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Simulation Model for Benchmarking Cloud Services over Internet

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Abstract— With an increasing footprint of Cloud in daily lives of individuals and businesses, the question of embracing Cloud is no longer on how, but how soon. Cloud is at the center stage on the topic of innovation and consumers find a differentiating advantage of with adoption of Cloud. This is aided due to multiple factors such as Open Source development, Big Data, and Social Computing being made available for consumer use. As a matter of fact the cloud computing technologies are now playing a very vital role in almost every commercial as well as non-commercial field; including large or small-scale businesses, IT organizations, Government, Quasi-Government, Public and Private sectors. The outreach of Cloud products and services has been the maximum in Individual Consumer segment due to the significant growth and innovation in Mobile space in the last decade. However in most cases, these services are pre-packaged and given to consumers, by manufacturers or service providers. The consumer has little choice to offer when they buy a packaged solution. The ability to appreciate the salient features and how can that be put to optimal use is a question that many consumers struggle with. The decision is also influenced by a variety of sources of information on cloud services and products who offer a good perspective, but often do not compare cloud products and services using a standard benchmarking technique. As it is a growing market, cloud providers try to attract the customers by highlighting only their strengths, and other marketing techniques. Over the last three research papers on similar topic, we have explained the rationale of why is a standard benchmarking technique needed, and how can that be achieved using a Service Demand Handler and Catalogue Manager for Cloud, and Unified Master Services Catalogue Manager. In this paper, we demonstrate how this technique can be used simulated using MATLAB software, and can be put to product implementation that can be used by standards benchmarking organizations such as IEEE or SPEC for further development.

Index Terms— Cloud Computing, Cloud Standards, Cloud Service Providers, Cloud Benchmarking, Cloud Benchmarking Parameters, Cloud, Unified Service Catalogue, Service Demand Handle, Cloud Computing Benchmarking.

I. INTRODUCTION

Cloud benchmarking has been attempted by many individuals and organizations over last decade. However, the applicability of such benchmark results is not uniform or impactful for end consumer. The consumer is unable to comprehend the usage and purpose of such benchmark results, and therefore often gets no conclusion from benchmark results. In this Paper, we propose implementation approach using MATLAB software, after analyzing the basic comprehensive set of criteria required for standardized benchmarking of cloud service offerings obtained from cloud service providers services and customers.

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The analyzed result shows the details that enables consumer to decide on some of the most important decision points, including Cost, Availability of service, Reliability, Scalability, Elasticity, Bandwidth requirement, Throughput, Quality of service, Operational efficiency. Evaluation of these criteria can be done on real time basis, as per information collected and updated by service providers. These obtained values are used for quality rating comparison analysis of - Cloud Service providers (QRCA-CSP). Using the data shared by cloud service providers, this simulation generates a comparison between service offerings from different Service Providers. The result is displayed via a unified window where customer can select best offering that fulfils their demand. This will also of great help in reducing complexity of obtaining better services in case of multi-cloud environment where options for choosing services from providers are available. The set of values of the features obtained from service providers can be stored in xml format or in a database. The obtained values are used for analysis and quality rating comparison. The implementation approach used here involves MATLAB environment. The screen helps customer to select required parameters, from the list of service details offering, fed and updated by different service providers on real time basis. The result will be the refined output showing the listing of services from different Service Providers. This simulated approach will help in creating a benchmarking of cloud service offerings thus enabling customers to initiate the computing by selecting services easier and faster thereby reducing the burden of selection process. The benchmarking can be further standardized in order to get standard quality rating comparative analysis of services, obtained from different service providers. For the purpose of this paper, we adopted the definition of cloud computing from the NIST Special Publication [(Mell & Grance, 2011)], which defines Cloud Computing as:

Cloud computing is a model for enabling ubiquitous, 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. Three roles exist within cloud computing. Cloud-Providers sell computing or software services purchased by the End Customer/Consumer. A Cloud-Provider builds its cloud using products from various Hardware and Software Vendors. However, in all cases, Cloud Computing has five essential characteristics, namely

1. On-demand self-service, where a consumer can provision compute and storage capabilities without requiring human intervention from provider.

2. Broad network access, where a consumer can access compute and storage capabilities over the network.

3. Resource pooling, where a provider groups together resources such as CPU, memory, disk, and storage to serve multiple consumers.

4. Rapid elasticity, where resources used can be rapidly and in some cases automatically increased or decreased to handle demand.

5. Measure service, where the service used a consumer is metered.

II. CLOUD BENCHMARKING PARAMETER DEFINITION

A. Service Models for Cloud Computing:

There are three service models for cloud computing. They affect the definition of a System under Test (SUT) for any cloud benchmarks. The following are a brief description of the service models.

IaaS: The Service Provider gives the End-Consumer the capability to the provision processing, storage, network, and basic computing resources. They can also deploy and run arbitrary operating systems. The End-Consumer does not manage or control the underlying physical cloud infrastructure, but has control over the operating system, assigned storage, deployed applications, and limited control of select networking components (e.g., host firewalls).

PaaS: The Service Provider gives the End-Consumer the capability to deploy consumer created or acquired applications created using programming, languages, libraries, services, and tools supported by the Service Provider. The Service Provider retains control and manages the underlying cloud infrastructure, including network, servers, operating systems, and physical storage. End-Consumer has control over the deployed applications and configuration settings for the application-hosting environment

SaaS: The Service Provider gives End-Consumer the capability to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The Service Provider retains control and manages the underlying cloud infrastructure, including individual applications, these application configurations, network, servers, operating systems, and physical storage. The End-Consumer might have limited control of user specific application configuration settings.

In our analysis, following parameters were used for comparison across cloud services.

Response Time
Local Sequential Read IOPS
Local Random Reads IOPS
Local Sequential Write IOPS
Local Random Write IOPS
Block Sequential Read IOPS
Block Random Read IOPS
Block Sequential Write IOPS
Block Random Write IOPS
System Performance
Single Core Processing
Multi Core Score
Memory Score Single CPU
Geekbench Memory Score

Parameter Definitions

Response Time: is defined as the time it takes for any workload (application) to place a request for work on the virtual environment and for the virtual environment to complete the request. The request could be as simple as a bi-directional exchange of data between two guest VMs on one host over the vSwitch. Or the request could comprise multiple hops among various VMs on multiple hosts and then include a database transaction, which ultimately requires a write to a storage array and a confirmation back to the original requesting component of the application. Each separate portion of the request and the associated responses must be timed so that the actual experience of the end-user who initiated the request can be evaluated. Sequential Read IOPS: Average number of sequential read I/O operations per second. Sequential operations access locations on the storage device in a contiguous manner and are generally associated with large data transfer sizes. Random Reads IOPS: Average number of random read I/O operations per second. Random operations access locations on the storage device in a non-contiguous manner and are generally associated with small data transfer sizes. Sequential Write IOPS: Average number of sequential write I/O operations per second. Sequential operations access locations on the storage device in a contiguous manner and are generally associated with large data transfer sizes. Random Write IOPS: Average number of random write I/O operations per second. Random operations access locations on the storage device in a non-contiguous manner and are generally associated with small data transfer sizes. System Performance: There are a number of different tests, or workloads, to measure system performance. The workloads are divided into different sections:

Integer performance: Integer workloads measure the integer instruction performance of your computer by performing processor-intensive tasks that make heavy use of integer instructions. All software makes heavy use of integer instructions, meaning a high integer scores indicates good overall performance. Floating point performance: Floating point workloads measure floating point performance by performing a variety of processor-intensive tasks that make heavy use of floating-point operations. While almost all software makes use of floating point instructions, floating point performance is especially important in video games, digital content creation, and high-performance computing applications. Memory performance: Memory workloads measure memory bandwidth. Geekbench 3 uses tests based on the STREAM benchmarks developed John D. McCalpin. Software working with large amounts of data (e.g., digital content creation) relies on good memory bandwidth performance to keep the processor busy.

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Single Core Processing: Processor configuration that allows single-thread performance for executing a given instruction set. Multi Core Processing: Processor configuration that allows multi-thread performance for executing a given instruction set. Geekbench Memory Score: The memory score is derived from Geekbench 3's Floating Point Score. Geekbench 3 scores are calibrated using Intel Core i5-2520M @ 2.50 GHz processor as a baseline with a score of 2,500 points. Higher scores are better, with double the score indicating double the performance.

III. CLOUD SIMULATION CONSIDERATIONS

From a user perspective, the key considerations that help in decision process include the following.

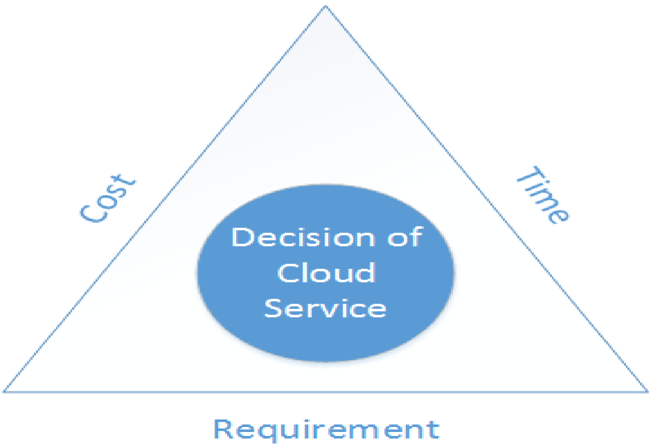

Fig: The Iron Triangle Decision Box

Requirement Parameters:

- Type & Duration of Service
- Availability
- Reliability
- Security

Cost Parameters:

- Interoperability
- Monitoring facility
- Bandwidth Requirement

Time Parameters:

- Scalability
- Elasticity
- Portability

A. Requirement Parameters

Type and Duration of services:

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Availability – is the degree to which a system or component is operational and accessible when required for use. The time during which the system is not available is called downtime; the time during which the system is available is called uptime. A small uptime and a very small downtime combination may result in a high availability measure – which could be misleading. Therefore, the mean uptime is also often known as the Mean Time between Failures (MTBF), together with Mean Time to Repair (MTTR), and considered as better indicators for availability. Where

$$\text{Availability} = \frac{\text{MTBF}}{\text{MTBF+MTTR}}$$

Reliability – is the ability of a system or component to perform its required functions under stated conditions for a specified period of time. The reliability of a system is usually measured by the probability of failures or by the mean time between failures (MTBF).

Security – Cloud computing security is the set of control-based technologies and policies designed to adhere to regulatory compliance rules and protect information, data applications and infrastructure associated with cloud computing use

B. Cost Parameters

Interoperability – Interoperability refers to cloud users being able to take their tools, applications, Virtual images, and so on and use them in another cloud environment without having to do any rework. Say one application runs in one environment and you need that application to operate with a partner's application in another cloud environment. If the right interoperability standards are in place, you can do this without needing multiple versions of this application. Simple Object Access Protocol (SOAP), representational State Transfer (REST), and Atom Syndication Format and Atom Publishing Protocol (both standards referred to as Atom) are all examples of widely used interoperability standards and protocols.

Monitoring facility – A cloud service provider must include a service management environment. A service management environment is an integrated approach for managing your physical environments and IT systems. This environment must be able to maintain the required service level for that organization. In other words, service management has to monitor and optimize the service or sets of services. Service management has to consider key issues, such as performance of the overall system, including security and performance. For example, an organization using an internal or external email cloud service would require 99.999 percent uptime with maximum security. The organization would expect the cloud provider to prove that it has met its obligations. More than maintainability, the target is sustainability, and this includes not one but three overlapping processes: maintainability proper is the extent to which preventive maintenance can be performed without degrading availability repair ability refers to the speed with which a component failure can be detected and fully corrected and recoverability identifies what happens at the after-correction time of a component failure, specifically the speed with which system facilities can be restored, including recovery of data damaged as a result of failure.

Bandwidth Requirement – Bandwidth can be defined as the net bit rate, information rate or physical layer useful bit rate, channel capacity, or the maximum throughput of a logical or physical communication path in a digital communication system. For example, bandwidth tests measure the maximum throughput of a computer network.

C. Time Parameters

Scalability – The service needs to be available all the time (7 days a week, 24 hours a day) and it has to be designed to scale upward for high periods of demand and downward for lighter ones. Scalability also means that an application can scale when additional users are added and when the application requirements change.

Elasticity – enables you to increase or decrease capacity within minutes, not hours or days. One can acquire one, hundreds or even thousands of server instances simultaneously. As, all this is controlled with web service APIs, an application can automatically scale itself up and down depending on its needs.

Portability – lets you take one application or instance running on one vendor's Implementation and deploy it on another vendor's implementation. For example, you might want to move your database or application from one cloud environment to another.

IV. SIMULATION PROCESS AND OUTPUT

Defining SUT for a cloud benchmark is challenging due to conflicting goals of interested parties and different cloud service models. As discussed in earlier sections, an End-Consumer does not have knowledge of the physical infrastructure for IaaS, PaaS, or a SaaS service. However, Hardware and Software Vendors are one of the interested parties in a cloud benchmark. In order for a cloud benchmark to have any useful meaning for these vendors, the physical infrastructure should also be part of the results that a cloud benchmark reports. However, mandating the reporting of physical infrastructure results is problematic, because it will exclude benchmarking many existing public Cloud-Providers. The System under Test (SUT) comprises all components (cloud service, hardware, software, network connections within the SUT, and support services which are being tested by the cloud workload or required by the specific benchmark run rules. It does not include any client(s) or driver(s) necessary to drive the cloud workload or the network connections between the driver(s) and SUT. The actual set of SUT's constituent pieces differs based on the relationship between the SUT and the tester.

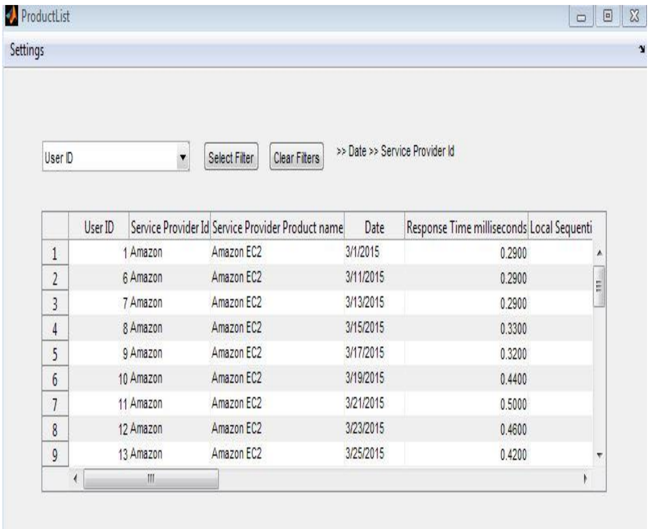
Black Box Cloud: The SUT consists of a description of the specific cloud offering used to run the workload with sufficient detail to meet Full Disclosure Report (FDR) Requirements as described in the appendix and the specific benchmark's reproducibility requirements on an instance of the same offering.

White Box Cloud: The SUT description can be more specific, similar to many existing SPEC benchmarks. These SUT descriptions consist of:

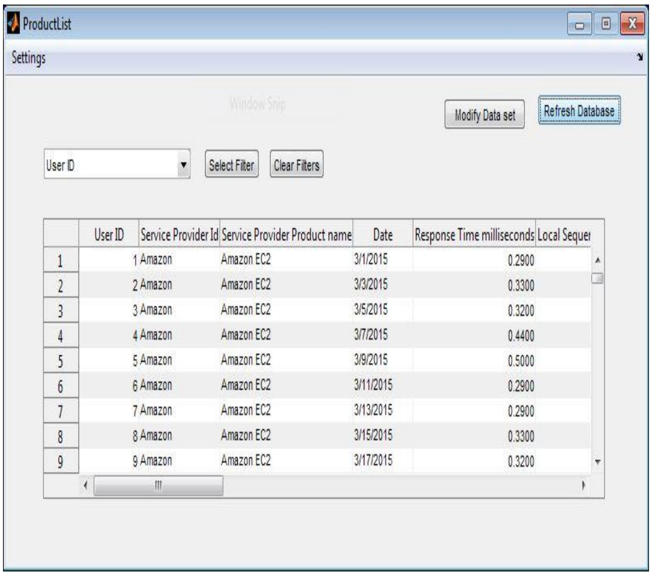
1. The host system(s) (including hardware and software) required to support the Workload and databases.
2. All network components (hardware and software) between host machines which are part of the SUT and all network interfaces to the SUT.
3. Components which provide load balancing within the SUT.

All software that is required to build, deploys, and run the specific benchmark workload. The design of Cloud Benchmarking Simulation Model is a MATLAB based program. The design construct is driven by a parameter table and a MATLAB designed user interface. This UI works in a user model and administrator mode, using which various features such as Data refresh, Parameter selection, Query results and Compare results can be achieved. Below screens show the design prototype of the user interface.

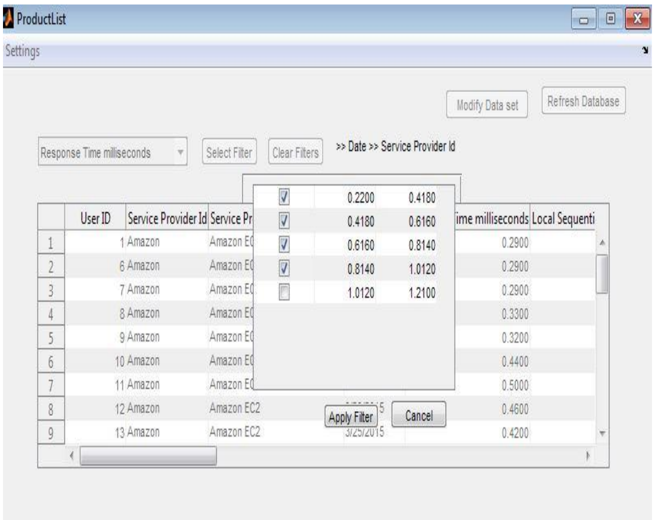
Use Mode:



Administrator Mode:



Query and Compare Result:



V. USER DECISION PROCESS

Consumer is expected to leverage advantage and benefits of the Cloud Benchmarking Simulation Model by leveraging the solution design that compares the features and functions across various cloud services available in the market. The administrator of the system is expected to collect data from various service providers into the parameter table, that helps drive the screen behaviour. As administrator of the software, you have the ability to refresh data sets, add or remove attributes and control the range of parameters that can be used by users. As user of the software, you get an intuitive, shopping cart like experience of choosing various cloud services that are benchmarked against each other, rather than being benchmarked individually. This allows user to make informed decision of the features of the cloud service that he finally chooses.

The salient features of this design are

- Collection of appropriate information
- Summarized view of comparative results
- Standardized definitions

VI. SUMMARY AND NEXT STEPS

We have designed the conceptual model of simulating the benchmark results for various cloud service providers. There are well documented processes and procedures established by various organizations, corporations and committees, and a comprehensive set of information available for public consumption on the benchmark test criteria, basis, execution and results. Despite availability of data, there is no one guideline or standards definition for benchmarking cloud services that has been universally accepted. It is our endeavour to highlight the fact that a simple decision process for a consumer starts by measurable and comparable facts, and for facts to be comparable, they should be measured on a common yardstick. Future work in this direction could be to:

1. Establish a common definition and methodology to measure cloud performance
2. Framework for the Cloud Benchmark - White box & Black box
3. Provide an API layer for extending benchmarking capabilities for all participants in Cloud development – service providers, hardware / software vendors, and consumers

As next steps, we recommend that the concept is productized by an international authority of repute that can enforce compliance to standards across cloud service providers globally.

REFERENCES

1. Gupta, Prarthana: Service Demand Handler and Catalogue Manager for Clouds; International Journal of Computer Technology and Electronics Engineering, Volume 2, Issue 1. ISSN 2249-6343
2. Gupta, Prarthana: Unified Master Services Catalogue Manager for Cloud; International Journal of Soft Computing and Engineering, Volume 2, Issue 3. ISSN 2231-2307
3. Gupta, Prarthana: Computing Services
4. Berkeley RAD Lab Project at http://radlab.cs.berkeley.edu/wiki/Projects/Cloudstone
5. M. Armbrust and A. Fox et al. Above the clouds: A Berkeley view of cloud computing, Technical Report EECS-2009-28, UC Berkeley, 2009.
6. A. Li and X. Yang et al.: Shopping for a Cloud Made Easy, Proceeding of the 2nd USENIX Workshop on Hot Topics in Cloud Computing (HotCloud 10), 2012.
7. T. Liu, Y. Li, and X. Li, A Collaborative Management as a Service Framework for Managing Internetware Systems, First Asia-Pacific Symposium on Internetware (Internetware 2009), 2009.
8. T. Wood and R. Shenoy et al. The Case for Enterprise-Ready Virtual Private Clouds,
9. jgaard-Hansen, K. ; Huan Cong Nguyen ; Schwefel, H. Session mobility solution for client-based application migration scenarios, Wireless On-Demand Network Systems and Services (WONS), 2011, p.76
10. David S. Linthicum, Cloud Computing and SOA Convergence in your Enterprise, Pearson, 2012
11. Mehrdad Mahdavi Boroujerdi, Soheil Nazem, Cloud Computing: Changing Cogitation about Computing, World Academy of Science, Engineering and Technology 58 2011
12. R. Buyya, C. S. Yeo, and S. Venugopal, "Market oriented Cloud Computing: Vision, hype, and reality for delivering it services as computing utilities", in Proceedings of the 10th IEEE International Conference on High Performance Computing and Communications
13. Controlling Data in the Cloud: Outsourcing computation without Outsourcing Control, Richard Chow, Philippe Golle, Markus Jakobsson, Ryusuke Masuoka, Jesus Molina Elaine Shi, Jessica Staddon Parc, CCSW 2009, Chicago, Illinois, USA.

14. "Utility Based Cloud Power," (2011) Computers Journal, www.dirjournal.com
15. Chong, F. and G. Carraro (2011) "Architecture Strategies for Catching the Long Tail," Microsoft Corporation, April 2011
16. Miller, M. (2008) Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online, Indianapolis: Que Publishing, 2008
17. SPEC. (2011) Standard Performance Evaluation Corporation. [Online] http://www.spec.org/index.html
18. Stefan Bouckaert, Stephen C Philips, Jerker Wilander, Shafqat Ur Rehman, Walid Dabbous, Thierry Turletti – Benchmarking Computers and Computer Networks

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Prof. Brajesh Patel, Head, Computer Science Department, Shriram Institute of Technology, Rajiv Gandhi Proudyogiki Vishwavidyalaya, Jabalpur, India. With great pleasure and deep sense of gratitude, I take this opportunity to express my sense of indebtedness to Prof. Brajesh Patel, Dept. Computer Science & Engineering., SRIT, Jabalpur, for his guidance, encouragement and whole hearted involvement in this paper, without which it would have been difficult for me to complete this work.