Analysis of Cloud Portability

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Abstract—Cloud Computing gains ground in the last few years as a result of the well-known key characteristics, such as Virtualization and pay-by-use, which together form an inovative concept. Although, there is no widely accepted definition for Cloud Computing, it has been used by many companies to deploy their infrastructure and promote their business. The purpose of this article is to explain why *portability* needs to be used in Cloud Computing. We will compare *portability* in Cloud Computing and Mobile Cloud Computing. Differences between Cloud Computing and Mobile Cloud Computing *portability* in all the service models (IAAS, PAAS, SAAS) will be explained. We will try to define and explain some of the Cloud Computing *portability* standards and reasons why they should be used.

Index Terms—Cloud Computing, IaaS, PaaS, SaaS, Portability, Mobile Portability

I. 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) Figure 1.

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. With the presence of numerous vendors in the cloud, a need for *portability* appears. As presented in Figure 2 cloud *portability* means that cloud applications and data could be moved from one provider to another or between public or private cloud. Consumers are seeking for *portability* so they can move services to the new provider for lower price, breached Service Layer Agreement or to use cloud provider geographically closer to them.

Organization: The rest of the paper is organized as follows: Section II describes *portability* related work. Then in Section III we define *portability* in Cloud Computing, definition of *portability*, requirements and standardization. Section IV presents some *portability* issues like Vendor Lock-In and Complex Service Level Agreements. Correlation to Mobile
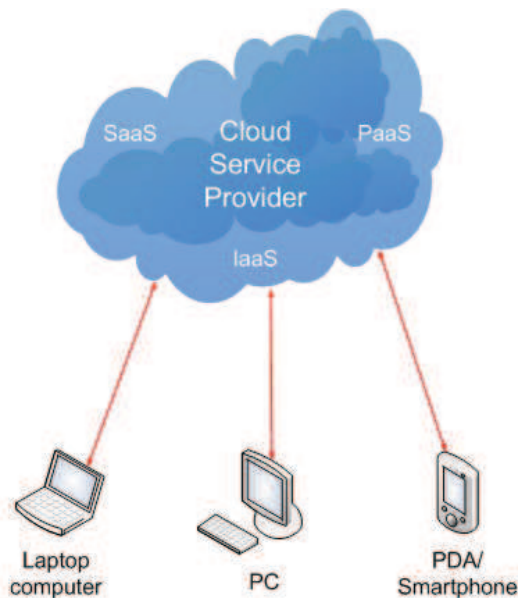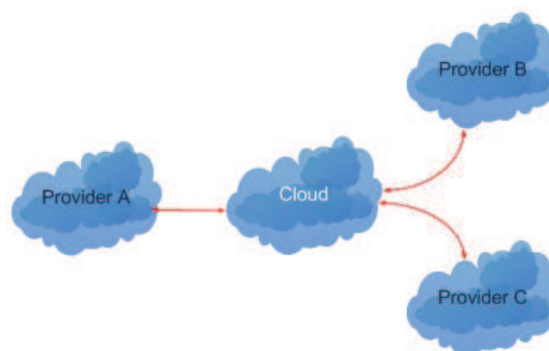

Fig. 1. Cloud Service Model

Fig. 2. Portability in Cloud Computing

technologies is explained in Section V and Mobile Cloud Portability in Section VI. Finally the concluton is given in Section VII.

II. RELATED WORK

Since Cloud Computing existence, Cloud Computing *portability* is well defined research area. But there is still lack of so-

lution to overcome major problems encountered. Consumers, whether they interact with the IaaS, PaaS or SaaS layer need to be able to easily change between cloud providers and be free to choose the one that better serves their needs in terms of quality and/or cost. The ability of the customers to easily migrate from one cloud provider to other is more critical if the cloud providers operation is unexpectedly terminated. A real example to illustrate this argument is the case of Coghead [3], a visual web-based application editor that allowed users to develop enterprise applications using an intuitive GUI. The company attracted hundreds of developers before it suddenly announced that it would stop operating calling all users to download their data stored in their application, but not giving option to port the applications. Cloud *portability* is expected to eliminate vendor lock-in problem and to allow customers to switch between vendors according their needs [4]. This will increase customers trust towards Cloud Computing and public cloud services.

To give boost to the cloud service *portability*, tech giants introduced TOSCA (Topology Orchestration Specification for Cloud Applications). Portable and standardize management of cloud services is enabled through the TOSCA [5]. The goal of the Topology and Orchestration Specification for Cloud Applications (TOSCA) is to substantially enhance the *portability* of cloud applications and the IT services that comprise them running on complex software and hardware infrastructure. Although the use of standard format makes *portability* simpler, it might be difficult to implement it with different platforms used by different service providers. Also the cost of *portability* is negligible because instead of switching data from one providers platform to other, only the change of the portion of common platform is switched i.e. the portion held by one service provider is allocated to another service provider.

III. PORTABILITY IN CLOUD COMPUTING

The cloud *portability* ensures competition among the service providers and provides the customers with wider options to switch to in case of service dissatisfaction. In this section we will explain definitions of Cloud Computing *portability*, cloud *portability* standards in order successful *portability* to be enabled and requirements for all thee cloud service models.

A. Definitions of Portability

NIST (National Institute of Standards and Technology) refers to *portability* as the ability of prospective Cloud Computing customers to move their data or applications across multiple cloud environments at low cost and minimal disruption, and to *system portability* as the ability to migrate a fully-stopped Virtual Machine (VM) instance or a machine image from one provider to another provider [6].

Two main features of *portability* can be drawn from this definition. The first feature addresses moving from one cloud to another. This process should be done with lowest possible cost, effort and time. The second feature of the *portability* refers to the ability to move any component of any of the three service models across different cloud platforms.

B. Requirements

According to the Cloud Security Alliance [7], there are different *portability* requirements in the three different cloud service models.

As [1] explains, in IaaS, the requirement is easy porting of VMs (Virtual Machines) and data from one vendor to another. For instance, a company which has several VMs operating on one cloud infrastructure provider should be able to easily port the same VMs on another provider. The requirement in PAAS is, to be able to deploy applications across different platforms. For example, if a developer deploys an application on one cloud platform, it should be possible the same application to be ported to another, different platform with minimal changes. In SaaS, when porting from one platform to another it should be possible to extract the data from one and load them to another provider. For example, if a company uses an application provided from one cloud vendor and decides to port it to another vendor, it should be possible all relevant data to be loaded and processed directly on the new platform [1].

C. Cloud portability and standardization

The existence of different types of cloud deployments should allow the organizations to move between them or to put together cloud services on behalf of the end users of the enterprise. That is the reason why *portability* of cloud applications becomes so compelling. In case a given organization decides to move cloud services, they want to know the process of switching, as well as its cost.

Cloud Computing is a new phenomenon for IT organizations, many of the blueprints for switching of cloud services have yet to be drawn and some of them are still in process of deployment for private and public clouds. Some of the methods which need to be used to enable successful *portability* are explained below [8]:

- **Standardized programming interfaces**: This will allow applications written on this interfaces to be able to move to another, new cloud. That is why well-identified programming toolsets can be leveraged by companies readying IT tasks for deployment on a Cloud Computing service [8].

- **Layers of abstraction**: Isolating of abstract layers on cloud services from basic infrastructure will facilitate *portability* between cloud resources. Reducing dependencies on underlying processors, operating systems and virtual software will increase the speed of switching cloud services and reduce the cost [8].

- **APIs**: PAAS clouds already provided a new application framework and APIs which provide special cloud functionality, such as massive scale-out capability. However, there are many factors when it comes to leveraging this APIs. In general, this APIs can be used only for new applications. Existing applications need to be modified in order to use this APIs, which is difficult and expensive procedure [8].

- **Management capabilities**: These capabilities should allow IT people easy managing with cloud services to

which they are subscribed without introducing new layers of complexity into an structure which is already complex. To be successful, these management capabilities have to work well with the existing management products, both for managing physical servers and virtual servers [8].

D. Cloud Portability Issues

Cloud service *portability* is a process of switching from one cloud service provider to another. Cloud *portability* ensures competition among service providers and provides customers with wider options to switch to in case of service dissatisfaction. It is almost impossible to implement cloud *portability* due to the issues like vendor lock-in, lack of standardization and service level agreements.

1) Vendor-lock-in: The "Data"is the heart of every organization. Data formats which are used by one cloud provider and are not available for license or to be technically supported by another cloud provider, can lock the data into specific cloud platforms and make transfer between competing cloud providers costly or impossible.

2) Complex Service Level Agreements: To mark their existence among competition, cloud providers use complex service level agreements. The use of proprietary contacts or service level agreements with extensive disclaimers increases the complexity and uncertainty of the cloud services. The use of "data hostage"clauses in combination with arbitration or litigation clauses by cloud providers can insulate service providers from liability for material breaches and be used to coerce non-breaching customers into paying hefty termination fees [9].

The outsourcing business experiences the negative impact of this lack of *portability*, or vendor lock-in phenomenon, when it wants to migrate to another Cloud Computing service provider and is confronted with a data hostage clause in its outsourcing agreement requiring the business to pay applicable termination fee for the data to be returned [9].

IV. 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 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 [10], Google Applications [11] etc.) which work on devices and/or on remote servers through wireless networks. Mobile devices that access the Internet are performing 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.

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 [12] and Google [13] that hosts applications and services used by the mobile devices are "closed"for using *portability*. That is the reason why *portability* 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 [14]: Apple [12] still wants to own the music it sold its users and keep their data hostage. Similar risks are run by owners of Amazon Kindle [15], who had their purchased books deleted too easily by Amazon [16] from the devices. Also most of the providers like RIM [17], Apple [12], prevent user to run applicatons 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 the open mobile cloud. These are just visible signals of proprietary services battling to own user data. If iTunes [14] and Amazon [16] 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 *portability* is more than necessarily in MCC, but it is still not deployable enough in CC.

V. MOBILE CLOUD PORTABILITY

Mobile Cloud Computing can be simply divided into Cloud Computing and mobile computing. Those mobile devices can be laptops, PDA, smartphones, and so on which connect with a hotspot or base station by 3G, WIFI, or GPRS. As the computing and major data processing phases have been migrated to cloud, the capability requirement of mobile devices is limited, some low-cost mobile devices or even non-smartphones can also achieve mobile Cloud Computing by using a cross-platform mid-ware. Although the client in mobile Cloud Computing is changed from PCs or fixed machines to mobile devices, the main concept is still Cloud Computing.

Similarly to Cloud Computing, *portability* in Mobile Cloud Computing refers to *portability* between different mobile platforms. Infrastructure (IAAS) *portability* between different platforms is impossible. There is no possibility to port the whole infrastructure from one device to another Figure 3.
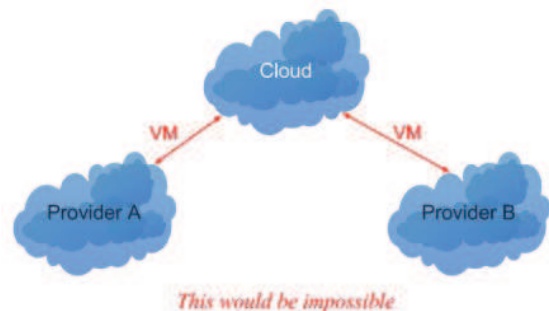

Fig. 3.   IAAS - Portability in Mobile Cloud Computing

In Application (PAAS) model *portability* is possible but only between same platforms Figure 4. Vendors like Apple and Google are "closed"for application and services hosted by them. There are a lot differences between Android and iOS platforms which forbid *portability* between them, distinct Kernel which is used by both platforms, distinct UI framework, distinct programming language, compiler, etc. If the user wants to port the applications from one mobile device to another he should first export the application and then import it to another device using the cloud. *Portability* between different mobile platforms is possible only between Android and BlackBerry mobile platforms by using BlackBerry runtime for Android apps to run Android platform applications on the BlackBerry Tablet OS and BlackBerry 10 [18].
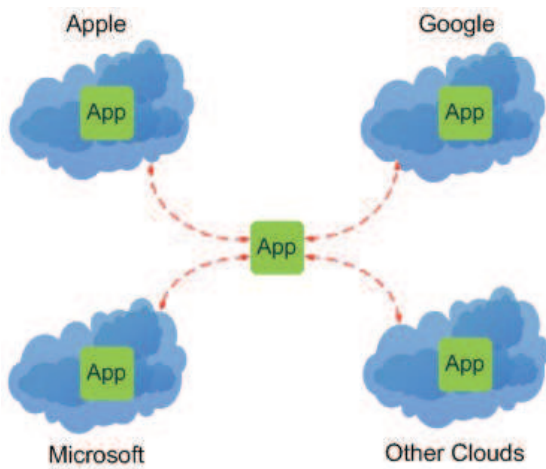
Fig. 4. PAAS - Portability in Mobile Cloud Computing

SAAS *portability* is possible only between same platforms Figure 5. Data can be ported between these plarforms using the Cloud. For example contacts from iPhone mobile device can be exported to the cloud and then imported again on the new device.
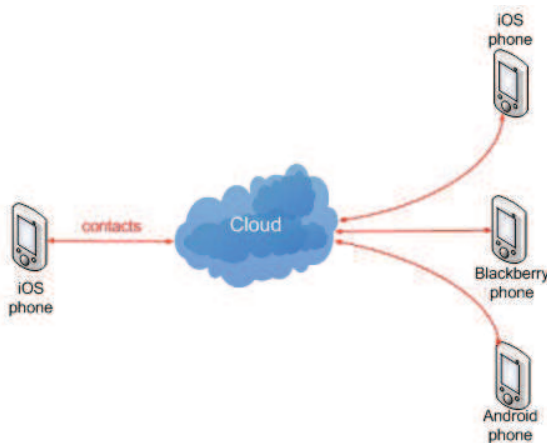
Fig. 5. SAAS - Portability in Mobile Cloud Computing

The development of applications which would work on all mobile Cloud Computing platforms can take place in quite a number of development environments. The downside is that a huge part of the applications development is made separately for each platform. Only a small part of the functionalities can be ported from one platform to another. There are a lot of initiatives for introducing standards which support increased *portability* between different platforms, but unfortunately most of the vendors like Apple and Google do not allow *portability* of the applications and services which they are hosting.

VI. CONCLUSION

This paper discusses *portability* in Cloud Computing and gives short review of the standards and methods that should be used in *portability*, what new standards should be implemented in order *portability* to be possible. The focus of this article is on Mobile Cloud *portability*. *Portability* in Mobile Cloud Computing refers to mobile applications *portability*, which currently is not possible between all platforms. Because of lots differences between vendors, *portability* is almost impossible. Till now only *portability* between Android and BlackBerry platforms is possible. The focus of our ongoing work will be to improve application and data *portability* between clouds, especially mobile. We need to check weather the standards used now are good enough or there is a possibility to introduce new one, much efficient and useful.

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