International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 4, April 2012)

A five-phased approach for the cloud migration

Rashmi[1], Dr.Shabana Mehfuz[2], Dr.G.Sahoo[3]
[1,3]*Birla Institute of Technology, Mesra, Ranchi, Jharkhand, India*
[2]*Jamia Milia Islamia, New Delhi, India*
[1]rashmirrai@gmail.com
[2]mehfuz_shabana@yahoo.com
[3]gsahoo@bitmesra.ac.in

***Abstract*— Cloud computing has no doubt become the buzzword in the IT industry today. It has been regarded as one of the most influential technology in new era. In the last few years, cloud computing has grown from being a promising business concept to one of the fast growing segments of the IT industry. Given the long term benefits of adopting this new phenomenon, many organizations have decided to migrate to the cloud. However, due to rapidly evolving market and the security issues hovering over the cloud, most of the organizations are unsure about how to proceed with the migration into the cloud. One of the biggest challenges organizations contemplating Cloud adoption face is where to start and what to focus on. Further, depending on the type of enterprise e.g. educational institutions, government or large corporations, the challenges and migration process would vary. This paper aims to provide an understanding of migration challenges. It also seeks to propose a new cloud migration model that various type of organizations could follow to migrate to the Cloud.**

***Keywords*— cloud migration; process; migration challenges; cloud implementation;**

I. INTRODUCTION

The advances of the cloud computing [1,2,3,4] phenomenon has changed the way information technology(IT) Services are invented ,developed , deployed, scaled and maintained. Over the last few years many companies such as Orkut (www.orkut.com) and Youtube (www.youtube.com) have used clouds to build highly scalable systems. However, cloud computing is not just for startups[5,6]; enterprises are attracted to cloud-based services as cloud providers market their services as being superior to in house data centers in terms of financial and technical dimensions e.g. more cost effective, equally or perhaps more reliable, and highly scalable [7, 8].

Measuring so many advantages of this disruptive technology, organizations are keen to migrate to the cloud. However, they are not clear about the migration process, outcomes and benefits.

The growing popularity of cloud migration and its management has not only accelerated the entire cloud environment but have also given rise to several cloud service providers to offer competitive and lucrative management solutions for organizations to run their daily operations competently.

While a cloud migration can present numerous challenges and raise security concerns, cloud computing can also enable a company to potentially reduce capital expenditures and operating costs while also benefiting from the dynamic scaling, high availability, multi-tenancy and effective resource allocation advantages cloud-based computing offers.

Even though implementing a Cloud migration intended at replacing an on premise major business application, may seem at times a simple straight forward process, it is fraught with loose ends which may undermine the true value of the investment and in fact put enterprises in worst situation than before.

A. Challenges for migration

All applications as well as the supporting network infrastructure may not be suitable for migration onto the Cloud. There are both business and technical factors to consider while evaluating the suitability of an application and infrastructure for Cloud migration. A typical Cloud migration challenges are depicted below.

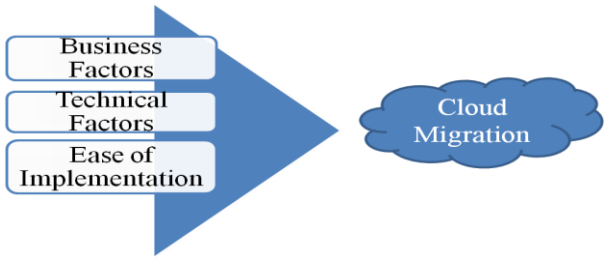

Figure 1: Migration Challenges

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 4, April 2012)

1) Business Factors

The key business factors to consider when moving to the Cloud are as depicted below:

- *Existing investments in IT:* Small and Medium Enterprises (SMEs) are definitely at an advantage over large organizations when it comes to Cloud migration. Due to a considerably limited installed IT base, SMEs may be able to directly move into the Cloud. Most large corporations, however, have already made significant investments in their IT infrastructure. Huge investments and complexity of hardware, network, application support, administration, customization and integration would make it difficult for them to move away from their existing IT environment.
- *Costs:* 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 while being high are budgeted and predictable. 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 those applications with varying demand for e.g. public facing websites. Therefore, it is important for organizations to estimate application usage and operational costs before moving to the Cloud. Further, migration costs need to be understood and factored in before making the decision to move into the Cloud. Failure to do this could negate the cost savings that are sought to be derived from the adoption of the Cloud.
- *Data security:* Security of data is a key concern while considering the move to the Cloud. Applications that have very sensitive and confidential information would be better off being behind the corporate firewall. Data with greater security tolerance however could be ported onto the Cloud. Technical mechanisms for data security in the Cloud are still evolving and security of data is still the top most inhibiter of Cloud adoption [10].
- *Regulations:* Geopolitical issues especially for Governments and financial institutions should be carefully evaluated before making the transition to the Cloud. In the Indian context this is especially relevant as most Cloud data centres are not located within the country. It is also important to ensure that local regulations relevant to each organization should be adhered to before deciding to move to the Cloud [11].
- *Provisioning:* One of the key benefits of the Cloud is the quick provisioning of resources. Applications that need to be quickly available and scaled up rapidly based on demand are ideal candidates for the Cloud. Most organizations have business requirements that need to be supported by quick provisioning of IT data, e.g. an organization running a limited period online marketing campaign. Several applications are seasonal in nature as well for example HR and Payroll applications, which need resources to be processed only during certain periods. These sorts of applications can make use of the ability of the Cloud to quickly provision resources.

2) Technical Factors

Some of the key technical aspects to be considered are:

- *Existing infrastructure:* The traditional IT architecture is optimized to cater to the current demand in the sector. Moving to the Cloud would necessitate a change in the IT architecture. With applications moving into the Cloud, the way IT is delivered to end users would undergo a radical change. Some end user support would be dependent on the Cloud service provider response. Hence, organizations would have to concentrate on building vendor management competencies [15].
- *Security architecture:* Application security and controls would need to change to adapt to the Cloud ecosystem. New types of mechanisms would be required to secure data in transit and at rest. Identity and access management mechanisms would need to be adapted to Cloud deployments. Further, data encryption mechanisms and key management for the Cloud are yet to mature [12].
- *Complexity:* Simple applications can be easily migrated to the Cloud and the amount of effort required to move such applications may not be not too significant. These applications can be directly migrated to Software as a Service [14] (SaaS) applications already available from various vendors. E.g. e-Mail applications can be directly ported onto Cloud offerings like Office365, Google Apps or Lotus Live. Similarly, moving a simple web server to an Infrastructure as Service [14] (IaaS) platform may not require as much effort. Migration of complex applications however, needs elaborate planning and testing prior to implementation. Legacy applications and existing enterprise applications could require code changes to work on the Cloud.

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 4, April 2012)

- *Network and support:* With applications moving to the Cloud, there is a real risk of the network becoming the single point of failure. Further, due to a large number of connections to the external Cloud, the bandwidth may need to be upgraded. Hence, organizations would need to plan for better and reliable network connections to the Cloud. This could mean that organizations may incur higher costs for additional and higher capacity network connections. Further, a higher level of support would be required of telecom providers to ensure that any downtime is minimized [13].
- *IT skills:* Although the Cloud is based on existing technologies, it would require updated skills within the IT team, especially on architecture, implementation, develop and operation. For organizations not yet exposed to newer IT technologies like virtualization, Web 2.0 etc. the learning curve would be sharper. Further, migration of applications to the Cloud is perceived by IT teams as a loss of control. These types of cultural challenges would need to be addressed prior to deciding the migration to the Cloud [15].
- *Service Level Agreements (SLAs):* Another key aspect to consider before migrating to the Cloud is whether Cloud service providers are able to provide SLAs that the business needs. This is quite essential considering the limited control organizations have over applications on the Cloud. SLAs need to address the concerns of availability, confidentiality and integrity of the application. Further, it should clearly outline service provider responsibilities and penalties for failure to meet agreed service levels [11].

B. *Related work*

Cloud computing is not just about technology; it also represents the fundamental change in how IT is provisioned and used. Before adopting the cloud computing; enterprises have to consider its benefits, risks and effects on their organisation [13]. The work by Khajeh-Hosseini *et al.* [16] illustrates the potential benefits and risks associated with the migration of an IT system in the oil & gas industry from an in-house data centre to Amazon EC2 from a broad variety of stakeholder perspectives across the enterprise, thus transcending the typical, yet narrow, financial and technical analysis. This work clearly states the need for a proper migration process.

Klems *et al*. [17] presented as a framework that could be used to compare the costs of using cloud computing with more conventional approaches, such as using in house IT infrastructure. Their framework was very briefly evaluated using two case studies. However, no results were provided because the framework was at an early developmental stage and more conceptual than concrete.

Another methodology and tools for model-driven migration of legacy applications to a service-oriented architecture with deployment in the cloud; i.e. the Service Cloud paradigm was presented by P. Mohagheghi et al. [18]. The migration approach used here is the Architecture Driven Modernization (ADM) [19] by OMG. In this concept, modernization starts with the extraction of the architecture of the legacy application (the "Recover" activity). Having the architectural model helps to analyze the legacy system, identify the best ways for modernization and benefit from Model-Driven Engineering (MDE) technologies for generation of the new system. This information will be then translated into models covering different aspects of the architecture: Business Process, Business Rules, Components, Implementation, and Test specifications. Though this process of migration is still a work in progress, it nowhere talks about the migration challenges and ways to handle them.

Another approach by a group [20] at IBM talks about many automated tools for cloud migration, the challenges and the experiences. In their work they have clearly stated the need for a smooth migration of workload from the previous environment to the new cloud enabled environment in a cost effective way, with minimal disruption and risk. They have introduced extensions to an integrated automation capability that enables workload migration and discussed the impact that automated migration has on the cost and risks.

All these work clearly states the need for a well defined process for cloud migration. Though a lot has been talked about cloud computing; there is significantly very less contribution on the process of migration. The model presented here for cloud migration is based on the software engineering approach and attempt to present the migration process along with feedback at each phase of migration.

This model has not been discussed to any significant extent in the previously mentioned literature.

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 4, April 2012)

C. *Contribution Summary*

In this paper we have introduced a new waterfall model for cloud migration. This model is based on the Software Development Life Cycle model of software engineering. We have highlighted some of the challenges in cloud migration process and various works done in the area of cloud migration. Section II describes the proposed model in detail, followed by section III which talks about the considerations which must be taken by some common industry before migrating into cloud. Section IV covers the conclusion and future work.

II. Five-Phased Waterfall Model

The proposed waterfall model for cloud migration is based on the Iterative Waterfall model from Software Development Life Cycle (SDLC).The Iterative Waterfall model improves upon the Classical Water Fall model by including the feedback paths .In dynamic development environments, defects do get introduced in almost every phase of the life cycle. These defects usually get detected much later in the life cycle. Once a defect is detected, we need to go back to the phase where it got introduced and redo some of the work done during this phase and subsequent phases. When we talk about cloud migration, a similar scenario exists .The cloud migration would involve drawing up detailed project plans for implementation, migration and deployment.

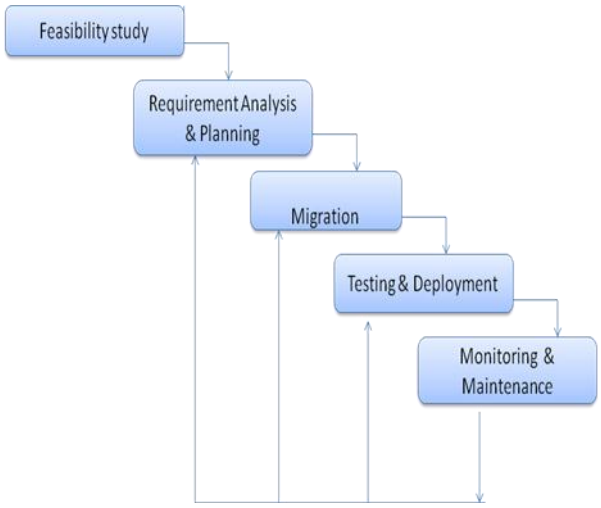

Figure 2. Five-phased Model for Cloud Migration

It is one of the areas that require close attention due to the possibility of project overruns. IT team and vendors would need to work closely to enable quick migration to the Cloud and at the same time taking the feedback from each stages of the migration process and redo the work. In this paper, we have proposed a similar Waterfall Model for Cloud Migration. This model consists of five phases. Each phase of the proposed Water Fall model is described here in detail:

Phase 1: Feasibility Study

The key idea of feasibility study is to determine whether the cloud migration is financially and technically feasible. It would involve the analysis of the existing application and the collection of the data which would be input to the system, the processing required to be carried out on these data, the output data required to be produced by the system, as well as study of various constraints on the behaviour of the system .A detail cost/benefit analysis is performed and it may also be determined whether the migration is not feasible due to high cost, resource constraints, or extraordinary technical reasons.

Phase 2: Requirement Analysis & Planning

In the planning phase, a detailed assessment is carried out of the existing IT environment with a view to understand the applications that are appropriate for moving into the Cloud. The migration considerations mentioned earlier in this paper would be taken into account. Once candidate applications are identified for migration, a detailed Return on Investment (ROI) and Total Cost of Ownership (TCO) assessment is carried out to understand the cost benefits that will be achieved from the migration.

Phase 3: Migration

In the migration phase, the applications selected will be ported to the Cloud and tested in a structured manner. Simple applications like e-Mail would just need testing prior to migration in terms of functionality and performance. However bespoke and/or complex applications would need the creation of a development and test environment. Procedures similar to those followed during Software

Development Life Cycle (SDLC) would need to be adopted prior to deployment of the application on the Cloud. Thereafter, validation of the new platform will be performed through User Acceptance Testing (UAT) and signoff from business process owners.

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 4, April 2012)

Phase 4: Testing and deployment (Go-Live)

In the Go-live phase, the live production data will be ported onto the Cloud. This will be followed by post-migration testing and release. During this phase, a higher degree of monitoring and support is essential to handle any unforeseen issues. Some organizations may choose to adopt a parallel operation approach before fully moving to the migrated application.

Phase 5: Monitoring & Maintenance

A key requirement for Cloud migration is post-migration monitoring. Given the shared nature of the Cloud, it is necessary to monitor Cloud application in terms of performance, availability and security. There are various monitoring tools being provided by Cloud vendors. These include Amazon Cloud Watch, Gomez, Hyperic CloudStatus etc. These tools can help IT teams detect breaks in SLAs and take the necessary corrective action

III. Analysis

While a standard approach (depicted in figure 2) can be used for migration of applications to the Cloud, Cloud migration will vary depending on type of organization. To illustrate the difference, we have considered three types of organizations and analyzed them for the proposed model.

- *Large organizations*

As mentioned earlier, large organizations already have significant investments in IT. Further, the IT environment tends to be much more mature and complex. For larger organizations to migrate to the Cloud, detailed assessments and planning would be required. Simple applications like e-Mail and collaboration solutions could be immediately moved to the Cloud to derive the benefits. However, it would be worthwhile for organizations to wait for complex Cloud-based applications such as ERPs to mature before migrating to them. It would be beneficial for large organizations to draw up a roadmap for the gradual adoption of the Cloud instead of following a big bang approach. This would enable them to derive Cloud benefits over a period of time without having to write-off existing investments. A phased approach would also enable a graceful migration to the Cloud. Large organizations should nevertheless conduct a comprehensive Cloud assessment including a risk assessment of its applications to identify any applications that would immediately benefit by migrating to the Cloud.

- *SMEs*

SMEs have a major advantage in migrating to the Cloud as they do not have major investments in IT infrastructure. SMEs have the opportunity today to quickly move to the Cloud and reap the benefits of software like CRM, ERP, etc. which were hitherto the domain of only large corporations. They would need to follow a different approach for Cloud migration and adoption. They would need to re-visit their business needs that were ignored earlier due to non-availability/cost of technology. With the availability of a plethora of Cloud services, SMEs are in an enviable position to pick and choose the best-of-breed Cloud offerings. However, SMEs should nevertheless perform application and vendor assessments prior to signing up for any Cloud service. Most of the business and technical factors mentioned earlier hold true for SMEs as well. Given the evolving nature of the Cloud, SMEs should understand relevant risks of the Cloud prior to making the move. SMEs can use the benefits of the Cloud like 'pay per use' thereby leveraging the Cloud without any capital expenditure investment.

- *Governments*

Governments across the world are looking at reducing IT infrastructure costs while retaining the control of data. While the US Government has already moved towards creating a Cloud for its use, other governments are mulling over their approach. In India, eGovernance has taken off in a big way. However, the underlying IT infrastructure still is State and Central data centers. Creation of a private Cloud just for the Indian government's use seems to be a pragmatic way for efficient utilization of IT resources. Indian state and national governments have heterogeneous systems and many of them have limited computerization. Therefore, migration across Government or Government agencies would still be a distant dream. In such a scenario, it would be worthwhile to first consider consolidation of applications and infrastructure at a state level through the development of State Clouds. These Clouds would be based on nationally-defined Cloud standards. Smaller states could also share Clouds implemented in larger states. Once a sufficient degree of standardization is achieved across the states, it would be easier to implement a national Cloud. Creation of Clouds for use by State and National Governments would result in several benefits including: Quick provisioning of IT infrastructure, efficient use of IT resources, and no need for disaster recovery sites for each data centre.

International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 4, April 2012)

IV. Conclusion And Future Work

While the Cloud promises several benefits, migration to the Cloud needs to be meticulously planned. Depending on business and technical considerations, organizations need to select the appropriate applications and infrastructure for migration, as all applications and infrastructure are not suited for the Cloud. A phased approach to Cloud migration is required to move applications to the Cloud while navigating through various minefields. This would enable organizations to ensure that the costs of migration to the Cloud do not exceed its benefits. Further, different types of organizations for e.g. SMEs, large corporations and Governments need to consider factors relevant to themselves before embarking on this journey. To summarize, the Cloud holds promise for all types of organizations. However, different approaches are required by each organization to leverage the Cloud effectively.

The new waterfall model described here is based on the existing software engineering model and it can be further enhanced and used by the cloud service providers for a phased migration.

REFERENCES

[1] Viega J. Cloud computing and the common man. Computer 2009;42(8):106–8.
[2] Vaquero LM, Rodero-Merino L, Caceres J, Lindner M. A break in the clouds: towards a cloud definition. In: ACM SIGCOMM, editor. Computer communica- tion review 2009. New York: ACM Press; 2009. p. 50–5In: ACM SIGCOMM, editor. Computer communication review 2009. New York: ACM Press; 2009. p. 50–5.
[3] Weiss A. Computing in the clouds. In: ACM networker, December 2007, 2007, p.16 25.
[4] Whyman B. Cloud computing. Information Security and Privacy Advisory Board; 2008.11-3
[5] Seccombe A, Hutton A, Meisel A, Windel A, Mohammed A, Licciardi A, et al. Security guidance for critical areas of focus in cloud computing 2.0
[6] M. Armbrust, A. Fox, R. Griffith, A. Joseph, R. Katz,A. Konwinski, G. Lee, D.Patterson, A. Rabkin, I. Stoica, and M. Zaharia,"Above the Clouds: A Berkeley View of Cloud Computing "2009
[7] H. Erdogmus, "Cloud Computing: Does Nirvana Hide behind the Nebula?," IEEE Software, vol. 26, 2009, pp. 4-6.
[8] M.A. Vouk, "Cloud computing issues, research and implementations," 30th International Conference on Information Technology Interfaces (ITI 2008),Cavtat/Dubrovnik, Croatia: 2008, pp. 31 40.
[9] Amazon Web Services, " Amazon Elastic Compute Cloud (AmazonEC2),"Available: http://aws.amazon.com/ec2/ [Accessed:Jan.19,2012]
[10] Subashini S, Kavitha V. A survey on security issues in service delivery models of cloud computing. J Network Comput Appl (2010), doi:10.1016/j.jnca.2010.07.006
[11] Seccombe A, Hutton A, Meisel A, Windel A, Mohammed A, Licciardi A, et al. Security guidance for critical areas of focus in cloud computing, v3.0. Cloud Security Alliance, 2011, 176 p
[12] Seccombe A, Hutton A, Meisel A, Windel A, Mohammed A, Licciardi A, et al. Security guidance for critical areas of focus in cloud computing, v2.1. Cloud Security Alliance, 2009, 76 p
[13] R. Buyya, C.S. Yeo, S. Venugopal, Market-Oriented cloud computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities, 10th IEEE International Conference on High Performance Computing and Communications, 2008 (HPCC08), 2008.
[14] NIST, NIST Definition of cloud computing v15, NIST, Editor. 2009, National Institute of Standards and Technology: Gaithersburg, MD (2009).
[15] Sean Marston, Zhi Li, Subhajyoti Bandyopadhyay,,Juheng Zhang, Anand Ghalsasi ,Cloud Computing – The business perspective , Decision Support Systems 51 (2011) 176–189 doi:10.1016/j.dss.2010.12.006
[16] A. Khajeh-Hosseini, I. Sommerville, and D.Greenwood, Cloud Migration: A Case Study of Migrating an Enterprise IT System to IaaS *Submitted to 1st ACM Symposium on Cloud Computing (SOCC 2010), 2010*.
[17] M. Klems, J. Nimis, and S. Tai, "Do Clouds Compute? A Framework for Estimating the Value of Cloud Computing," Markets, Services, and Networks, Lecture Notes in Business Information Processing, vol. 22, 2009.
[18] P. Mohagheghi, T. Saether, Software Engineering Challenges for Migration to the Service Cloud Paradigm Ongoing Work in the REMICS Project, 2011 IEEE World Congress on Services
[19] OMG ADM; http://adm.omg.org/ [Accessed on 01 March 2012]
[20] C. Ward, N. Aravamudan, K. Bhattacharya, K. Cheng, R. Filepp, R. Kearney, B. Peterson, L. Shwartz, C. C. Young ,IBM , Workload Migration into Clouds – Challenges, Experiences, Opportunities, 2010 IEEE 3rd International Conference on Cloud Computing
[21] The cloud :Changing the business ecosystem,2011 www.kpmg.com/ [Accessed on Feb 2012]