Cloud Computing: A Survey on its limitations and Potential Solutions

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Abstract

Cloud computing has brought a new paradigm shift in technology industry and becoming increasingly popular day by day. The small to medium enterprises (SMEs) are now adopting cloud computing in much more higher rate than large enterprises. That raises a debate whether this cloud computing technology will penetrate throughout the IT industry or not. The SMEs are adopting cloud computing for the low cost implementation of total IT infrastructure and software system whereas the large enterprises are relying on their own infrastructure for data security, privacy and flexibility to access their own infrastructure. In this paper, we provide a survey about possible limitations of cloud computing that is delaying its penetration. We also identify the ongoing potential solutions that will help the enterprises to adopt cloud computing for their IT infrastructure and software systems.

Keywords: *Cloud Computing, Enterprise, SME, Limitations, Survey, Potential Solutions.*

1. Introduction

Cloud computing is a modern computing technology where software and hardware infrastructure of an enterprise can be placed over a network to access later in on demand basis via internet instead of having them locally within the enterprise. Cloud computing service provider holds the responsibility to manage and share all the hardware and software using virtualization among the clients, and the clients only pay for the subscribed services [1][12]. Cloud computing turned out to be useful for small to medium enterprises (SMEs) in order to have low implementation cost for their total IT infrastructure and software systems. For SMEs, the pay per user basis service license drastically reduces the cost of both hardware and software [15][17]. Despite of many benefits of cloud computing towards small to medium enterprises (SMEs), large organizations are still skeptical to adopt cloud-computing services and still relying on their own infrastructure for data security, privacy, reliability and flexibility issues. Evidently, cloud computing comes with few potential limitations that is delaying its adoption in the IT industry [6].

This paper explores all the possible drawbacks of cloud computing and lists all the prospective solutions available till today. Thus SMEs and large enterprises will be able to take decision about adopting cloud computing and the readers will have a clear overview about the future penetration of cloud computing in the IT industry.

2. Adoption of cloud

Cloud computing is adopted mostly by the SMEs due to its numerous benefits. By utilizing the tremendous abilities of cloud computing, SMEs can deploy applications lot quicker and cheaper compared to the cost of setting up whole IT infrastructure and services by themselves. Moreover, cloud computing does not limit on software license – small numbers of users get the same benefit as larger number of users [1][13].

An enterprise must check several things in order to move into the clouds. Firstly, the customer must technically comply with the existing cloud system. Secondly, moving the data to the cloud should not violate any security law of the nation or break the customer data privacy policy. Thirdly, the internal must allow executing the workloads on the cloud environment. Finally, companies must prepare their business process in a way that on demand cloud products can be acquired whenever required [9].

However, large enterprises have enormous private resources to keep their data private and secure. Furthermore, these large companies want to control their own total IT infrastructure by themselves to

provide reliable service to their customers, rather than risking their reputation to a third party cloud service provider. Therefore, large enterprises are not adopting cloud computing [1][16].

3. Limitations of cloud computing

Enterprises observe different obstacles when they move their IT infrastructure into the clouds. SMEs can sacrifice the sufferings of these obstacles to some extent, since adopting cloud would be a cheaper solution compared to the cost of running an individual IT infrastructure. A perfect trade-off between costs and benefits can help SMEs to make proper judgment of adopting cloud computing [5]. In this section, we analyze all the potential problems that delay the adoption cloud computing for some of the SMEs and the large enterprises.

3.1 Privacy and Security of data

Privacy and security are the two main concerns related with the adoption of cloud computing. As the resources are distributed among different cloud clients, privacy and security of data faces severe threat. An eavesdropper or unethical client can become a potential threat towards the normal users.

Moreover, clients have to completely depend on cloud service provider companies for their data security. The data administrator of the cloud provider can easily manipulate the sensitive data. For smaller organizations with limited resources, trusting a cloud provider may be safer than keeping them on premises.

Nevertheless, for larger organizations, cloud providers cannot provide sufficient protection against safeguarding of sensitive data of the customer, trade policy, business strategy, price information or any other classified information [1][16]. For example, an online bookmarking organization encountered a serious data failure in 2009 that resulted into total loss of client bookmarks. Also in 2008, a cloud vendor named 'The Linkup' having more than 20,000 paying customers, have lost most of its customer's data after a tragic system crash. The Linkup went out of business after this catastrophic system failure. They blamed their problems on their storage partner company but could not do anything else to rectify customer's loss [18].

3.2 Vendor Lock-in and Interoperability

Cloud computing software and hardware platforms are vendor dependent. Since different vendors use different software and hardware architecture for their own system, migration of user data and service from one vendor to other is nearly impossible. A client, that uses two separate vendors for its IT services, cannot integrate different services between two vendors. This phenomenon is known as vendor lock-in.

Data portability, migration and vendor lock-in situation will increase with the rise of cloud computing. Many providers are now entering into the cloud market with their own software and hardware solutions. Furthermore, the clients have no control over the IT infrastructure and software services once all the services are in the cloud. The client then have to rely solely on the service providers, consequently they no longer have full control over their own IT [6].

All the major cloud providers have their proprietary data storage. For example, Google uses BigTable, Facebook uses Cassandra and Amazon uses Dynamo. There is no common interface to access these databases. Migration of contact data from Salesforce to Gmail and vice versa is not possible due to the absence of common interface and database systems. This leads cloud computing into vendor lock-in state and data cannot be migrated in this situation [6].

3.3 Service availability

Every single organization, whether SMEs or large, want 100% availability of the services they subscribed to. SMEs might accept minor unavailability of service when they make trade-off with the cost. Service like VOIP needs constant uptime. A small fragment of missing data may result in strong customer dissatisfaction. Even organization like Google or Amazon sometimes might face service outage. In contrast, if a cloud customer cannot access his services in the cloud, he has nothing to do except waiting for the service to be made online by the service provider. Aside from technical faults, a cloud provider can also face service unavailability due to going out of business or being the target of regulatory actions [2]. This in turn will have huge effect on all of its clients.

3.4 Absence of proper Service Level Agreement (SLA)

Lack of well-defined service level agreement (SLA) is another burning issue of cloud computing. Currently there is no standard SLA for guiding the services provided by a vendor and each cloud vendor has their own defined SLA. Absence of proper SLA is the barrier to data migration among different vendors. It also keeps the client into dark about the services they could expect from any cloud vendor. Furthermore, lack of interoperability keeps the customer locked into a single cloud vendor [8].

There are different efforts of preparing standard SLA for cloud computing. Some are led by the vendors, while others by different standard body. As a result, there is no single point of control for implementing a universal SLA. Customer input can help

standardization to meet satisfactory level of service because a customer can note down its requirement towards a vendor. As cloud computing is evolving every day, an SLA prepared today can be obsolete tomorrow due to the rapid changing behavior of the clouds [8].

As the cloud market observed perfect market competition, pricing pressure results into decrease of guaranteed level of performance, service uptime and vendor responsiveness. For example, a well-known cloud provider can offer service up-time of 99.99% along with 10 minutes of downtime per year with a 10% discount on service charge on the month that fails to meet this requirement. In this way, a cloud vendor is offering certain discount knowing that their infrastructure will not be able to meet that up-time requirement in exchange for the benefit of claiming the level of service reliability. If a customer really needs the 99.99% up time, then this discount will not help him from facing severe loss of revenue [4][6].

3.5 Performance Instability

Cloud computing observes severe performance instability during high load. The expected behavior cannot be predicted as the cloud resources are shared among different users with variable process load. Some researches in Australia conducted different stress test on Amazon, Microsoft and Google to demonstrate the variations in service availability and performance due to variable load. They have measured the consequences of sudden demand of 2,000 simultaneous users and found that the response time varies by a factor of 20 at different points of the day [6].

3.6 Latency on network

The internet data transfer rate is relatively lower than the Ethernet data rate. Nowadays, fiber optic cable is replacing the local networks and some parts of the wide area network. Fiber optic uses light to send data; hence, data travels at the speed of light. But the internet infrastructure cannot handle such high rate of data. Again, the applications use large volume of data. Transmission bottleneck is observed as the internet medium is transmitting large volume of data. For example, computer scientists in University of California, Berkeley, have measured the cost of sending 10 terabytes of data from Bay Area to Amazon in Seattle. On an average bandwidth internet link, it takes almost 45 days to transmit this large volume of data with a cost of USD $1,000 as the network transfer fee. On the other hand, shipping ten 1 terabyte disks via any standard shipping service takes 1 day and costs USD $400 only. Therefore, cloud computing is not suitable for sending large volume of data [2][6].

3.7 Lack of scalable storage

Scaling the storage system as required is not possible in a cloud computing architecture. Relational databases (RDBMS) are widely used in different organizations. In the cloud, there is no common interface to access different RDBMS at the same time. Cloud vendors have their own solutions for handling databases. If a customer requires more space in database but the cloud provider is out of space on its existing database, it cannot be increased just by adding an extra hard drive. Furthermore, updating of database requires longer time in the cloud. As a result, cloud computing might be inconvenient for data manipulation centric organizations [2][6].

3.8 Reputation fate sharing

A single customer's illegal behavior can affect the reputation and fate of other customers using the same cloud network. In the clouds, all the clients of the cloud provider share the same resources. A malicious user can get banned from a specific service that results into service unavailability towards the rest of the users on that cloud due to banning of internet IP address. Additionally, cloud providers transfer the legal liability to the users for performing illegal activities through their network. In March 2009, FBI raided a data center located at Dallas because one company, whose services were hosted there, was investigated for some criminal activities. At that time, all services on that data center were shut down and the other innocent customers suffered long downtime, for which some of them even went out of business [14].

4. Potential solutions

The problems mentioned in the previous section of this article currently do not have any precise solution. Many researchers around the world are working to solve the above specified issues with cloud computing.

i. Privacy and security: Privacy and security issues are two major obstacles to adopt cloud computing. Complex encryption method of data can provide more security. Research is going on developing such encryption method where users can send their data in encrypted bits. The cloud provider can search and calculate the encrypted data but cannot see what the actual data is. Theoretically such method do exists. But it requires high bandwidth and processor cycle, incurring higher expenses. Using of hardware based security can be more effective in respect to bandwidth and processor speed. But it also incurs higher cost [5][10]. Again, hosting the cloud infrastructure in more trusted region like European Union can add extra privacy and security towards the customers [1][11].

ii. Vendor lock-in problem: Vendor lock-in problem can be solved by enforcing all the vendors to use a unified API. It can result in decreasing of profit for the cloud vendors, but on the other hand more customers will now be interested to adopt cloud computing [2].

iii. Service level agreement: Proper SLA is far away from the light. Because the cloud computing itself is not mature enough to stick with a single unified SLA at this moment. Lots of changes are going on every day. All the vendors and standardization bodies should agree on making a unified SLA and work step by step rather than making their own SLA and convincing it to be accepted by others [8].

iv. Performance instability: Proper scheduling technique can solve performance instability problem. Research is on going to fix this problem [2].

v. Scalable database: Researchers are working to solve the issue of scalable database. Creating a new storage system with unified interface for all the cloud providers may be a solution [2]. A scalable storage with an SQL-like API is under construction to solve this issue [3].

vi. Hybrid solutions: Apart from the solutions mentioned above, a hybrid solution can also be adopted. In this case, an enterprise will only move the part of its IT infrastructure which has no effect from the regular problems of cloud computing. The remaining parts of the IT infrastructure will belong to the enterprise itself [7].

5. Conclusions

This survey paper explored different limitations of cloud computing and presented the ongoing potential solutions towards those problems. The fundamental problems identified by most existing research are data privacy, security, vendor lock-in, interoperability, service availability, absence of unified SLA, performance instability, network bottleneck, lack of scalable storage and reputation fate sharing. Cloud computing is widely adopted by the SMEs for its low cost in spite of having such problems. On the other hand, large enterprises tend to rely on their own infrastructure rather than depending on cloud vendor. Since researchers are working to overcome the barriers of adopting cloud computing, soon most of the problems of cloud computing will be solved or the risk will be mitigated to an acceptable level. This literature indicates that there is much work to be done in developing the solutions. This is perhaps the most important concern of the future of cloud computing, as many enterprises might want to move their IT system into the clouds after a careful analysis.

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