Interoperability Standards Impact on the Cloud Virtualization

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ABSTRACT: *The domain Cloud Computing has emerged as a unique discipline characterized by the crucial features such as virtualization and pay-by-use. However, the field cloud computing has many unresolved issues. One such important problem is in the interoperability. In this paper we describe a few interoperability standards and the causes for its deployment. Mobile computing with three systems of models are also explained in this study.*

Keywords: Cloud Computing, SaaS, PaaS, IaaS, Interoperability, Mobile Services

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1. Introduction

Cloud computing is an entirely new technology based on the development of parallel computing, distributed computing, grid computing and virtualization technologies, thus defining the shape of a new era [1]. It has emerged as a result of the evolution of Virtualization, Utility computing, Software–as-a- Service (SaaS), Infrastructure-as-a-Service (IaaS) and Platform-as-a-Service (PaaS). Cloud computing can be defined as accessing third party on-demand software and services[2]. It allows scalability and virtualized resources over the Internet as a service, providing a cost effective and scalable solution to the customers. Cloud computing rapidly evolved as a technology especially in the last 3-4 years with the presence of many vendors in the cloud computing market.

The presence of numerous vendors in the cloud requires a need of interoperability. With interoperability consumers can share

applications, services, data on different machines from different vendors. This means that application and services that are used by an enterprise can be placed on different platforms hosted by different vendors. Interoperability means a possibility for two or more networks, systems, applications, or devices to externally exchange and readily use information, in a secure and effective manner, as presented on Figure 1.

As the hype over cloud computing evolves into a more substantive discussion, one thing has become clear – customers do not want to be locked into a single cloud provider[3]. They like to move among the clouds, from private to public and back again. This would give customers the freedom to switch between providers according to their needs and also the ability to move applications around as their business requirements change. True cloud interoperability will not occur for some time. Standards are nascent and will take years to fully develop.

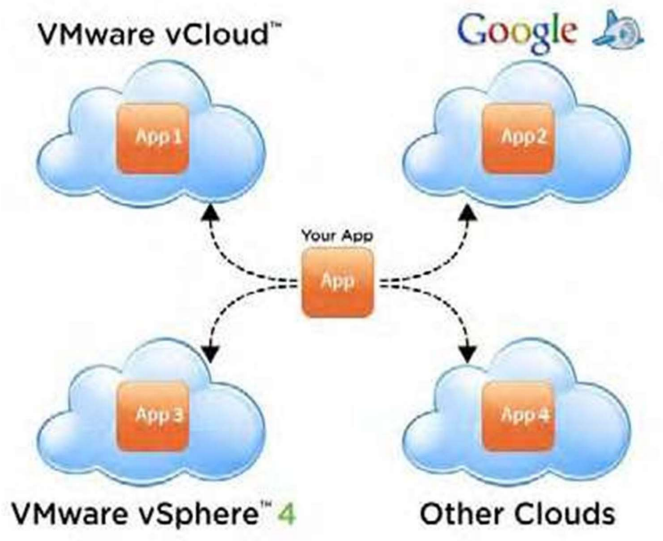

Figure 1. Interoperability in Cloud Computing

The rest of the paper is organized as follows: In Section 2 we define interoperability in cloud computing, definition of interoperability, requirements, as well as two dimensions of interoperability, Vertical and Horizontal. Then in Section 3 we define Interoperability Issues in cloud computing.

Correlation to Mobile technologies is explained in Section 4. Finally, the related work and conclusion are presented in Sections 5 and 6 respectively.

2. Interoperability In Cloud Computing

This section explains the definition of interoperability, as well as the requirements that each of three service models (IAAS, PAAS, SAAS) have. Also this section covers two dimensions of cloud computing, Vertical and Horizontal.

2.1. Definitions of Interoperability

In the IEEE glossary [4], interoperability is defined as the ability of two or more systems or components to exchange information and to use the information that has been exchanged. According to Petcu[5], there can be several definitions of cloud interoperability in the literature. For example, interoperability has been defined as the possibility to abstract programmable differences from one cloud to another, the possibility to translate between the abstraction supported from different clouds, to flexibly run application, locally, in the cloud or in a combination, or to use the same management tools, server images, software in multiple clouds.

2.2. SAAS Interoperability

Interoperability in SAAS enables different applications to exchange information between themselves. Enterprises store and maintain their data in an existing enterprise application, on premise, or somewhere in the cloud. Therefore they need

to be sure that every SaaS application which is a part of their global strategy will be interoperable. This means that every SaaS vendors must provide the exchange of data interfaces in order to keep applications synchronized. Nevertheless, heterogeneous, common data must be able to flow between applications. Also, data modification, in master enterprise application should be synchronized with other SaaS applications, in a seamless manner.

2.3. PAAS Interoperability

During the deployment of the applications in PaaS, developers are able to use tools, libraries or APIs from different PaaS providers. PaaS providers make efforts to achieve better interoperability between cloud providers. One of the main elements of PaaS is the existence of APIs.

Although having an API doesn't make a certain system a platform, APIs are the key of the great success of PaaS. APIs facilitate the work of the developers and allow them easier access to the platform functionalities. Instead, they use the API from the very beginning and have easy access to the functionality. Interoperability of the applications deployed on PaaS is limited because every application is developed using a different programming language, .NET, Java, PHP, Python, Ruby. This enables dealing with different data models and proprietary runtime frameworks that each application requires and each provider enables quite challenging. At the moment, there are no developed standards for interoperability, but there are several initiatives by nonprofit groups and some providers [7].

2.4. IAAS Interoperability

Interoperability in IAAS refers to the ability of the client to use infrastructure resources from different vendors through a common management API. VMs comprise the fundamental working structure for an IaaS platform. The number of consumers that want to have mixed virtual environment in theirs enterprises and to be able to move VMs between providers is growing. For instance, every customer should be able to do the same set of operations on VMs from different providers without creating clients for them[6].

2.5. Two Dimension of Cloud Computing Interoperability

There are two main dimensions of cloud computing interoperability: Vertical and Horizontal. Vertical dimension defines how cloud computing facilitates interoperability in one enterprise cloud platform, but between different devices and applications which are used by the end users to access the information stored by the cloud provider. The vertical dimension defines interoperability in terms of the cloud computing affordances of a single provider, generally from an end-user or a consumer perspective[8]. Assessing the vertical dimension implies asking such questions as Does cloud based software works on most Internet connected devices? or Can cloud based software allow using of other applications or data available from users' device?

The vertical dimension simplifies two interrelated elements, device independence and location independence. When a customer accesses their data or services on the cloud, they are not limited to use the device on which the data and applications are stored. Instead they can use any Internetconnected device to do this. The possibility to store and use the applications on the cloud allows the user to access the information and applications from devices with lower performances. The customer becomes less dependent from devices performance and also may benefit in both convenience and cost savings.

On the other hand, horizontal dimension defines interoperability between different platforms. This dimension implies how an enterprise which hosts its service on a cloud can easily switch it to a competing provider which offers favorable rates and reliable service. It also addresses whether there are consistent ways to coordinate among distinct cloud products, such as standardized contractual arrangements, security features, data privacy terms of service, or identity management capabilities. These multifaceted dimensions of horizontal interoperability might be salient for end-users as well as for companies that purchase cloud products[8].

3. Interoperability Issues

Initiatives like OGFs Open Cloud Computing Interface (OCCI, 2010), are trying to bring APIs specification for development and monitoring in a short period of time. It takes time for standards to mature and for reference implementations to become available. Until then, the users will use APIs from cloud computing vendors, which they think are most suitable for their requirements. When standards emerge and vendors want to use services from other vendors then brokers/adapters need to be used for interoperability. However new users will be able to use the new standard APIs. With some of the major vendors like Microsoft and Amazon rejecting CCIF agenda and using their own interoperability agenda, standardization becomes more difficult to

achieve. This could lead to a scenario in the long run where multiple standards co-exist and customers would use brokers/ adapters for interoperability for using services from multiple cloud service providers[9].

3.1.Towards a Solution

Stepping towards a commonly and widely adapted solution means that there is a considerable amount of work and research to be performed. However, initially there are key observations collected, which cannot be ignored simply by an approach for developing a new interoperability standard[10]. Amazon, GoGrid, SalesForce, Google, AT&T, and other cloud providers, probably will not accept the standardization for export/import of cloud configurations. They are not interested in giving total freedom to their clients in changing providers and they don't want to compete with other companies. Each of the cloud providers offers different services and wants to have unique services to attract more customers.

3.2. Upcoming Cloud Standards

In order to regulate cloud computing, a standard similar to the popular TCP/IP for networking is required. Most likely it would be an API that will be implemented in all cloud products and services and would promote transparent interoperability. But such implementation is way out in the future. It is more straightforward to come up with standards to the low-level cloud concept (IaaS), than PaaS (Platform as a Service) or SaaS. In this way, efforts have to be undertaken to distinguish which features or common characteristics should be interesting to standardize in each level[10]. Some of the vendors are pushing their own standard. VMware has submitted its vCloud API to the Distributed Management Task Force (DMTF) for ratification as an open standard, and Red Hat has submitted its Delta cloud platform to the DMTF as well. VMware's vCloud is being used in VMware-based private clouds and in its partners' vCloud Express public clouds, providing users with some cloud interoperability, but at the expense of almost total lock-in. The only real cloud standard to date is OVF (Open Virtualization Format). However, it only relates to the packaging of virtual machines for facilitating their mobility [3].

4. Related Work

Recently, some of the CC concerns are about the interoperability between different providers (Parameswaran and Chaddha,2009), (Dikaiakos et al., 2009). It should be possible for developers to swap enablers between platforms whenever they need to (performance issues, actual costs, etc.) without re-architecting the solutions. This can be very challenging with different data models and runtime frameworks that each application required and each provider enables. Currently there are no standards for interoperability, but there are initiatives from non-profit groups with the collaboration of researchers and some Cloud service providers.

The Open Cloud Manifesto (OCM, 2010) is an initiative supported by various vendors with the vision to standardize Cloud Computing (interoperability, portability, security, governance and management, etc.). The goals of open cloud such as flexibility, speed and agility are outlined to lead a discussion for the new cloud computing paradigms and impacts.

Another group, the Cloud Computing Interoperability Forum (CCIF, 2009), proposes to unify Cloud APIs with a standardized semantic interface (Unified Cloud Interface) (UCI, 2009) and abstraction layers from the underlying infrastructure. The orchestration layer and the federation of clouds are the characteristics of the CCIF presented architecture.

5. Correlation To Mobile Technologies

Mobile and Cloud Computing are the two dominant transformations driving the IT industry in the recent and moreover, upcoming years. The mobile devices (smartphones, computers, etc.) are increasingly becoming an important part of the human life as most efficient and most proper communication tools. The mobile device users accumulate wide experience of different services from mobile applications (iPhone Applications, Google Applications etc.) which work on devices and/or on remote servers through wireless networks. Mobile devices that access the Internet perform mobile cloud computing: handsets need to borrow storage and computing power from the cloud because of their limited resources or because it makes more sense. Accessing data in the cloud from mobile devices is becoming a basic need.

5.1. SAAS interoperability vs. Mobile Technology

Mobile cloud services are largely dominated by the vendors. Installing new software on phones was not an option for the mass

market until recently. Vendors like Apple and Google that host applications and services used by the mobile devices are ”closed” for using interoperability (Figure 2). That is the reason why interoperability is facing a lot of problems. Users of one handset may want to get their email from a provider but sync pictures with another. Or if they buy music from a digital store from the desktop computer, they want to sync their playlists with any phone. Consider these recent cases that demonstrate that users of mobile cloud services are exposed to serious problems. For example, users cannot access the music that they bought and stored in Apple’s iTunes: Apple still wants to own the music they sold to its users and keep their data hostage. Similar risks are run by owners of Amazon Kindle, who had their purchased books deleted too easily by Amazon from the devices. Also most of the providers like RIM, Apple, prevent user to run applications which are not digitally signed. With mobile cloud it is more important than ever that people have the full ability to access and preserve their data, which means using the open mobile cloud. These are just visible signals of proprietary services battling to own user data. If iTunes and Amazon used interoperable and open standards, which could be safely implemented in free open source software, their users would not face these problems. Due to the fact that there are nearly 6 billion mobile devices, the use of interoperability is more than necessary in MCC, but it is still not deployable enough in CC.

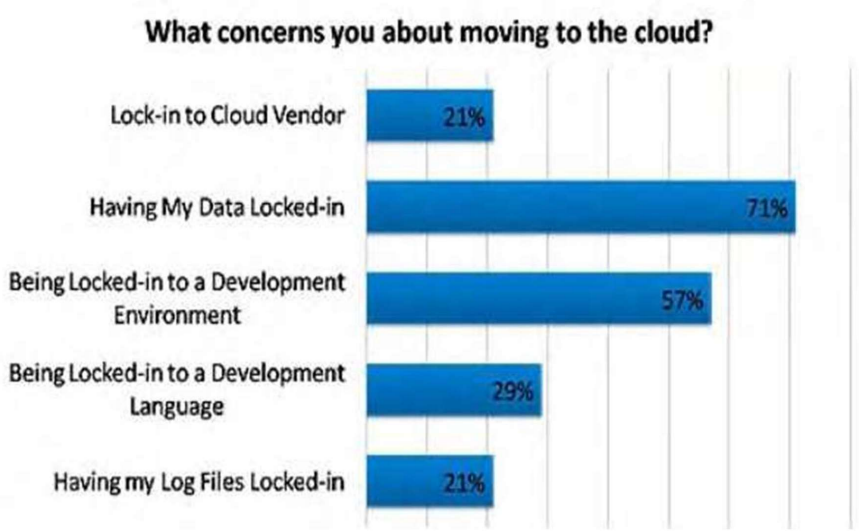

Figure 2. Interoperability Lock-In

5.2. PAAS interoperability vs. Mobile Technology

Developing an application which can be used on various mobile platforms is very difficult. All of them (Android, iOS, BlackBerry, Symbian, Windows Phone, etc.) are using different SDK (Software Development Kits), different libraries and different ways of design user interfaces. Programing languages are also different for each platform. Developer should know these languages in order to deploy an application. Also, developer should be familiar with platform standards, SDKs, etc. In addition, developers need to know devices available for each platform. For instance, Android has many different devices available, like smart phones, tablets. IOS, has only iPhone and iPad. These devices have different screen resolution, different aspect ratio, which makes difficult for developer to make user interface well scalable. The solution to this is using multiplatform Frameworks like JQuery Mobile, PhoneGap and Titanium Mobile. These multiplatform frameworks come in many variations. Some of them only change the visual appearance of web apps while others offer whole software development kits on their own, which can build the developed apps to multiple target platforms as native apps. These frameworks are growing rapidly and new features are being added. So when developers wants to use some of the frameworks, they first should check several platforms features before starting multi-platform development.

5.3. IAAS interoperability vs. Mobile Technology

As stated before IAAS refers to the ability of the providers to use infrastructure resources from different vendors. In Mobile IAAS, Interoperability means the use of infrastructure and standards from different mobile providers. A pure example for IAAS Interoperability is Roaming. Roaming refers to the extension of connectivity service in the locations different from home

location. Roaming enables customers to use services provided by his home provider while travelling outside the coverage area of the home network. There are a couple of roaming types: Regional Roaming enables customer to move between different regions inside the national coverage of the mobile operator and to use the services provided in that region by the operator. National Roaming allows customers to move from one operator to another in the same country. This usually happens when a mobile provider gets a license and starts trying to be competitive but doesn't have coverage in all areas. This kind of operator requires the existing operators to allow roaming for the customers while he has time to build his own network. International Roaming means moving to foreign service providers networks. The easiest way is by using the GSM standard, used by approximately 80% of the providers worldwide. But still there may be a problem, because countries using different frequency band. Most of the world operators are using GSM 900/1800MHz frequencies, but United States and most of the countries in the East are using 850/1900MHz.

The solution is in Inter-Standard Roaming. Customers want to use their phones in areas where there is no standard used in their home network or there is no Roaming agreement with the country they originate from. So with Inter-Standard Roaming customers arriving in Europe from USA of East can register on available GSM network.

6. Conclusion

Interoperability between cloud providers is the only way to avoid vendor lock-in and open the way towards a more competitive market for cloud providers and customers. Hence, addressing the issue of interoperability and portability is both timely and necessary. In this article we explained two dimensions of cloud computing interoperability and their advantages, why they are so important and where they can be used. The only way to achieve interoperability is by introducing cloud standards accepted by all big cloud vendors. Until now most of them are not interested to give total freedom of their clients. Each of them offers different services and wants to have unique services to attract the customers. That's why interoperability standards are far from adoption and there is a long way to go in order to achieve interoperability. True cloud interoperability will not occur for some time. Standards are nascent and will take years to fully develop.

References

[1] Fotis, G., Paraskakis, I. & Kourtesis, D. (2012) Addressing the challenge of application portability in cloud platforms. *In: 7th SEE Doctoral Student Conference*, p. 565576.

[2] Ashesh, C. & Parameswaran, A.V. (2009) Cloud interoperability and standardization. *Journal of Networks*, 7.

[3] Bill, C. (2013). Computerworld. Available: www.computerworld.com/s/article/9217158/Cloud interoperability Problems and best practices.

[4] IEEE (2012) Ieee standard glossary [Online]. Available: www.ieee.org/educationcareers/education/standards/standardsglossary.html.

[5] Dana, P. (2011) Portability and interoperability between clouds: Challenges and case study. In: Proceedings of the of the 4th European conference on towards a service-based internet, Poznañ, pp. 62–74.

[6] Cunha, D., Neves, P. & Sousa, P. ('12) Interoperability and portability of cloud service enablers in a paas environment. In: *Closer,* Vol. 2012, pp. 432–437.

[7] iyush, H., Dudouet, F., Cascella, R.G., Jegou, Y. & Rennes, C.M.I. (2012) Using open standards for interoperability issues, solutions, and challenges facing cloud computing 6th International DMTF Academic Alliance Workshop on Systems and Virtualization Management: Standards and the Cloud.

[8] Matthew, B. (2012). Interoperability case study: Cloud computing," *Berkman Center for Internet and Society*. Harvard University: USA.

[9] Chaddha Asheesh, V.P. (2009) Cloud interoperability and standardization. *Setlabs Briefings*, 7, 19–26.

[10] Sperb Machado, S.G. & Hausheer, D. Considerations on the Interoperability of and Between Cloud Computing Standards.