International Journal of Cloud Computing and Services Science (IJ-CLOSER)
Vol.2, No.1, February 2013, pp. 50~58
ISSN: 2089-3337

Development and Usage of Software as a Service for a Cloud and Non-Cloud Based Environment- An Empirical Study

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Article Info

Article history:

Received Oct 12th, 2012
Revised, Oct 30th, 2012
Accepted, Nov 06th, 2012

Keyword:

Virtualization
Grid Computing
Reliability
Scalable
Resources

ABSTRACT

Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand. Cloud computing is a natural evolution of the widespread adoption of virtualization, service-oriented architecture and utility computing. The computer applications nowadays are becoming more and more complex; there is an ever increasing demand for computing resources. As this demand has risen, the concepts of cloud computing and grid computing have found many followers with more and more companies looking to outsource computing needs to a third party vendor. However, this growing dependence on third party providers is causing large corporations as well as research groups to look for alternative models that can support the increased demand for computing resources. The concerns of reliability, privacy, efficiency at the expense of resilience and environmental sustainability are at the forefront of such research. For application providers, cloud computing has the advantage that it reduces the administrative effort required to satisfy processing and storage requirements. However, to simplify the task of building scalable applications, some of the cloud computing platforms impose constraints on the application architecture, its implementation and tools that may be used in development. The changing scenario in education has given rise to need of technology in education. Information Technology has played a major part in improving the learning outcomes of individuals. Technologies like cloud computing has not only reduced the burden of economy as well as resources required. This paper has shown the different aspects of using cloud and non-cloud environment.

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1. INTRODUCTION

Cloud computing is the latest computing paradigm that delivers hardware and software resources as virtualized services in which users are free from the burden of worrying about the low-level system administration details. Migrating Web applications to Cloud services and integrating Cloud services into existing computing infrastructures is non-trivial. It leads to new challenges that often require innovation of paradigms and practices at all levels: technical, cultural, legal, regulatory, and social. The key problem in mapping Web applications to virtualized Cloud services is selecting the best and compatible mix of software images (e.g., Web server image) and infrastructure services to ensure that Quality of Service (QoS) targets of an application are achieved. Cloud computing is Internet-based computing, where all IT-resources like software, data and other devices are provided on-demand. Cloud computing is a new way of delivering computing resources. Computing services ranging from data storage and processing to software, such as

email handling, are now available instantly, commitment-free and on-demand. Cloud computing can help companies accomplish more by eliminating the physical bonds between an IT infrastructure and its users. Users can purchase services from a cloud environment that could allow them to save money and focus on their core business. The main aim of the cloud computing technology is to move any application stored on a computer to a remote location, eliminating all the standard components, including operating system and hard drives, which are necessary in today's computers and make them accessible on line for users through a standard browser. It is an emerging computing paradigm in which applications, data and IT resources are provided as a service to users over the Internet [1-2].In terms of web services, it provides the best utilization of resources. Cloud computing is helpful from the business point of view as it helps to foster innovation and reduce IT costs as well it can play important role in minimizing the alarming problem of global warming and climate change. It is a virtualization of resources that maintains and manages itself. Through cloud computing higher level service capabilities are available used to build applications. Behind the services are data and compute resources. Cloud computing overlaps some of the concepts of distributed, grid and utility computing. This technology is based on pay per use basis. Cloud computing has the potential to shrink our computing world, making hardware smaller and cheaper [3].

2. PROBLEM STATEMENT

Information Technology (IT) has been witnessing revolutionary changes in both Hardware and Software for the last 40 years. In software, the architecture of application software and their deployment methods have also changed with changes in IT. Starting Console application, client-server application, multi-user application and web applications are major architecture of software application. To deploy these applications, users manage their own IT infrastructure. In case of web site hosting, users either arrange their own infrastructure or hire outside hosting service provider. Now, the scenario has been changed with development in the cloud environment. In cloud environment, users pay as per usages. Cloud provides three services: IaaS, PaaS and SaaS. Users are adopting clouds for their applications deployment. While moving from traditional web hosting to cloud environment, performance issues arise due to differences in their architecture especially for academic user whose already running applications are not developed according to features of cloud environment.

3. REVIEW OF LITERATURE:

3.1. Cloud Computing

Cloud computing refers to computing with a pool of virtualized computer resources and is driven by economics of scale. A cloud can host a variety of different workloads, and allow workloads to be deployed and scaled-out quickly on-demand by rapid provisioning of virtual machines or physical machines. Cloud computing has become a main medium for Software as a Service (SaaS) hosting as it can provide the scalability a SaaS requires. A cloud supports redundant, self-recovering, highly scalable programming models and allows workloads to recover from many unavoidable hardware/software failures. A cloud also monitors resource use in real time to enable rebalancing of allocations when needed. The idea is to move desktop computing to a service-oriented platform using server clusters and huge databases at datacenters. According to National Institute of Standards and Technology (NIST) in 2009, respectively its updated version in 2011,"CLOUD computing is a model for enabling ubiquitous, convenient, on demand network access to 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. This CLOUD model is composed of five essential characteristics, three service models (Software / Platform /Infrastructure as a Service), and four deployment models, whereas the five characteristics are: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. The deployment models include private, community, public and hybrid CLOUD."

3.1. 1. Deployment Models*:*

The four deployment models are as follows [3]:

a) **Public Cloud*:*** In simple terms, public cloud services are characterized as being available to clients from a third party service provider via the Internet. The term "public" does not always mean free, even though it can be free or fairly inexpensive to use. A public cloud does not mean that a user's data is publically visible; public cloud vendors typically provide an access control mechanism for their users.
b) **Private Cloud*:*** A private cloud offers many of the benefits of a public cloud computing environment, such as being elastic and service based. The difference between a private cloud and a public cloud is that in a private cloud-based service, data and processes are managed within the organization without the

restrictions of network bandwidth, security exposures and legal requirements that using public cloud services might entail.

c) **Community Cloud*:*** A community cloud is controlled and used by a group of organizations that have shared interests, such as specific security requirements or a common mission. The members of the community share access to the data and applications in the cloud.

d) **Hybrid Cloud*:*** A hybrid cloud is a combination of a public and private cloud that interoperates. In this model users typically outsource non-business critical information and processing to the public cloud, while keeping business critical services and data in their control.

3.1. 2 Services:

There are three types of services offered by cloud computing. These are SaaS (Software as a Service), PaaS (Platform as a Service), IaaS (Infrastructure as a Service).The term services in cloud computing is the concept of being able to use components across a network, provided by web service providers. This is widely known as "as a service."

1. **Software as a Service (SaaS):**

- Companies host applications in the cloud that many users access through internet connections.
- The example of Software as a Service is Gmail, face book etc.

2. **Platform as a Service (PaaS):**

- Developers can design, build and test applications that run on the cloud provider's infrastructure and then deliver those applications to end users from the provider's servers.
- These services are used by the developers of the web applications.
- The example of Platform as a service is google app engine.

3. **Infrastructure as a Service (IaaS):**

- The IT companies obtain general processing, storage, database management and applications through the network and pay only for get used.
- These services are used by the IT companies so as to reduce the infrastructure cost for their companies.

3.2. Academic Perspective on CLOUD:

Cloud computing has revolutionalized the IT industry by introducing a whole new concept and platform of enterprise systems (ES).With the flexibility and capability of Cloud Computing, it enabled ES to be delivered via the Internet and accessible to wide variety of users at a much lower costs. With organizations having to reduce most of their IT budgets during economic turmoil, Cloud ES concept is certainly an option that attracts the attention of Academia and Industry. The important values of the Cloud ES are reduction of hardware and license costs, lower total cost of ownership, lower upfront costs, reduces the cost and effort of upgrades, ease of implementation, best fit solution regardless of delivery model, focusing internal resources elsewhere and limited IT resources, scalability and manageability [4]. Penetration of Higher Education in all regions is increasing all over the globe at a very fast pace. With the increase in the number of institutions offering higher education, ERP implementations has become one of the key ingredient to achieve competitiveness in the market. Still more than half of the institutions in the developing countries are following traditional approach due to different reasons. In these kinds of implementations different modules like admissions, fee collection, attendance, grading, Feedback system, Billing, Smart classes, Inventory, Human resource management etc are implemented in an Adhoc manner without having an overall objective of a comprehensive ERP.

Many of the modules are generally developed at different times and these modules don't talk to each other. There is no concept of service architecture being used in these kinds of implementations. Cloud computing theory is out of scope for these kinds of implementations. In On-Campus implementation, organizations have developed in-house infrastructure for ERP implementations and don't have any outside dependence. Implementations with Internet Host Provider have virtualization, Server side scripts or tools, Storage and networking component is looked after by the host who has been hired for providing the services. It leads to lower cost of hardware by the organization. It also dilutes the requirement of highly skilled professionals to maintain the system. Databases and applications are still run and managed at the campus. These implementations take some advantages of ubiquitous computing but bottlenecks still remain. Benefits

of Cloud Computing in ERP Implementations at higher Technical Education Institutions which are as follows [6-9]:

- **Cost:** Cost is reduced because deployment of software and hardware is the responsibility of the cloud service provider.
- Unrestricted and unlimited usage.
- Standard encryption and decryption techniques for security purpose.
- **Uptime:** Almost zero downtime can be expected. However it may also depend upon the trust factor of your service provider and the feedback from the existing customers.
- **Manpower:** No extra manpower is required to be recruited at the institution.
- Applications can be developed as per the requirement and the budgetary allocations.
- **Integration:** It can also integrate with the biometric, fingerprint, swipe and other machines already working in your organizations.
- Backup of data is maintained so there is no additional risk in case of any fault.

Following challenges being faced in cloud computing for ERP Implementation in Higher Technical Education [10-13]:

- Skilled manpower to develop and maintain applications.
- Internet speed and reliability is also another issue.
- ACID (Atomicity, Consistency, Isolation and Durability) Support and fault-tolerant databases.
- Issues related to storage space.
- Platform Independent applications are required.
- Applications should be less time consuming.

Cloud computing in academic environment will be benefitted by every student and staff where lots of collaboration and safety of data is needed in academic. Academic has various departments and many semesters where lots of students need to access the computers for highly available up-to-date software and hardware is must. Cloud computing has the capacity of scaling and elasticity which is perfect for such an environment. Private cloud (also called internal cloud or corporate cloud) is a marketing term for a proprietary computing architecture that provides hosted services to a limited number of people behind a firewall. Advances in virtualization and distributed computing have allowed corporate network and datacenter administrators to effectively become service providers that meet the needs of their "customers" within the corporation. Marketing media that uses the words "private cloud" is designed to appeal to an organization that needs or wants more control over their data than they can get by using a third-party hosted service such as Amazon's Elastic Compute Cloud (EC2) or Simple Storage Service [14].Cloud Computing For E-Learning is a new trend in education that tries to make the best use of information technology (IT). Cloud computing is an attractive environment for students, faculty members and researchers. As an emerging IT, Cloud computing can provide universities and research centers with powerful and cost-effective computational infrastructure. Students can connect to campus educational services through their personal mobile devices from anywhere. Faculty members can have efficient and flexible access to their course material in their class rooms. Researchers can find articles, models and run their experiments on the cloud faster than ever [15].

3.3. Web Development and Hosting:

Mainly Traditional Hosting comes in two forms: Shared hosting and Dedicated Hosting. With shared hosting, which is more common among small and medium sized businesses, the client pays for a set amount of space (storage) on a single server, and that server's resources are shared by a number of other websites. It's a cost-efficient, low-maintenance way to host a website or application, and the hosting company is responsible for managing, maintaining, and updating the units. We will need to adapt by purchasing additional server space to add to our storage space and processing power. With dedicated hosting, a company pays for the complete resources of one or more servers from a service provider. The client has a set amount of dedicated bandwidth, CPU, RAM, and drive space, and the client has full control over the servers resources [16].Web hosting services allow individuals or organizations to own a piece of space on the World Wide Web. Companies called Web Hosts, provide space on a server they own or lease, for their clients. With Dedicated hosting, the client leases an entire server and does not to share it with others. This would be more flexible when compared to other types of hosting, since here the organization has complete control over the selection of operating system, hardware, etc. with the hosting company providing add-on services like server administration. These servers are found to be housed in data centres and the server hardware owned by the

provider. With the help of a dedicated server, we remove all of the third-party risks. We pay for a server and it is entirely ours**.** Though we pay the same amount each month regardless of the number of resources we use, traditional servers could be quite expensive. When we own a dedicated server, we need to pay fixed rentals [17]. The traditional web hosting architecture is built around a common three-tier web application model that separates the architecture into presentation, application and persistence layers. The architecture is designed to scale out by adding additional hosts at the presentation, persistence or application layers and has built-in performance, failover and availability features [18]. Traditional Web development methodologies are often sequential, involving a series of steps or phases. One of the more popular traditional Web development methodologies is the waterfall approach. This approach involves a structured progression from one phase to the next.

The waterfall approach begins with the system's operational requirements or what the software, application or Web site would do, as well as the environment it would use to run. After the requirements are laid out, programmers and developers would then plan out how the software or the application will be designed. Up next is when the programmers and Web developers would write the actual code for the software or application, the user interface and reports also crop up in this stage. It will then go to the next phase, the testing stage. In the testing stage, all defects are ironed out, user feedback is solicited, and scripts are tested. Everything is taken into consideration. The final stage is focused on implementation. In this stage, the final product is deployed and training and documentation are undertaken. Another traditional Web development methodology is the Unified Process which organizes all work flows and is implemented in increments. The projects go through four stages: inception, elaboration, construction and transition. These stages very much follow the stages in the waterfall methodology. After the tests are carried out, the software or Web application is then introduced to the users, this is called the transition stage. The last of the widely used traditional methodologies is the spiral model, which has four main stages: objective-setting, risk management, development and validation, and planning.

An offshoot and a result of refining the waterfall model, the spiral model is often used in large projects. Generally, traditional Web development strategies aim to make the development process more predictable and manageable, and more efficient. Moreover, traditional Web development methodologies tend to be process oriented, with each process broken down into tasks assigned to each member of the team. Each task has a well defined system and procedure to follow. Traditional Web development methodologies are often resistant to change. This inflexibility becomes a problem because at one point in time, requirements for the program will change, whether voluntarily (like when a customer changes his or her mind about what he or she wants) or involuntarily (like when there are critical parameters unforeseen in the planning stage). In short, traditional Web development just does not deliver when it comes to creating applications for the Web. It includes certain limitations — like its inflexibility and rigidness, longer development time, costliness, as well as not being able to deliver software with full or optimized functionality — make it inherently unsuitable in a highly competitive and constantly dynamic area like Web development [19].

4. QoS(QUALITY OF SERVICES)

Web Applications are enabling new business models for using the semantic web. It promises a lot of benefits like no capital expenditure, speed of application deployment, shorter time to market, lower cost of operation and easier maintenance for the tenants. Cloud computing becomes helpful in the sense that there is no requirement of extra hardware and manpower to be incurred on for infrastructure setup and software installation. In cloud computing all the infrastructure support, platform support and software support is available in the form of IaaS (Infrastructure as a Service), PaaS (Platform as a Service) and SaaS (Software as a Service) like for the practical implementation of .Net ,there is requirement of software on each computer along with better configuration and support. Now without cloud computing scenario, there is requirement of .NET framework on each computer as well as manpower that is familiar to installation of software and its usage. All this process consumes time, resources, storage and regular maintenance. But on the other hand, it is also true that reliable services in the form of Internet is required for providing quality to end users otherwise, in lack of good internet speed, end-users will find it difficult to adopt cloud computing.

4.1. Tools and Techniques:

4.1.1. Windows Azure Platform:

Windows Azure is a platform by Microsoft. In this platform, we can code our application in supported languages like VB, Microsoft.Net, C#, Java, Php and host the code on Azure servers that are located on Internet. We can also edit the code located on the Azure platform and managing applications becomes extremely easy. Windows Azure SDK provides clouds on desktop. To run in the cloud and to leverage cloud –based services, applications requires cloud-based platforms. Microsoft offers windows based

azure and it is hosted into highly secure geo-redundant Microsoft Data centres. Windows Azure Platform leads to on-premise Applications and cloud-based applications. It offers on demand scalability, familiar development environment and rapid application deployment. Windows Azure operating system, Sql Azure, Windows Azure platform (Appfabric), a web-based service which provides security. It provides development, service hosting and service management.

Windows Azure consists of 3 main services:

- **Compute service*:*** Compute service scales to support large no. of users and have a heavy work load.
- **Storage service*:*** Storage service stores large objects i.e. Blobs, Tables using simple query language and provides queues to support applications.
- **AppFabric**: provides the processing power required to operate the computer storage services.

Sql Azure is tightly integrated and distributed computing system of networks, servers and storage. It provides relational database service on windows azure platform referred to as Sql Azure database. Sql Azure Database operates in the cloud and includes tables, stored procedures, triggers, views and indexes. It provides compatibility with Microsoft Visual Studio.Net, ADO.net, and ODBC.It eliminates the capital investment expenses of disks and DBMS Software. It also reduces operational and support expenses by providing High availability, geo-distribution, load balancing, automatic failover, automatic replication, backup and recovery.
AppFabric provides cloud based services like service bus and access control. Service Bus provides secure connection between application services to enable them to navigate among network boundaries and firewalls. Cloud services that are registered on the service bus can be easily accessed among all network topologies. Access control provides Rule based Authorization, Authentication. They use the REST (Representational State Transfer Protocol).It provides secure accessed applications across organisational boundaries. Windows Azure helps in building cloud based applications from small scale to large scale. **Advantages of using Azure Platform:**

- Saving Expenses
- Scalability
- Ease of use and accessibility.
- They don't have to support large amount of IT Staff for users.

4.1. 2. Cloud Simulators:

Cloud Simulators provide modelling and simulation of large scale Cloud Computing environments. It is a self-contained platform for modelling clouds, service brokers, provisioning, and allocations policies. There is a support for simulation of network connections among the simulated system elements. It provides the availability of a virtualization engine that aids in creation and management of multiple, independent, and co-hosted virtualized services on a data center node. There is flexibility to switch between space-shared and time-shared allocation of processing cores to virtualized services. Cloud simulators provides cloud services which includes Virtual machine provisioning, CPU allocations, Memory allocations, Storage allocations and Bandwidth allocations[23].Then we can use the tools in the Windows Azure SDK to run, test, debug, and fine-tune our application before we deploy it as a cloud service to Windows Azure. Windows Azure SDK includes a Storage Emulator and a Compute Emulator that developers can use to locally write, test, and debug their applications before they deploy them to the cloud. There are also tools and an API to manage our Windows Azure accounts. The Windows Azure SDK includes the following tools:

- Windows Azure compute emulator – A tool that locally emulates the environment in which cloud services run.
- Windows Azure storage emulator – A tool that locally emulates the services of Windows Azure storage.

The compute emulator is a local emulator of Windows Azure that we can use to build and test application before deploying it to Windows Azure. The storage emulator uses a Microsoft SQL Server instance and the local file system to provide local services similar to the Windows Azure storage services. By default, the storage emulator is configured for a database in Microsoft SQL Server 2012 Express Local DB. We can install SQL Server Management Studio Express to manage our Local DB installation. The storage emulator connects to SQL Server or Local DB using Windows authentication. We can choose to configure the storage emulator to access a local instance of SQL Server instead of Local DB [24].

4.1.3. Aneka Cloud:

Clouds that enable millions of users make use of software simultaneously. ICT services are billed to be delivered as "computing utilities" over shared delivery networks akin to the water, electricity, gas and telephony services. With this sweeping change, there is a demand for new skill sets in parallel and distributed computing. Universities play an important role in this regard in training the next generation of ICT professionals and equipping them with the necessary tools and knowledge to tackle the challenges. In addition to the research being done in this field, there are several courses on offer on Parallel, Grid and Distributed computing. Complementing these are network based parallel and distributed computing technologies such as Manjra soft's Aneka, which offer low cost solution for teaching and learning in this field. In educational environment, Manjra soft's Aneka technology is used to [25]:

- Setup a Lab by building an enterprise Grid or "on premise" Cloud using existing LAN-connected desktop computers.
- Teach concepts of parallel and distributed programming using models such as Task, Thread, and Map Reduce.
- Conduct Lab classes and mount student projects in parallel and distributed computing.
- Teach concurrent programming using the Thread model on multi-core desktop computers or servers.
- Teach and demonstrate Cloud computing concepts by deploying on public Clouds such as Amazon EC2 by renting the computing infrastructure.

5. BENEFITS OF CLOUD COMPUTING [26]:

- Reduced implementation and maintenance costs.
- Increased mobility for a global workforce.
- Flexible and scalable infrastructures.
- Quick time to market.
- IT department transformation (focus on innovation vs. Maintenance and implementation)
- Increased availability of high-performance applications to small/medium-sized businesses.
- It gives businesses an immense amount of agility and it allows them to tap into the business opportunities out there much more rapidly.
- Private clouds can provide the benefits of public clouds while allowing for control of security, regulatory compliance, and quality of service.
- Resource optimization through virtualization.
- Capability to affordably deploy many current technology-based applications as they exist today, possibly to re-architect them over time.
- Minimized capital outlay, which is especially important for start-ups, where initial funding is way too limited to use to capitalize infrastructure.

6. CONCLUSION AND FUTURE SCOPE:

Cloud computing is a paradigm that incorporates the concept of software as a service. This means the software and data are stored on servers that can be accessed over the Internet. The applications of cloud computing are practically limitless. With the right middleware, a cloud computing system could execute all the programs a normal computer could run. Everybody wants to take the services provided by this technology because it provide web services faster, all applications run on the cloud and not in our desktop. Therefore there is no need to worry about the operating system. It reduces the cost of hardware because we store our data on the hardware provided by the cloud and not in our desktop. It also reduces the cost of software. We can access our data from the cloud anywhere in the world with the help of internet. Apart from this there are some technical issues and security issues. Establishing a cloud computing system is a technical challenge. Hundreds or thousands of individual computers or servers have to be purchased, linked together, and managed. In addition, feature rich web based software has to be developed, and served to users with 24/7 up time. All of this takes significant resources, which smaller companies might not possess. It is the responsibility of the cloud on which the users relie to provide better performance and security to the users. If cloud does not provide better service no one would like to take its services. From this study we can conclude that whether migration from traditional web based application to cloud based web application will be advantageous or not. Secondly, we can increase the Quality of Service by resolving the issues after doing performance analysis and using Application performance indicators. However, future scope of this study can

be increased by doing performance analysis, hosting and testing of cloud based web application to traditional web sites developed in other technologies like Java and PHP also. It will result in judging the complexities of different environments on cloud and help in resolving the issues like reliability, scalabilty, database usage, deployment etc to make cloud based technologies in real sense "public cloud".

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