PROPOSITION OF VOLUNTEER CLOUD COMPUTING

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1. Introduction

In this current era we can see a shift in how software and hardware are conceived, the end- goals are not the same as they used to be 2 decades ago. This can be attributed to the following, the fact that the Internet speed got a lot faster, by a factor of 1000 (based on a 56kbps connection in 1995, compared to a 50mbps connection today), but also because the hardware performance augmented at a similar pace. Initially in the pre-Internet era, software was written to be executed locally without any network interactions. Then in the genesis of the Internet, the objectives of software slowly shifted to access external resources, thus the apparition of the e-mail and the web-browser. Slowly as the connection bandwidths increased, there was an increased number of possible usage such as online games, content streaming, social-media, etc. Nowadays we can access fully virtualized computing environments within our web-browsers, and this takes us the very genesis of the Cloud Computing era.

1.1. **The Genesis of Cloud Computing.**

The embodiment of Cloud Computing, namely the Internet of Things, can actually be traced back to the vision of J.C.R. Licklider of the *"Intergalactic Computer Network"* [1]:

> At this extreme, the problem is essentially the one discussed by science fiction writers: *"how do you get communications started among totally uncorrelated sapient beings?"*

This quote shows us the state of electronic tele-communication in the sixties, which is described as being fabric of fiction. There was military but also academic interest of providing an infrastructure that supports long-distance information processing. One of the most interesting idea of this memorandum is best conveyed in this following quote:

> When the computer operated the programs for me, I suppose that the activity took place in the computer at SDC, which is where we have been assuming I was. However, I would just as soon leave that on the level of inference. With a sophisticated network-control system, I would not decide whether to send the data and have them worked on by programs somewhere else, or bring in programs and have them work on my data. I have no great objection to making that decision, for a while at any rate, but, in principle, it seems better for the computer, or the network, somehow, to do that.

This very quote reflects the concept of offloading, not only of information or data, but of computation as a service. In other words that in some case it would be better, given

the proper networking infrastructure, to offload the computation and send the data to be processed remotely.

Around the same time the concept of virtualization was being explored in the context of mainframe computers, in order to logically divide the resources between applications allowing them to run simultaneously. Throughout the years, the concept of virtualization broaden and now it is possible to run a complete Operating System on the application level. There is a direct correlation with the coming of the virtualization of hardware and the birth of the Cloud. At its very core the Cloud is use to describe the outsourcing of content, resources (computing and storage), and then providing it on a "as-a-service" basis or a pay-per-use model.

1.2. **The Cloud.** Cloud Computing infrastructure offers many advantages compared to the traditional on-premise infrastructure and it is why numerous companies consider outsourcing their IT infrastructure to an off-premise solution. Among the most important characteristics that this type of infrastructure offers, the NIST enumerates the following five [2]:

(1) **On-demand Self-service** *Consumers are not required to interact with any representative of the provider to provision computing capabilities, rather it is automated through the provider's infrastructure.*

(2) **Broad Network Access** *Services are available over standard network infrastructure and through standard mechanisms, enabling different client platforms like cellphones, laptop, tablets, etc.*

(3) **Resource Pooling** *Providers offers a pool of Resources to different clients via a multi-tenant model, consisting of physical and virtual resources that can be assigned and re-assigned dynamically to cater to the clients demands. Clients are only aware, or able to choose the location of these resources with respect to pre-defined geographical regions.*

(4) **Rapid Elasticity** *Resources and services can be provisioned to scale to meet the fluctuations of the client's needs at any time, at any magnitude. The provider offers a seemingly unlimited number of services and resources to the client.*

(5) **Measured Service** *Resource usage can be monitored, controlled (optimized) and reported in a manner that proves transparent to both provider and consumer.*

In this modern day and age, among the major service providers of *The Cloud* we can find the likes of Google, Microsoft and Amazon, to name a few. They provide their services as a three different service models:

Cloud Services

Software-as-a-Service SaaS | Platform-as-a-Service PaaS | Infrastructure-as-a-Service IaaS

We will briefly explain each of these services in order to have a clearer picture of where this proposition resides in the grand scheme of the Cloud. In order to do so we will explore the question with respect of the Separation of Responsibilities, via a very concise graphical depiction [3]:

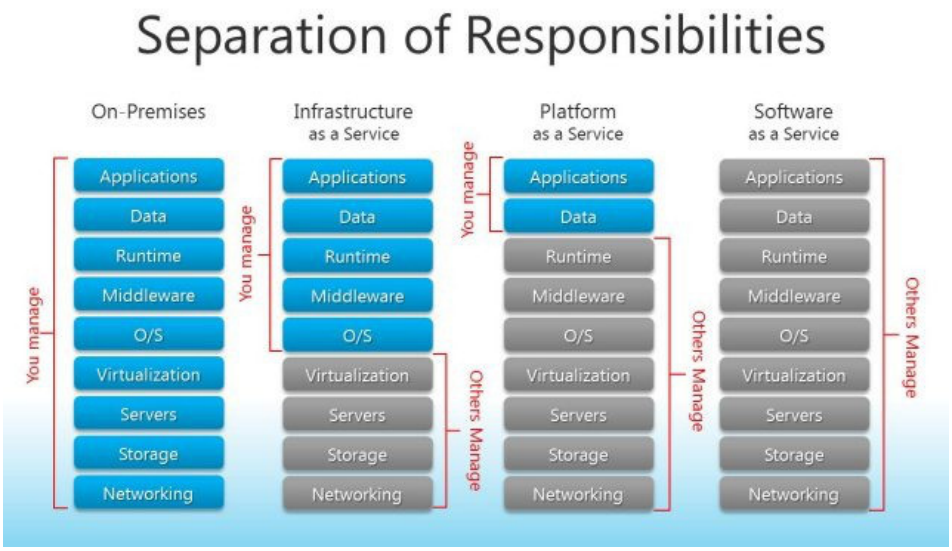

FIGURE 1. Cloud Services w.r.t. Responsibilities

1.2.1. *Infrastructure-as-a-Service (IaaS).* This service model provides, to its consumers, a virtualized environment that represents the full stack, from the hardware-level to the software-level, while taking care of the hardware management aspect. With this model, consumers can deploy any Operating System they wish, and as a matter of fact create the software environment that they deem most appropriate for their use. Since the hardware management responsibility is left out to the service provider, the client can easily augment or reduce the computing power at will to cope with the fluctuation of their demands. Amazon's Elastic Cloud Compute (EC2), or Windows Azure are part of the available IaaS solutions currently available.

1.2.2. *Platform-as-a-Service (PaaS).* This service model, if we refer to Figure 1, to its clients the ability of having to manage only the Application and Data aspect of the full-stack, everything else is managed and taken care of by its provider. Using such a service

the client can focus on simply developing their application using the libraries, services and tools supported by the provider, and then deploy it onto the Cloud. Google's App Engine is perhaps one of the most popular example of this model.

1.2.3. *Software-as-a-Service (SaaS).* This service model, the consumer is provided with the capability to use applications (or software) running on the provider's cloud infrastructure, with little to no management capability, as depicted in Figure 1. From a user's perspective application are served as an atomic service, in the likes of Oracle ON DEMAND which offers on demand a customer relationship management application.

Finally we need to discuss the different *Deployment Models* that are offered in the Cloud eco-system. Relying again on the NIST [2] document, let's briefly present the 4 models:

(1) **Private Cloud** *This cloud infrastructure is meant to be used by a single organization, which can act also as a single provider or a providing partner with a 3rd party or solely as a consumer. Exclusivity is the key here.*

(2) **Community Cloud** *Very similar to the private cloud model, but in this case exclusivity of usage is shared among a community sharing common interests.*

(3) **Public Cloud** *This deployment model is aimed for open use by the general public, and the embodiment of this model's infrastructure is known as a Cloud Provider, such as Amazon, Google, Windows, etc.*

(4) **Hybrid Cloud** *This is the result of the combination of two or more distinct cloud infrastructure (which remain distinct to one another), but are combined using standardized or proprietary technologies to enable data and application portability.*

In the following subsection we will present a fifth deployment model, namely Volunteer Cloud Computing.

1.3. **Volunteer Cloud Computing.** The concept of Volunteer Cloud Computing is a fairly new one, since as we can see there is no mention of it whatsoever in [2][4]. It revolves around user-provided resources as the building components of the cloud infrastructure, and typically takes place in a decentralized manner for which no single provider is designated, rather the collection of the participants form at the same time the provider and the consumers. One of the driving factors of this topological ideology is to harvest and make efficient use of distributed idling resources to provide a cloud infrastructure, with no real added cost.

In the following section we will review the literature to find out more about the position of Volunteer Cloud Computing with respect to the current deployment models in place, and if any implementation exists.

2. Related Work

2.1. **Cloud@Home.** The first real apparition of the term Volunteer Cloud Computing can be attributed to [5], in 2009 when they proposed the Cloud@Home paradigm. It can

be described as a continuation of the @Home distributed computing effort and the merging of volunteer computing and Cloud computing. They propose an infrastructure in which it is possible for heterogeneous computing resources to be connected and to co-operatively provide a Cloud infrastructure, at a cost or for free. Thus this is a leap into monetizing the idle time of the consumer-grade computing resources, to provide a seamless Cloud experience to consumers. Although they provide a very detail analysis of the majority of the factors present in a Cloud architecture, little to no information was released after the publication of a series of more specific papers on the subject,

2.2. **P2P Cloud Architecture.** There was other notable effort conducted with respect to this concept, albeit presented under a different category one of Peer-to-peer Cloud Architecture. (cite italian paper)

3. Motivation

The motivation behind this proposal, is to analyze where past effort have not been has successful has expected. From this analysis, we wish derive a design that take on past the shortcomings of the previous attempts and venture to propose a viable implementation for this paradigm, which to this day seems lacking.

4. Contributions

In this section we will present our novel contributions with respect to previous related work.

References

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[4] Rimal, B. P., Choi, E., & Lumb, I. (2009, August). *A taxonomy and survey of cloud computing systems.* In INC, IMS and IDC, 2009. NCM'09. Fifth International Joint Conference on (pp. 44-51). Ieee.

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