Volume 5, Issue 2, February 2015 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Analysis of Interoperability and Portability for Cloud Computing

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Abstract— The computational world is becoming very large and complex. Cloud Computing has emerged as a popular platform for more agile and cost effective business application and IT infrastructure. The concept of a cloud operated by one service provider or enterprise interoperating with a clouds operated by another is a powerful idea. Security is an issue which is consistently raised. The greatest challenge beyond trust and security for the long term adoption of cloud computing is the interoperability between clouds. In this paper we provide cloud computing standards and interoperability, some interoperability factors and also reveal a new approach in providing cloud portability.

Keywords— cloud, computing, portability, interoperability, standardization.

I. INTRODUCTION

Although the cloud computing market place is still in the early stage of developments but it is still exciting, fast growing and full of opportunities. Cloud computing can be defined as accessing third party software and services on web and paying as per usage. The benefits of cloud computing are very clear that is the ability to leverage virtualized infrastructure for greater efficiency, and to be able to upload or download a specific service, based directly on business need. The uniqueness of cloud computing is that distributed physical resources such as storage, networking, CPU, programming framework and libraries and services can now be integrated and offered on demand through the use of internet in as "pay as you use" manner. With the presence of numerous vendors, the need is emerging for interoperability between clouds so that a complex and developed business application on cloud is interoperable. Now a day many companies still do not tie their critical applications to specific cloud providers services due to the underlying technology. The incompabilities can be either technical or semantic. For the same features different cloud providers use different modelling and notation [1].

The cloud computing community typically uses the term interoperability to refer to the ability to easily move workloads and data from one cloud provider to another or between private and public clouds. Even though this definition corresponds to the meaning of the term portability- the ability to move a system from one platform to another- the community refers to this property as interoperability.

Cloud portability is the ability to move applications and data from one cloud computing environment to another with minimal disruption. Cloud portability enables the migration of cloud services from one cloud provider to another or between a public cloud and a private cloud. Customers or organizations don't want to be locked into a single provider option and may want to mitigate risk and increase their flexibility through the ability to move their applications and data between cloud service providers as their computing workloads vary and the business requirements change.as the need arise they would like the freedom to move among the different cloud deployment models by potentially shifting to public clouds as well as between public, private and hybrid clouds.

Table 1 Interoperability and portability

Notion	General Understanding	In the case of Cloud Computing
Interoperability	Concerned with ability of systems to communicate Requires communicated information is understood by receiving system	Ability to write code that works with more than one cloud provider simultaneously, regardless of the differences between the providers
Portability	Ability to run components or systems written for one environment in another environment.	Includes software and hardware environments (both physical and virtual).

II. MOTIVATION

Existing cloud computing solutions have not been built with interoperability in mind [1]. The current software stacks of cloud services are heterogeneous and the provided features are often incompatible between different providers. They generally lock customers into a single cloud infrastructure, platform and services [2]. This limits the cloud environment and is an obstacle with respect to demands such as promoting portability and preventing vendor lock-in. The European

Network and Information Security Agency (ENISA) and European commission have recognized the vendor lock-in problem as a high risk issue [3]. Cloud adoption will be hampered if we don't find a solution for integrating data and application across cloud. Interoperability is a term that will remedy this situation and benefit both the customers and providers of cloud.

Portability and interoperability combine to provide compatibility of cloud solutions. They are important considerations for cloud planning because together they ensure that cloud solutions continue to operate (through interoperability) and do so unchanged (through portability). When portability and interoperability between components is not addressed, unanticipated processing failures will be the likely result with the associated costly disruption of business continuity. Therefore standardization bodies and researchers need to sit together and agree on a set of common principles that all interoperability solutions will adhere to.

III. METHODOLOGY

Analyzing the past to prepare for the future [4]. The proposed research uses a systematic methodology to review existing literature concerning cloud computing, interoperability and portability. For this a survey was conducted by searching some databases of computer science using the keywords cloud computing, interoperability, portability, framework, architecture etc.

After reviewing some publications were selected as most relevant and they were organized depending on the content

a. Cloud computing interoperability meaning;
b. Cloud interoperability and standardization;
c. Interoperability frameworks of cloud computing;
d. Interoperable cloud solutions.

After studying these publications a set of requirements were derived which will constitute the theoretical framework for the existing cloud computing solutions in order to ensure cloud computing interoperability.

IV. REVIEW OF LITERATURE

D. Jamil and H. Zaki [5]describes that cloud computing is becoming more and more popular today and is ever increasing in popularity with large companies as they share valuable resources in a cost effective way. Due to this increasing demand for more clouds there is an ever growing threat of security becoming a major issue. The work shall look at ways in which security threats can be a danger to cloud computing and how they can be avoided.

T. G. Peter Mell [6] described Cloud computing is an evolving paradigm. The NIST definition characterizes important aspects of cloud computing and is intended to serve as a means for broad comparisons of cloud services and deployment strategies, and to provide a baseline for discussion from what is cloud computing to how to best use cloud computing.

C. Wang, K. Ren and Q. Wang [7] discuss the Cloud Computing has been envisioned as the next-generation architecture of IT Enterprise. In contrast to traditional solutions, where the IT services are under proper physical, logical and personnel controls, Cloud Computing moves the application software and databases to the large data centres, where the management of the data and services may not be fully trustworthy. This unique attribute, however, poses many new security challenges which have not been well understood. So the focus is on cloud data storage security, which has always been an important aspect of quality of service. To ensure the correctness of users' data in the cloud, the authors introduce an effective and flexible distributed scheme with two salient features, opposing to its predecessors.

Interoperability in the area of cloud computing means "the ability to write code that works with more than one cloud provider simultaneously, regardless of the differences between the providers" [8].

According to Cohen [9] a common cloud taxonomy can be the base for the development of such a common understanding between different cloud systems.

According to Cerf [10], Tim Berners Lee argues that semantically linking data may be the missing part of vocabulary needed to interconnect computing clouds and therefore solving cloud interoperability problems. In particular semantics of data, actions taken on the data and the vocabulary in which these actions are mentioned or expressed are the beginning of an inter cloud computing language.

The distributed management task force(DMTF) [11] has introduced open cloud standards incubator which aims at standardizing the interactions among cloud environments.

The Open virtualizations format describes virtual appliances for the deployment across heterogeneous platforms, allowing its users to deploy their virtual appliances in various clouds.

The cloud computing interoperability forum (CCIF) is planning to come up with global cloud computing ecosystem where two or more cloud platforms will be able to work together seamlessly.

The organization for the advancement of structured information standards (OASIS) plans to develop cloud models, profiles and extension on existing standards to support cloud computing security and interoperability.

The Open cloud consortium (OCC) has developed the benchmarks for interoperation between different cloud providers.

Hoff [12]states that cloud community address cloud computing interoperability as service brokers, semantics and APIs.

Cohen [13]states that cloud providers can interoperate when they share a common set of APIs as well as a common terminology taxonomies that describes them.

A. Govindrajan and Lakshmanan [14] states that besides APIs and brokers, interoperability should be investigated to control data, security and aspects and also propose to build relevant layers of abstraction to help interoperability and portability.

Urquhart and Sambyal [15]states that there there are only two interface points, management interface and unit of delivery which PaaS and IaaS services need to standardize.

Mell and Grance [16]have proposed a model to address a cloud computing interoperability where cloud capabilities fall into two categories, core and advanced capabilities. They also stated that each cloud model has its own specifications and they need to be focused separately.

Hoff and Sambyal [12] [15] also stated that cloud computing interoperability frameworks share a set of common characteristics and directions for achieving interoperability using semantic approach. They also stated that a common standardized API is of high importance to cloud interoperability.

B. Bernstein and D. Vij [17] proposed a mediation mechanism enabling connectivity among desperate cloud providers. The mediation mechanism captures the capabilities available from a cloud provider infrastructure, logically groups and exposes them as standardized units. The mediation utilizes a resources catalog approach defined using RDF and a common ontology of cloud computing resources. Inter cloud root providers act as brokers and host the cloud computing resource catalogs.

B. S. Lee, S. Yan, D. Ma and G. Zhao [18] defined generic service models for IaaS by abstracting the commonly used operations from leading IaaS providers and make IaaSA with full coverage of functionalities to satisfy IaaS user requirements.

SITIO is defined as a business process based on semantic platform where services are executed from a SaaS perspective. It's a platform which is oriented towards interoperability and cost reduction. It allows external developers to create addon applications that integrate into the main SITIO application and are hosted on cloud computing infrastructure.

V. FINDINGS AND DISCUSSIONS

After studying the literature on cloud computing, we found some missing pieces which are required to solve the problem of interoperability and portability. A set of requirements that should be included in the cloud computing framework is derived. We also observed that cloud community utilizes semantics model and techniques for addressing cloud interoperability. The community also needs to develop and adopt standardized methods and models to address the issue of cloud computing interoperability and portability. A set of standardized cloud models should be developed for describing the fundamentals cloud entities. A standardized cloud API should be developed and supported by the cloud vendor.

However in real life persuading the whole community to agree and adopt a common model is hard to achieve. Thus a more flexible approach is needed which aims at developing a common or unified cloud computing interface referred as cloud broker The cloud broker serves as a common interface for the interactions between remote platforms, networks, systems, apps, services and data. This model addresses both PaaS and IaaS. The goal of this approach is to facilitate a hybrid cloud computing environment that is decentralized, extensible and secure.

The survey motivates and encourages the cloud community to adopt a common cloud computing interoperability framework, creation of a common data model and standardized cloud interface. This will form the base for development of a semantically interoperable cloud environment.

VI. CONCLUSION

Interoperability and portability standardization have a huge impact on the cloud adoption and usage. Standardization will increase the adoption of cloud computing. The common data model supports and provides a mechanism for improving the portability and interoperability aspect of cloud computing. Users will have a wide range of choices in cloud and organizations can use their own existing data center resources seamlessly. Standardization also provides the users to choose and use services provided by many different cloud vendors based on various criteria. it also benefits the vendor by providing additional higher level services apart from normal cloud services that are needed by the user. Thus standardization will open the way towards realizing the true potential and benefits of cloud computing.

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