Above the Clouds: A Berkeley View of Cloud Computing

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Overview

This paper presents itself as a primer to Cloud Computing, presenting key definitions, exploring why Cloud Computing gained traction when it did, what its unique selling points are, why it makes economic sense and what the key challenges facing the growth of Cloud Computing are. The paper begins with an executive summary in which the above points are expanded on briefly. The paper then goes into detail about how the Cloud Computing paradigm was shifting (the paper was published in 2009), and discusses some detractors of Cloud Computing. In the third section, the paper goes over its definition of what constitutes Cloud Computing, and why a company would want to become a Cloud Computing provider.

In the fourth section, the paper discusses why Cloud Computing was on the rise at the time and proposes that it was because of new technology trends and the resulting new opportunities. In the next section, the paper posits a new classification for Cloud Computing based on abstraction, with AWS EC2 on one end (low-level abstraction), Google's AppEngine on another end and Microsoft Azure in the middle of the two. In the sixth section, the paper goes into detail about the economic benefits of adopting Cloud Computing and in the section after that, discusses ten potential challenges to Cloud Computing's growth and opportunities to overcome them. The paper then concludes by summarizing the prior sections and stating that they believe that eventually Cloud Computing providers will overcome the ten obstacles mentioned previously.

Contributions and Positive Aspects

In this section, I will go over what I believe are significant contributions made by this paper as well as the good aspects present in it.

The most important thing to note is that this paper seems to have its finger on the pulse regarding the cloud computing paradigm. The paper was published in 2009, and since then Cloud Computing has become ubiquitous as the paper repeatedly hints will happen. Google Scholar says this paper has been cited 7,174 times, a fact that illustrates how influential this paper proved to be. It's safe to say that the paper's predictions about the adoption of cloud computing were accurate.

Another strong aspect of this paper is its definitions and proposed taxonomy for Cloud Computing. Although, in my opinion, it is not without problems which I will discuss in more detail later, these definitions, as contained in the paper are consistent and comprehensive. The three hardware-related new aspects of Cloud Computing perfectly encapsulate what makes Cloud Computing new. The spectrum of Cloud Computing based on abstraction is also unique, and in my opinion, formalizes and makes clearer the distinction between IaaS, PaaS and SaaS, even though the paper itself avoids that nomenclature.

The paper also makes very compelling economic arguments for adopting Cloud Computing. The reasoning behind stating how risks of operating a datacenter are transferred to the Cloud Provider

as well as pointing out that the operational costs of maintaining a data center must also be taken into consideration, make adopting Cloud Computing a very appealing prospect.

Challenges/Points of Contention

In this section, I will discuss a few statements made by the paper that I believe there is contradictory evidence for, which the paper either does not consider, or that has not held true through the course of time.

Firstly, the paper seems to argue that Cloud Computing is a good solution for almost everybody. It does bring up potential cases where Cloud Computing may not be a good fit, such as using the formula to calculate the revenue for using a Cloud versus utilizing a private data center, as well as the ten potential obstacles for the growth of Cloud Computing. However, I believe that the formula is overly simplistic and seems skewed towards giving a better result to using the Cloud. The paper says that optimal provisioning of Cloud Resources maximizes costs, but fails to consider how that might work from company to company. For example, constantly monitoring usage and predicting when demand might be high or low to adequately provision resources would also involve effort and cost depending on the sector of the company and the size of its userbase or how it is using the Cloud. When these external factors are taken into consideration, the costs sunk into using Cloud Computing would look different than the formula.

Regarding the obstacles to Cloud Computing, while the paper does bring up valid obstacles, in my opinion, the fixes or opportunities are also overly simplistic. For example, proprietary lock-in is a major concern for people thinking about adopting the Cloud, but the paper's proposed solution of standardization among Cloud providers seems very naïve and utopian. Leaving aside the improbability of rivals like Google and Amazon working together to standardize their Cloud Platforms, there are other factors that make this standardization unlikely. Firstly, given that as the paper says, an aim of Cloud providers is to make money, it could be argued that proprietary lock-in is a feature, not a bug of Cloud platforms. Secondly, given the different levels of abstractions and different implementations of platforms to achieve this, the idea of standardization seems easier said than done.

I also contend that the paper underestimated how serious of an issue security is when it comes to public Clouds. Doing a Google search for 'Drawbacks of Cloud Computing' reveals that security is still most people's number one concern when it comes to Cloud Computing, and there are several examples of data breaches in major Cloud platforms which makes it unlikely that companies with sensitive data would adopt the public Cloud. Another concern that the paper refers to only obliquely is the legality of handling sensitive or confidential data on a public Cloud, which boils down to the question of how safe and private the public Cloud really is. This is an issue I feel the paper doesn't address enough.

Drawbacks

In this section, I will discuss what I believe to be the drawbacks of this paper. Unlike the previous section, these are opinion-based, although I formed these opinions based on the content in the paper.

Despite the high number of citations of this paper, I believe that the definitions in this paper are not authoritative or comprehensive enough. The paper listed inconsistent definitions of what Cloud Computing really is as a major drawback of Cloud Computing, but in my opinion did nothing to rectify this. I believe the paper made a mistake by not considering the 'XaaS' nomenclature, since most Cloud Providers do use that taxonomy on their websites, and it is as ubiquitous as any other definitions of Cloud Computing are.

Another drawback of this paper, in my opinion, is that the paper seems so heavily in favour of Cloud Computing that it doesn't bring up as many drawbacks of Cloud Computing as it could. While it does discuss obstacles facing the growth of Cloud Computing, I believe the paper could have done a better job of explaining why not adopting the Cloud is a better choice for some companies beyond economic concerns.

Given its considerations of public clouds versus private clouds, I find the lack of any mention of hybrid Cloud Computing glaring. I'm not well-versed in the timeline of Cloud Computing, so it's possible that hybrid Cloud Computing was not an established concept when this paper was published, but I find that unlikely. Given how hybrid computing could be used to overcome the drawbacks of public and private Clouds, it could have been a useful addition to this paper.

Overall, the paper seems very general, and not particularly in-depth about any topic. Since it is so general, for each point made, it is easy to come up with a counterexample in which the point might not hold true. The paper doesn't discuss how different domains might use the Cloud and how that might be a factor in economic considerations and as mentioned earlier, the formula to calculate the cost-effectiveness of using a public Cloud versus a private Cloud seems incomplete.

Conclusion

This paper serves as a good primer to concepts in Cloud Computing and generally accurately predicted the upswing in the adoption of Cloud Computing by companies and corporations around the world, along with some very compelling reasons for why they might have done so. However, it is hamstrung by its overly-general nature, its sense of incompleteness and glossing over of some key drawbacks for adopting the Cloud.