Migrating Applications to the Cloud: Issues and Challenges

¹Sameera Dhuria*, ²Anu Gupta, ³R. K. Singla
¹Department of Computer Applications, Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India
²,³ Department of Computer Science and Applications Panjab University, Chandigarh, India

Abstract— Cloud Computing is a new computing model in the world of Information Technology that delivers services as utility over the Internet. It has several advantages as compared to traditional computing models like on-demand services, agility, scalability, reduced information technology overhead for the end-user, greater flexibility, reduced cost etc. The advantages and long term benefits of this new technology motivate organizations to migrate their existing applications to the cloud. Though migrating to cloud provides many benefits, there are a number of challenges and security issues related to cloud, that hinder the process of its adoption by the organizations. The present paper aims to discuss the major challenges related to migration to Cloud Computing.

Keywords— Cloud Computing, Virtual Machine, Security, Scalability

I. INTRODUCTION

Cloud Computing is a set of IT services that are provided to a customer over a network on a leased basis and with the ability to scale up or down their service requirements. Usually Cloud Computing services are delivered by a third party provider who owns the infrastructure [1]. Cloud Computing provides computing resources on demand and the user is charged only for the consumed resources. This helps to use computing resources in a better way and achieve higher throughput. There are many formal definitions of Cloud Computing. The definition given by NIST (National Institute of Standards and Technology) [2] incorporates almost all its essential features:

"Cloud Computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."

Above mentioned definition enumerates five major characteristics of Cloud computing namely On-demand self-service, Broad network access, Resource pooling, Rapid elasticity and Measured Service.

The above mentioned elements of Cloud Computing and its other features attract organizations to migrate to Cloud Computing. However, despite providing considerable opportunities to the IT industry, there are many issues related to cloud that need to be carefully addressed. Section 2 discusses migration to Cloud Computing. Some of the migration challenges associated with Cloud Computing have been discussed in Section 3. Section 4 concludes the paper.

II. MIGRATION TO CLOUD COMPUTING

Legacy applications are still pervasive in many organizations that have been in business long enough. They are typically written in programming languages that are no longer used and run on platforms that are no longer supported. Nevertheless, many of these applications still perform critical business functions on a daily basis and cannot be simply discarded, which makes continued support and maintenance for them a priority for IT departments. In many cases, they have been developed over time and matured into monolithic client/server applications that are ubiquitous throughout an organization and viewed as irreplaceable [3]. Migration of these applications to Cloud environment may improve the working of organizations as there are several advantages of using Cloud Computing. Some of the main cloud adoption drivers are:

- Elastic Scalability: Scalability is one of the major reasons to migrate an application to the cloud. Scalability comes in two variants; scaling up or scaling out. Scaling up allows user to add resources to a single host system. Scaling out allows user to add additional nodes (host computers) to an application to handle increased demand for the application [3].
- Reduced Cost: The economic aspect of Cloud Computing i.e. reduced cost is one of the main reasons for moving to clouds. Companies can do potential savings in computer related cost that includes maintenance cost of computer systems as well as the initial cost of purchasing the computer infrastructure because capital cost is shifted to operating costs. Also, IT expenditure gets more controlled and can be easily tracked due to increased transparency in usage of resources.
- Easy access: Services hosted in the cloud are generally web-based. Therefore, they are easily accessible through a variety of devices with Internet connections. These devices not only include desktop and laptop computers, but also cell phones and PDAs [4].
- Pay-as-you-go pricing model: The usage-based pricing model of Cloud Computing provides many benefits like low capital expenditure, scalability, easy access to resources as and when required etc. It is also beneficial for organizations that have workloads with varying demand.

- Reduced Energy Consumption: Cloud Computing reduces energy consumption as the resources are shared among users. It provides an eco-friendly or green computing model.
- Business Agility: Business Agility is the ability of an IT organization to adapt quickly to the needs of the business. Traditionally, when a new development project was started, engineers need to prepare development environments and new hardware to support development and testing processes. These processes may include ordering new software, hardware and licenses. The time to provision all these resources could potentially span from days, weeks or even months. With the use of Cloud Computing, the time required to provision new servers with operating systems already installed and development environments already configured has reduced considerably [3].

Migrating workloads into cloud models is an "application centric" activity where each image/instance in the cloud typically runs a single application workload.

A multi-step process is to be followed to get applications run correctly in the targeted cloud environment.

1) First, the targeted applications need to be identified and "segregated" from the other applications running on that same server.
2) Then an image of that application, its underlying Operating System and infrastructure management agents need to be created and added to the cloud catalog.
3) Finally, the image needs to be instantiated in the cloud environment and verified to run with acceptable Quality of Service (QoS) characteristics [5].

There are few case studies related to cloud migration [6, 7 and 8]. Babar and Chauhan [6, 7] modernized an Open Source Software (OSS) framework, Hackystat [9], for leveraging the flexibility and scalability of using cloud computing paradigm.

Khajeh-Hosseini et al. discussed a case study that investigates the migration of an IT system from a company's in-house data center to Amazon EC2. The primary focus of the case study is on the financial and socio technical enterprise issues that decision-makers should consider during the migration of IT systems to the cloud [8].

An easy way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

III.   OBSTACLES/ISSUES IN USING CLOUD COMPUTING

A number of challenges are associated with adoption of Cloud Computing. It is necessary to identify these challenges before moving to cloud. This section highlights different issues addressed by various researchers and discusses some of the critical issues in detail.

Identification of correct workload, Security and Privacy, Quality of Service, Cost Savings Potential, Network Performance and Integration Complexity are the challenges identified by Banerjee [5]. Issues discussed by Vouk [12] are Economy-of-scale and Economics of image and service, Metadata Management, Optimization of image and image portability, Security, Calculation of return-on-investment and the total-cost-of-ownership. Zhang et al. [4] has summarized Automated service provisioning, Virtual machine migration, Server consolidation, Energy management, Traffic management and analysis, Data security, Software frameworks, Storage technologies and data management, Novel cloud architectures as challenging research issues in Cloud Computing. Many other issues have been discussed by various other researchers [10, 11, 13, 14, 15 and 16].

Out of above mentioned issues, following have been identified as critical issues and being discussed in detail.

- Security

For end-users to feel comfortable with a "cloud" solution that holds their software, data and processes, there should exist considerable assurances by the service providers that their services are highly reliable and available, as well as secure and safe, and that privacy is protected [12]. This is because security is a major challenge in leveraging Cloud Computing services. Gartner 2008 identified seven security issues that need to be addressed before enterprises consider switching to the Cloud Computing model. They are: (1) privileged user access (2) regulatory compliance (3) data location (4) data segregation (5) recovery (6) investigative support (7) long-term viability [17].

- Cost

The existing cost model for IT is a combination of capital expenditure and operational expenditure. Organizations generally budget for peak loads incurring higher capital expenditure. However, these costs may be budgeted and predicted. Moving to an operational cost model through the adoption of the Cloud would mean paying for resources as per usage. This model implies unpredictable operational costs especially for applications with varying demand e.g. public facing websites. Therefore, it is important for organizations to estimate application usage and operational costs before moving to the Cloud [16]. Also, application migration cost and usage cost must be considered. If the cost of application migration is more than the cost of developing a new application, application migration is not a good choice. Similarly, if the usage cost of Cloud Computing is more than the cost of hiring private servers, it is better not to migrate the application to the cloud. Thus, it is important to estimate these two costs [18].

- Service Level Agreement (SLA)

Although cloud consumers do not have control over the underlying computing resources, but they need to ensure the quality, availability, reliability, and performance of these resources after migrating their core business functions onto their entrusted cloud. This is done through Service Level Agreements (SLAs) negotiated between the providers and

consumers. The very first issue with SLA is the definition of SLA specifications in such a way that has an appropriate level of granularity so that they can cover most of the consumer expectations and is relatively simple to be weighted. Another issue is that different cloud offerings (IaaS, PaaS, and SaaS) will need to define different SLA meta specifications. This also raises a number of implementation problems for the cloud providers [19].

- Cloud Interoperability Issue

Currently, each cloud offering has its own way on how cloud clients/applications/users interact with the cloud. This severely hinders the development of cloud ecosystems by forcing vendor locking. More importantly, proprietary cloud APIs makes it very difficult to integrate cloud services with an organization's own existing legacy systems. The primary goal of interoperability is to realize the seamless fluid data across clouds and between cloud and local applications [20]. But achieving interoperability between multiple cloud providers is a big challenge.

- Fault Tolerance

Cloud Computing has several benefits but it is vulnerable to a large number of system failures and, as a consequence, there is an increasing concern among users regarding the reliability and availability of Cloud computing services. Fault tolerance becomes of paramount importance to the users as well as the service providers to ensure correct and continuous system operation even in the presence of an unknown and unpredictable number of failures [21]. There are a large number of issues associated with fault tolerance like development of a new approach that can integrate fault tolerance techniques with existing workflow scheduling algorithms [22]. Also, there is a need to implement autonomic fault tolerance technique for multiple instances of an application running on several virtual machines [23].

- Server consolidation

Server consolidation is an effective approach to maximize resource utilization while minimizing energy consumption in a Cloud Computing environment. Live VM migration technology is often used to consolidate VMs residing on multiple under-utilized servers onto a single server, so that the remaining servers can be set to an energy-saving state [4]. The major problem faced is of optimally consolidating servers in a data center. This is because server consolidation activities may hurt application performance. For server resources that are shared among VMs, such as bandwidth, memory cache and disk I/O, maximally consolidating a server may result in resource congestion when a VM changes its footprint (resource usage) on the server [24], thus, affecting application's performance.

- Energy management

Improving energy efficiency is another major issue in Cloud Designing energy-efficient data centers has recently received considerable attention. Computing Infrastructure providers are under enormous pressure to reduce energy consumption. The goal is not only to cut down energy cost in data centers, but also to meet government regulations and environmental standards [4].

IV. CONCLUSION

Cloud Computing has emerged as a new computing model that delivers Information Technology infrastructure as utility over Internet. In order to utilize these infrastructure resources and services, existing applications need to be migrated to clouds. Though migration to cloud provides many benefits, but users must understand that there are numerous issues and challenges that hinder Cloud Computing acceptance. These issues must be considered before migrating applications to cloud environment. This paper highlights some of the challenges faced by organizations planning to migrate to Cloud environment. There are many other issues related to migration that need to be explored and worked upon by the researchers for efficient migration to Cloud Computing environment.

REFERENCES

[1] S. O. Kuyoro, F. Ibikunle and O. Awodele, "Cloud computing security issues and challenges," *International Journal of Computer Networks*, pp. 11-14, 2011.

[2] P. Mell and T. Grance, "The NIST definition of Cloud Computing (draft)," NIST special publication, vol. 800, pp. 145.

[3] F.D. Biase, "Legacy to Cloud Migration: Assessing the Cloud Readiness of Legacy Software," M. Sci. thesis, University of Applied Sciences, Northwestern Switzerland, Feb. 2013.

[4] Q. Zhang, L. Cheng, and R. Boutaba, "Cloud Computing: State-of-the-Art and Research Challenges," *Journal of Internet Services and Applications, Springer*, pp. 7–18, 2010.

[5] J. Banerjee, "Moving to the cloud: Workload migration techniques and approaches," in *High Performance Computing (HiPC), 2012 19th International Conference,* p. 1-6, IEEE.

[6] M. A. Chauhan and M. A. Babar, "Migrating service-oriented system to cloud computing: An experience report," in *Cloud Computing (CLOUD) IEEE International Conference*, 2011, p. 404-411.

[7] M. A. Chauhan and M. A. Babar, "Towards process support for migrating applications to cloud computing," in *Cloud and Service Computing (CSC) International Conference,* IEEE, 2012, p. 80-87.

[8] A. Khajeh-Hosseini, D. Greenwood and I. Sommerville, "Cloud migration: A case study of migrating an enterprise it system to iaas," In *Cloud Computing (CLOUD), 2010 IEEE 3rd International Conference IEEE* p. 450-457.

[9] Hackystat,http://code.google.com/p/hackystat/ [February, 2011].

[10] F. Gens. (2009, Feb.). "New IDC IT Cloud Services Survey: Top Benefits and Challenges",IDC eXchange, Available: <http://blogs.idc.com/ie/?p=730> [Feb. 18, 2010].

[11]   B. P. Rimal, E. Choi, and I. Lumb, "A Taxonomy and Survey of Cloud Computing Systems," in *Fifth International Joint Conference on INC, IMS and IDC*, 2009, p. 44–51.

[12]   M.A. Vouk, "Cloud computing issues, research and implementations," in *30th International Conference on Information Technology Interfaces,* 2008, p. 31-40.

[13]   V. Andrikopoulos, T. Binz, F. Leymann and S. Strauch, "How to Adapt Applications for the Cloud Environment: Challenges and Solutions in Migrating Applications to the Cloud," *Computing*, vol. 95, no. 6, pp. 493-535, 2013.

[14]   A. Fox, R. Griffith et al., "Above the clouds: A berkeley view of cloud computing," Dept. Electrical Eng. and Computer Sciences, University of California, Berkeley, Tech. Rep. UCB/EECS, vol. 28, 2009.

[15]   M.D. Dikaiakos et al., "Cloud Computing: Distributed Internet Computing for IT and Scientific Research," *IEEE Internet Computing*, vol. 13, no. 5, pp. 10–13, 2009.

[16]   M.S. Rashmi and G. Sahoo, "A five-phased approach for the cloud migration," *International Journal of Emerging Technology and Advanced Engineering* 2, vol. 4, pp. 286-291, 2012.

[17]   J. Brodkin. (2008, Jun.). "Gartner: Seven cloud-computing security risks." Infoworld, Available:<http://www.infoworld .com/d /security-central/gartner-seven-cloudcomputingsecurity-risks 853?page=0,1 > [Mar. 13, 2009].

[18]   Q. H. Vu and R. Asal, "Legacy application migration to the cloud: Practicability and methodology," in *IEEE Eighth World Congress on Services*, 2012, p. 270-277.

[19]   C. Weinhardt, A. Anandasivam, B. Blau, and J. Stosser. "Business Models in the Service World." *IT Professional*, vol. 11, pp. 28-33, 2009.

[20]   T. Dillon, C. Wu, and E. Chang, "Cloud Computing: Issues and Challenges," in *IEEE International Conference Advanced Info. Networking and Apps.*, 2010, p. 27–33.

[21]   R. Jhawar and V. Piuri, "Fault tolerance and resilience in cloud computing environments," *Computer and Information Security Handbook,* pp. 125-141, 2013.

[22]   Y. Zhang, A. Mandal, C. Koelbel and K. Cooper, "Combined fault tolerance and scheduling techniques for workflow applications on computational grids," in *Cluster Computing and the Grid, 2009. CCGRID'09. 9th IEEE/ACM International Symposium,* p. 244-251.

[23]   Gang Chen, Hai Jin, Deqing Zou, Bing Bing Zhou, Weizhong Qiang, Gang Hu, "SHelp: Automatic Selfhealing for Multiple Application Instances in a Virtual Machine Environment," in *IEEE International Conference on Cluster Computing*, 2010.

[24]   P. Padala, K-Y Hou et al, "Automated control of multiple virtualized resources," in *Proc. of EuroSys*,2009.