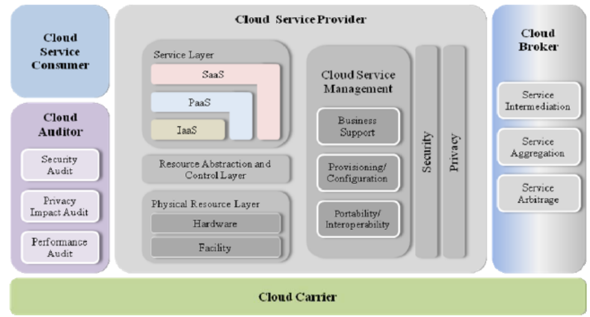

Fig. 7: NIST Cloud Computing Reference Architecture

2.8. A Business-oriented Cloud federation model for real-time applications

Cloud federation allows users to work interactively to offer best-effort services to service customers. The research that has been done in this paper is discussing the current federated cloud computing for computationally intensive real-time (real time interactive applications (ROIA). The aim of this research is to discuss developing business oriented federated cloud where multiple independent infrastructure providers can cooperate flawlessly to provide scalable IT infrastructure and QoS –assured hosting services for ROIA. The aim of federated cloud computing is to federate disparate data centers or cloud providers including those owned by separate organizations to enable a flawlessly infinite service computing utility (figure 8).

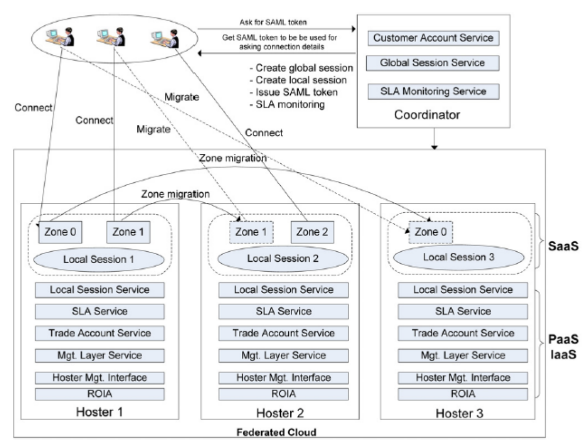

Fig. 8: A Business-oriented Cloud federation model for real-time applications

3. Discussion and Evaluation

Regarding to our research based on more than nineteen articles, the figure below shows the fifteen major characteristics which should be present in a cloud model.

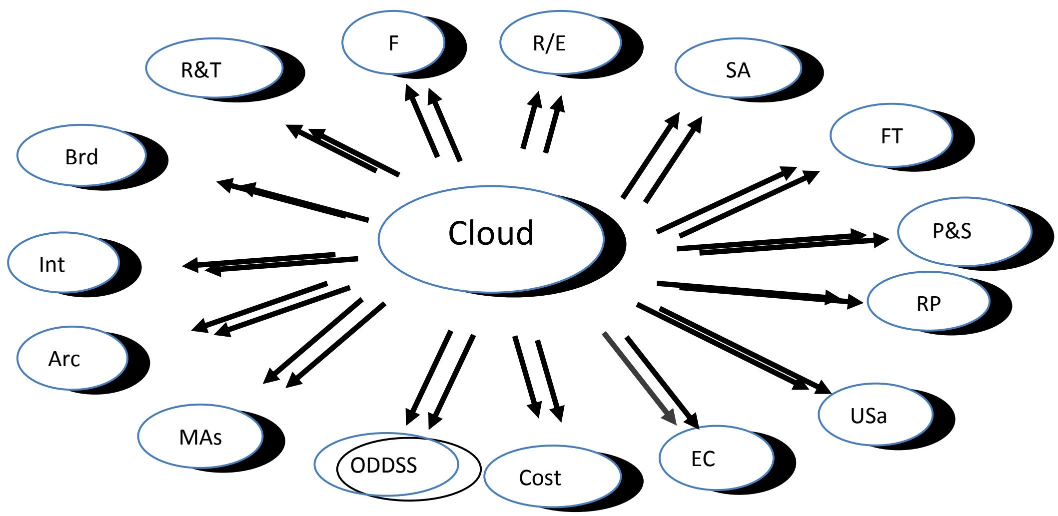

Figure 9: evaluation factors diagram

The table (table 1) below indicates the various factors presented in the figure above (figure 9) that surround and affect the functionality of a cloud-computing model.

Table 1: list of the factors or characteristics for cloud model evaluation

No.	Characteristic
1	Security and Compliance (SA)
2	Performance & Scope (P&S)
3	Fault Tolerance (FT)
4	Resource Pooling (RP)
5	Elasticity (EC)
6	Cost
7	On demand Self Servicing (ODSS)
8	Architecture (Arc)
9	Interoperability (Int)
10	Usability (USa)
11	Measured Service (MAs)
12	Broad network access (Brd)
13	Resilience/Effectiveness (R/E)
14	Flexibility (F)
15	Reliability and Trustworthiness (R&T)

The table (table 2) below shows an evaluation of the researched-upon models while comparing the fifteen of the most common factors that any cloud models must have:

Table 2: comparison table among eight models based on fifteen characteristics

Models	Composable Services Architecture (CSA)	High level market-oriented market architecture	Computer music as a Service	NIST Cloud Computing Reference Architecture	A Business-oriented Cloud federation model for real-time applications	ViteraaS	Resource rental Model for HPC-as-a-Service	Cloud Computing Open Architecture (CCOA)

1	Security and Compliance	Y	Y	Y	Y	Y	Y	X	X
2	Performance & scope	X	X	X	Y	X	Y	X	Y
3	Fault Tolerance	Y	Y	X	X	Y	X	X	X
4	Resource Pooling	Y	X	X	Y	Y	Y	Y	Y
5	Elasticity	Y	Y	X	X	Y	X	X	Y
6	Cost	X	Y	X	X	Y	X	Y	X
7	On demand Resource Provisioning	Y	Y	X	Y	Y	Y	X	Y
8	Architecture	Y	Y	Y	Y	Y	Y	Y	Y
9	Interoperability	Y	Y	Y	Y	X	Y	X	Y
10	Usability	X	Y	X	X	Y	Y	X	X
11	Measured Service	Y	Y	X	Y	Y	X	Y	X
12	Broad network access	Y	Y	X	Y	X	X	X	X
13	Resilience/ Effectiveness	Y	Y	X	Y	Y	Y	X	X
14	Flexibility	Y	Y	Y	Y	X	Y	Y	Y
15	Reliability and Trustworthiness	Y	X	X	Y	X	X	X	Y

In regard to the table above, our findings show that the most important characteristics that every architectural cloud model should have include the following by percentage:

i. **Architecture (100%):** There should be a predefined architecture that constitutes of a variable organization of different services that the clients can use. In the interim a comparison of IaaS, PaaS, and SaaS must be variably considered to come up with an optimal output even with many other factors concerned.

ii. **Flexibility & Interoperability (87%):** This includes the ability for a particular model being set up in such a way that is can be able to handle vast growing platforms. It concerns setting a structure that supports various forms of operating devices and systems over the network in order to support various technologies and systems.

iii. **Security and compliance (75%):** Security and compliance defines the ability for the architecture to handle several forms of malpractices that may lead to the common breaches of confidentiality, integrity and availability. The model is set up in such a way to handle and prevent various forms of malicious attacks and access and as a result elevating client trust ability.

As a result, the above listed factors have to be considered if a suitable model is to be chosen for implementing certain functionality. Based on our analysis and the result which has showed in table 2, the first model that is covered more than 80% of characteristics is "High level market-oriented market architecture, Composable Service Architecture" and the second model is "NIST Cloud Computing Reference Architecture" with covered about 73% of all factors.

4. Conclusion

Cloud computing is a modern concept where clients use third party resources based on some policies to perform certain functionality. In this paper, we discussed eight models in cloud computing, which are built upon three major services namely IaaS, PaaS, SaaS and including other minor services such as, Hardware-as-a-Service (HaaS), Virtual Cluster-as-a-Service (ViteraaS).

In this research we have compared some architecture based on several characteristics and drawn conclusions on which is the best architecture based on the features that are most necessary. This research also highlights the missing parts for evaluation and improvement to make cloud computing more standard technology for future use. Based on our analysis "High level market-oriented market architecture, Composable Service Architecture" and "NIST Cloud Computing Reference Architecture" are the architectures covering most of the characteristics.

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