ABSTRACT:

In modern years, cloud computing platform is an emerging computing model in information technology sector. It provides efficient computing by centralizing storage, memory processing, and bandwidth. This paper gives the basic concept of Cloud Computing, architectural overview, software testing approach to cloud-based architecture, advantage and the disadvantage of cloud computing.

Keywords: Information technology, Cloud Computing, Software testing, Architecture

[1] INTRODUCTION

Cloud Computing is an execution of computerized jobs in an elastic environment, where jobs may dynamically scaled up or down requesting/releasing resources on a fly. Economically, the main appeal of cloud computing is that customers only use what they need, and only pay for what they use. Resources are available to be accessed from the cloud at any time, and from any location via the internet. Cloud computing facilitates convenient on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage, applications, and services that can be quickly provisioned and released with minimal management effort or service provider interaction.

Cloud computing platform deviates from the old Client-Server model by presenting applications from a server that are executed and controlled by a client's web browser, and the client version of the application is not installed on the machine. Any PC/computer or web-enable device connected to the Internet may access the shared pool of computing resource, applications, and files in a cloud-computing environment. Users may remotely store and access personal files such as music, pictures, videos, games or word documents on a remote server. It does not require end-user knowledge of the physical location and configuration of the system that delivers the services.

Cloud – Testing is a new approach to load-testing and testing in general. This new approach leverages cloud-computing resources to increase testing functionality and significantly decrease costs.
Figure: 1. Cloud Computing

3.0 Cloud Computing Patterns:

3.1 Storage as a Service: also known as disk space on-demand. It gives the capability to leverage storage that physically exists at a remote site, but is inevitably a local storage resource to any application that requires storage. This is the most primitive component of cloud computing.

3.2 Database as a Service: provides the capability to support the services of a remotely hosted database, experiencing it with other users, and having it logically function as if the database were local.

3.3 Information as a Service: refers to the capability to consume any type of information, remotely hosted, through a well-distinct interface such as an application programming interface (API). Examples include stock price information, address validation, and credit reporting.

3.4 Process as a Service: relates to a remote resource that is capable of binding many resources collectively, such as services and data, either hosted inside the same cloud computing resource or remote, to create business processes.
3.5 Application as a Service: relates to any application that is delivered over the Web to an end user, typically supporting the application through a browser. Many associate AaaS with enterprise applications such as Google Docs, Gmail, and Google Calendar are available.

3.6 Platform as a Service: points to a whole platform, including application development, interface development, database development, storage, and testing, delivered by a remotely hosted platform to subscribers.

3.7 Integration as a Service: is the capability to perform a complete integration stack from the cloud, covering interfacing with applications, semantic mediation, flow control, and integration design.

3.8 Security as a Service: is the capacity to deliver core security services remotely over the Internet. While the common security services provided are rudimentary, more sophisticated services are becoming available such as identity management.

3.9 Management/Governance as a Service: points to any on-demand service that provides the ability to manage one or more cloud services. These are typically simple things such as topology, resource utilization, virtualization, and uptime management.

3.10 Testing as a Service: is the capability to test local or cloud-delivered systems utilizing testing software and services because of remotely hosted. While a cloud service demands to test unto itself, TaaS systems have the capability to check other cloud-based applications, Web sites, and internal enterprise systems and do not require hardware or software footprint within the industry.

3.11 Infrastructure as a Service: is actually Datacenter as a Service (DaaS), or the ability to remotely access computing resources.

4.0 Cloud Delivery Models

4.1 Private Cloud: Private cloud is a term used to denote a proprietary computing architecture providing hosted services on private networks. This type of cloud computing is used by large companies and allows their corporate network and data center administrators to become effectively in-house ‘service providers’ catering to ‘customers’ within the corporation.

4.2 Public Cloud: The cloud infrastructure is maintained by an organization selling cloud services [2] to the general public or to a large industry group basically over the internet.

4.3 Community: Community cloud shares infrastructure between several organizations from a particular community with common concerns like security, jurisdiction, compliance, etc. whether managed by a third-party or internally and hosted internally or externally.

5.0 Architectural Overview:

Cloud architecture comprises of 3 layers as shown below:

- Cloud Application
- Cloud Platform
- Cloud Infrastructure
5.1 Cloud Application
The topmost layer in cloud architecture is Cloud Applications. All applications run and interact via a web browser on hosted desktop or remote client. In a commercial cloud computing, applications users never need to purchase expensive software licenses themselves. Instead, the cost is incorporated into the subscription fee. A cloud application reduces the requirement to install and run the application on the customer's computer, thus removing the responsibility of software maintenance, ongoing operation and support.

5.2 Cloud Platform
The middle layer in cloud architecture is Cloud Platform, which provides a computing platform or framework as a service. A cloud computing dynamically provisions, reconfigures and de-provisions servers as needed to cope with increases or decreases in demand. It’s a distributed computing model where many services pull together to deliver an application or infrastructure request.

5.3 Cloud Infrastructure
This layer provides IT infrastructure through virtualization. The infrastructure includes servers, networks and other hardware appliances provided as either Infrastructure “Web Services” or “cloud centres”. These are when interlinked with others for additional capacity as and when required. It’s a kind of virtualization which allows the splitting of hardware into independent entities which can be scaled regarding CPU, RAM, Disk and other elements.

6.0 Comparing Traditional Testing with Testing over Cloud Platform.

Traditional Testing over the below points
• Testing tools
• Test scripts
• Test standards
• The workflow
• Test metrics
• The test environment (Architecture, Platform, and the applications themselves)

But Testing over Cloud Platform cover below additional points
• Complete utility model for platform, test experts and tools
• Predictable End-to-end cost
• Access to variety of tools where in some cases more test coverage because of multiple tools testing
• One stop solution is possible for all testing. Option to change the tools selection, when not satisfied (Try and use).
• Verify architectural / design level –using new generation performance tools –before going live.

7.0 Cloud Platform Testing Methodologies
Cloud Elasticity testing methodology validates [3] the Quality of Service (QoS) of cloud infrastructures as well as the Quality of Experience (QoE) across cloud services. Cloud testing is a form of software testing in which web applications that use cloud computing environments
endeavor to simulate real-world user traffic as a means of load testing and stress testing in a highly cost efficient manner. With cloud-testing we have unlimited resources at our disposal, paying only for what we consume, only when we consume it. Broadly there are three methodologies of cloud testing:

7.1 Functional Testing
Functional Testing is to validate that the cloud is behaving as expected. Like traditional testing life cycle, it includes Test Requirements, Test Planning and Test data management. Also, it might include support for multiple browsers, availability, accessibility, data security and privacy. System testing techniques provide validation for the quality of the system, and its components are good enough to be released. Similarly integration testing examines effects of the cloud on other existing or intended systems, providing information on whether or not this combination of systems can successfully work together. User acceptance testing provides validation that what is delivered by the Cloud meet the needs of the user.

7.2 NonFunctional Testing
Unlike the traditional [4] performance testing techniques, where scalability is limited to certain number of users within the network, in cloud, the applications scalability scope is much wider. It includes following:

7.2.1 Performance Testing: It measures response time and isolate issues related to specific steps or actions while the system is subjected to increasing load from different locations and multi-user operations.
7.2.2 Load/Stress Testing: It measures the application/system stability as the user count is demanded to be in multiples of hundreds. It pushes the system to maximum load capacity and beyond it to check its sustainability.
7.2.3 Capacity Testing: It determines maximum capacity for current or future hardware, bandwidth or any other needs to validate that installed hardware and network will support expected usage scenarios.
7.2.4 Security Testing: Security testing techniques such as penetration testing ensures that the tools in place to ensure the security of the cloud are robust and provides the desired protection.

7.4 Cloud Solutions
Different solutions are provided for the different type of testing. Below provides the detail of Test Objective to Cloud Test Services

- Determine Limits -> Load Test
- Measure User Experience -> Performance Tests
- Verify Redundancy -> Failover Test
- Exceed Break -> Points Stress Test
- Plan for the future -> Capacity Test

8.0 Testing concern and Challenges:

8.1 Concern:
Migrating to a cloud environment requires a knowledge of the new business needs and inherited challenges associated with it. Accordingly, the scope of the software testing also needs to be widened to cover enough those business conditions and the inherited risks linked with cloud computing. To meet these testing requirements, the platform needs to be performed with
additional resources. These include the new infrastructure such as different testing skills required by test engineers to perform the job of testing in a cloud.

8.2 Challenges:
- Testing cloud applications and networks demand a broad mix of application traffic, current security coverage and incredibly high-performance and throughput.
- Traditional testing tools were just not designed for this dynamic, complex and high performance computing environments.
- Amazingly high-performance and throughput are actually required.
- Predictability becomes even more critical.
- Availability – The most efficient method to maximize reliable availability is to ensure that we fully understand cloud architecture and identify the possible reason for cloud unavailability so that precautionary step can be taken.
- Dependencies on the Internet – Those applications are not installed locally in managed environments which make it difficult for testers to clone the user platform.
- [5] Security- Since information travels through the Internet, testers have to perform security testing to make sure there is no data leakage when data is sent over the Internet. “Wikileaks” is an example of threats that we have to prepare for and test before the application can be released to customers.
- Testing of all the layer – Testing the server performance, network connection, database, and software application combine many layers to testing. Testers have to test the interface between the layers, test the connection between elements, and also plan for the uncertainties. Testers have to test ahead what they can physically manage in their environment.

9.0 Advantages of Cloud Testing
- [6] It is something like “service on demand” or “testing on demand”. The cost of hardware, software, tools, tester, etc. is charged on usage basis. When we use cloud testing, we take advantage of hardware and bandwidth that more closely mimics our observed, real world conditions. Essentially, we execute the test in cloud-based infrastructure and bandwidth. This allows us to design and execute global tests that give more meaningful results much faster.

- Tool License Costs: We don’t need to invest in tool license. We have various options for selecting the tool of our selection depending on product to be tested. The service provider is deemed to ensure that latest version of the tool is given. So instead of paying a substantial amount for buying a tool, keeping record of updating it with newest patches and fixes, getting worried about the new release and then depending on it for all the product range; we just need to pay-as-we-use basis.

- Infrastructure Costs: To perform testing, to load tool and to provide a substantial hardware/infrastructure platform in-house; we can go straightaway for the cloud service provider. In
traditional testing, one tests using only one tool. The cloud provides an opportunity to test using multiple tools

- Flexibility and Wide Range: We have the flexibility of using only when we really require. And we have an option of choosing the right tool for right product.

- No Setup and Procurement Time Wastage: We can bypass to invest our [6] time in procurement and setup process. Straightaway select the cloud vendor, and get the setup already up and running to start testing instantly.

- Expertise: We don’t need to hire tool experts


The key motive to issue this paper is to give a glimpse of understanding on cloud computing and cloud testing as a technology for a new era. Its potential is considered so vast that it is surely going to give up a new dimension for the generation to come. [7] There is a big push for cloud computing services by several big companies. Amazon.com has been at the forefront of the cloud computing movement. Google and Microsoft have also been very publicly working on cloud computing offerings. Moving to a cloud computing model can help any organization to survive in a tough economic climate, equipping with the latest business tools and giving access to advanced technologies at a part of the cost of purchasing and running the same systems in-house.

To ensure that the benefits of cloud architectures for both provider and user are being realized, they must both have an in-depth understanding of potential risks and concerns, and the measures that can be taken to address them. Not all cloud architectures are same. The scale, purpose and available budget of individual cloud architecture vary. [8] Hence, moving testing to the cloud must be considered as a strategic initiative. With this in mind, it is essential that clouds go through thorough testing to ensure that common flaws and flaws of individual cloud architecture are identified. Testing increases the likelihood of benefits being realized, and also allows for early preventive action to be taken against identified flaws. By testing the cloud architecture, we can be sure that we have given the cloud the greatest chance of success.

[9] Realizing the potential for the improvement of performance in the near future in the cloud the next section of Performance in Cloud mainly consists of the IDC Survey NIST researches data, various graphs depicting the: Average response time, Availability, Response Time of various Cloud Providers and Significant Performance Differences across Browsers/Devices, how to scale the storage and Analysis of Data Using Distributed Data Grids. The next section is dedicated to the list of various tools available in the market to perform testing in the cloud.

[10] In future, as it is getting more matured architecture for cloud computing and more and more testing on the cloud applications there is every possibility of more testing challenges
which can be explored by researchers.

REFERENCES


Author[s] brief

Introduction
Susham Ghose received his Bachelor of Engineering Degree in Electronics & Communication in 2000 from Gulbarga University. He is currently working as an Enterprise Architect in Tata Consultancy Service. As an Author, He has published two books on Cloud Computing. Also, he has 16 years of work experience in IT with area of practice include IoT, Big Data analytics, Virtualization, Cloud Computing.