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A Simulation-based Comparative Study of Cloud Datacenter Scalability, Robustness and Complexity

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Abstract— This, paper presents a novel approach towards a comprehensive analysis of various simulation-based tools to test and measure the Cloud Datacenter performance, scalability, robustness and complexity. There are different Cloud Datacenter resources in cloud Computing Infrastructure like Virtual Machine, CPU, RAM, SAN, LAN and WAN topologies. The server machines need to be analyzed for their extent of utilization in terms of energy and service to clients in cloud computing. We have analyzed various Cloud resources using CloudSim, CloudReports and Cloud Analyst tools. Resources provisioning, Cloud Management, Load Balancing, Robustness and Cloud Scalability are the primary scope of work discuss in this paper. In this regards some Simulation test results and Simulations are presented in order to compare them with real time scenario to bring the performance and scalability issues into our notice for future directions.

Keywords: *Cloud Computing, CloudSim, Cloud Reports, Cloud Analyst.*

I. INTRODUCTION

There is enormous growth in IT services in variety of fields. It's a fact of the day that almost everything related to human life is control and managed by IT resources. It was obvious to develop a more comprehensive service paradigm to cover the needs of human life through latest and the greatest state of the art technologies, such as Cloud Computing to handle demands of the day in a more efficient and coherent way. Nowadays traditional Datacenter technologies are adopting Cloud Computing concept in order to optimize Cloud Storage and other IT infrastructure elements to be optimized and utilized as per the basis of user's demands [1]. There is constant growth in data volume, so that there will be constant demand to improve and optimize service platforms whether it is Infrastructure as a Service (IaaS), Software as a Service (SaaS) or Platform as a Service (PaaS). Due to heavy demand of scalability in Cloud Computing domain, the entire virtualization is very essential. Virtualization would reduce the cost of service as well as management for end users.

To test and measure performance of Cloud Computing Infrastructure or in other words Cloud Datacenter technologies, researchers and developers need Simulation environment to design and test the various designs according to demands of scalability, robustness and complexity.

Traditional IT and Networking simulation tools helps to some extent [2]. But in recent years Cloud Computing researchers are focusing more on providing a simulation environment specific to Cloud Infrastructure designing, planning and implementation in simulation environment before real time implementation [3]. Cloud Simulations, such as CloudSim, Cloud Reports, and Cloud Analyst [4] [5] are very popular for Cloud Datacenter designing, testing and performance measurement for scalability, Robustness and Complexity aspects of Cloud.

Beside, Robust designing to provision Cloud service with high reliability and availability, it is essential to fulfill business demands such as service level agreements (SLAs) as per market price and regulations of local governments [6].

II. LITERATURE REVIEW

Cloud Computing provides services with low cost, reliability, availability and flexibility. These services are required to be delivered Quality of Services (QoS) in order to get customers satisfaction. In this section, we present related work that also targets QoS metrics for Cloud Computing services.

Xiong and Perros[7] has discussed the service performance issue in the Cloud Computing based on three challenging questions: (1) for given service resources, what level of QoS services can be guaranteed? (2) For a given number of customers, how much service can be guaranteed in term of the percentile of response time. (3) For given service resources, how many customers can be supported to ensure that customer service can be guaranteed in term of the percentile of response time? Queuing network model has been proposed to simulate the performance of computer services in Cloud Computing. As a result of the proposed model, Xiong and Perros [7] have developed an approximation method for computing the Laplace transform of a response time distribution in the Cloud Computing system. Finally they validated the proposed approximate method through conducted numerical experiments.

In the area of scalability, Becker et al. 2015 have addressed issues of scalability, elasticity, and efficiency in Cloud Computing [8]. To tackle these issues, they derived metrics for these properties using the Goal Question Metric (GQM) method. Through using the GQM method, they systematically derived an initial set of six metrics for scalability, elasticity, and efficiency. These six metrics are: (1) Scalability Range (ScR). (2) Scalability Speed (ScS). (3) Number of SLO

Violations (NSLOV), (4) Mean Time To Quality Repair (MTTQR). (5) Resource Provisioning Efficiency (RPE). (6) Marginal Cost (MC). They stated that these metrics help software architects, requirements engineers, testers, etc. to design and analyze Cloud Computing systems to fulfill the scalability, elasticity, and efficiency needs.

Falatah and Batarfi [9] provided scalability through their proposed model, called Perform Scalability Model, which consists four phases: (1) Identify Applications Types. (2) Derive Key Performance Indicator (KPI). (3) Assign Convent Resources. (4) Performance Monitoring. These four phases assist in defining the features of applications that run on Cloud Computing. First phase deals with application classification as: (1) Web development, access and use applications. (2) Bulk-data-transport applications. (3) Tele-service applications. (4) Visualization applications. (5) Distributed-computing applications. (6) Operations, administration, maintenance and provisioning. (7) Client-server applications. These seven types of applications are used as resources for proactive scaling which enables providers to schedule capacity changes that meet the expected changes in application demand.

In the second phase, a scaling indicator is selected for using in scaling the application. Scaling indicators are used to find out the different threshold (availability, delay, and capacity) as an automatic scaling of applications.

The third phase is concerned about allocate the substantial resources that satisfy the demand. The last phase is the monitoring of the running applications in Cloud resources and a reactive scaling is used to add or remove resources.

III. CLOUD SIMULATIONS TOOLS

CloudSim, Cloud Reports, Cloud Analyst tools are easy in installation and operation. These tools do not need any high end personal computer to run them. We need to do Simulation in order to analyze the resource allocation in cloud Datacenter environment which is scalable to n servers. In cloud Datacenter Infrastructure allocation of resource plays an important role. If resource are not properly allocated the high load on few servers and other servers with fewer load will lead to more energy consumption.

CloudSim: CloudSim tool kit is a very popular simulation platform to run and execute Cloud Simulations [10]. By using this tool whole bunch of objects of a standard datacenter can be designed and developed in simulated environment to relate the simulated results before hand with real time scenarios [11]. This reduces good amount of resources and time in real time world of IT or Cloud Infrastructure.

As per Fig1 the following components play the important role.

Cloud Datacenter: Cloud Datacenter infrastructure level services (hardware, software) offered by resource providers in a Cloud computing environment. It encapsulates a set of compute various hosts of same or different as per their resource configurations such as (memory, cores, capacity, and storage). Furthermore, every Cloud Datacenter component instantiates a generalized resource provisioning component

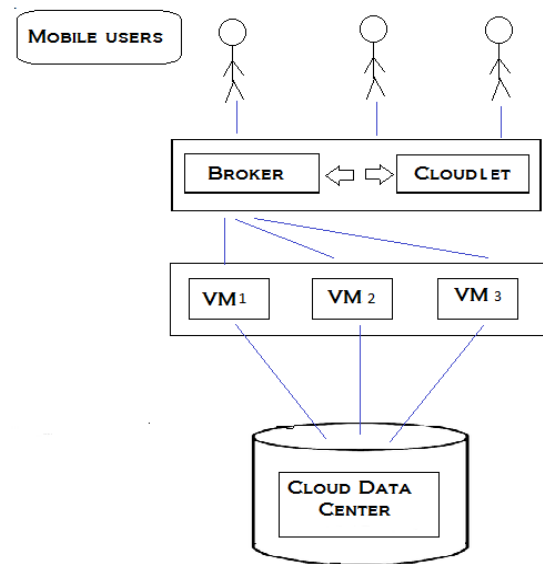


Fig 1. CloudSim Architecture

that implements a set of policies for allocating bandwidth, memory, and storage devices. Virtual Machine VM: The infrastructure services related to the Clouds are modeled in the simulator by a Datacenter Hardware component for handling services request/response method. These requests are application elements housed in sandboxed within VMs, which need to be allocated as a share of processing power on Cloud Datacenter's host components. By VM processing, we mean a set of operations related to VM life cycle, provisioning of a host to a VM, VM creation, VM destruction, and VM migration.

Broker: A cloud broker is a software application that facilitates the distribution of work between different cloud service providers. This type of cloud broker may also be called a cloud agent. It negotiates with them for an allocation of resources that meet QoS needs of users.

Cloudlet: This is a Cloud-based application services agent (content delivery, social networking, business workflow), which is commonly deployed in the data centers. CloudSim represents the complexity of an application in terms of its computational requirements. Every application component has a pre-assigned instruction length and amount of data transfer (both pre and post fetches) that needs to be undertaken for successfully hosting the application.

Mobile Users: Since there is tremendous growth in mobile users of internet and IT resources throughout the world. Especially now in Saudi Arabia there is big discussion going on for Hajj crowd Management using mobile applications on smart phones as well as many other techniques like RF wrist band, satellite imaging, HDTV camera surveillance to check and monitor Hajj crowd density and provide Hajj pilgrims and various Hajj management agencies with valuable inputs on time to save pilgrims life due to stampede and many other calamities of nature [12].

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4:190: Broker: Destroying VM #1
4:190: Broker: Destroying VM #2
4:190: Broker: Destroying VM #3
4:190: Broker: Destroying VM #4
4:190: Broker: Destroying VM #5
4:190: Broker: Destroying VM #6
4:190: Broker: Destroying VM #7
4:190: Broker: Destroying VM #8
4:190: Broker: Destroying VM #9
4:190: Broker: Destroying VM #10
4:190: Broker: Destroying VM #11
Broker is shutting down...
Simulation: No more future events
CloudInformationService: Notify all CloudSim entities for shutting down.
Datacenter_0 is shutting down...
Datacenter_1 is shutting down...
Broker is shutting down...
Simulation completed.
Simulation completed.

===== OUTPUT =====
Cloudlet ID STATUS Data center ID VM ID Time Start Time Finish Time
4 SUCCESS 2 4 3 0.2 3.2
16 SUCCESS 2 4 3 0.2 3.2
28 SUCCESS 2 4 3 0.2 3.2
5 SUCCESS 2 5 3 0.2 3.2
17 SUCCESS 2 5 3 0.2 3.2
29 SUCCESS 2 5 3 0.2 3.2
6 SUCCESS 3 6 3 0.2 3.2
18 SUCCESS 3 6 3 0.2 3.2
7 SUCCESS 3 7 3 0.2 3.2
19 SUCCESS 3 7 3 0.2 3.2
11 SUCCESS 3 7 3 0.2 3.2
8 SUCCESS 3 8 3 0.2 3.2
20 SUCCESS 3 8 3 0.2 3.2
32 SUCCESS 3 8 3 0.2 3.2
18 SUCCESS 3 10 3 0.2 3.2
22 SUCCESS 3 10 3 0.2 3.2
34 SUCCESS 3 10 3 0.2 3.2
9 SUCCESS 3 9 3 0.2 3.2
21 SUCCESS 3 9 3 0.2 3.2

```

Fig 2. CloudSim output at run time

In Fig 2 we obtained multi Datacenter outputs to measure response time for resources provisioning and allocations in high load scenario. Various Datacenters provision various VMs in different times. Start and Finish time varies Datacenter to Datacenter. The same process can be compared and measured with real time Hardware of a Standalone dedicated server with virtualization, hypervisor and power full hardware to build a small Cloud Datacenter to large scale enterprise level state of the art to VMAX3 by EMC and many other platforms.

Fig3. Represents the Simulated output of CloudSim with Multi Datacenter Simulations resulted in Fig2.

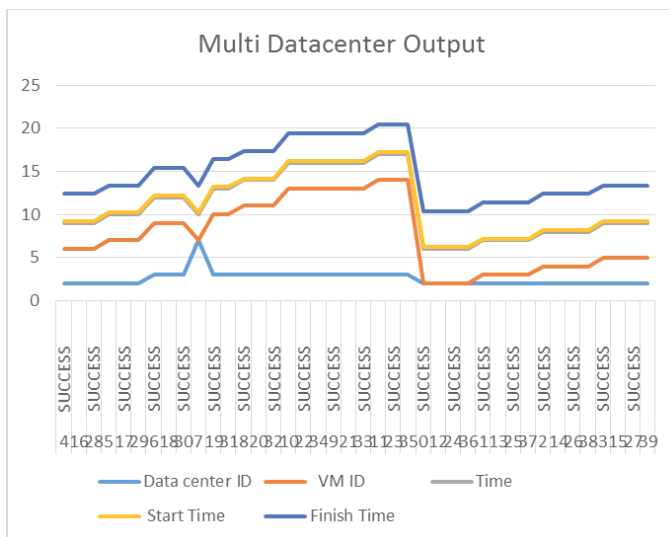


Fig 3. CloudSim results

Cloud Reports: Cloud Reports is a GUI interface of CloudSim that simulates distributed computing environments based on the Cloud Computing. Cloud Reports provide different features of customization for service providers and users.

Cloud Reports provide environment for simulating cloud computing paradigm with no programming skills and generation feature makes it easier to understand the simulation results by displaying charts and lists of the simulated environments' characteristics. Supported types of APIs in the Cloud Reports are Broker policies, Virtual machines allocation policies, Power consumption models, Virtual machines schedulers and Resource utilization models.



Fig 4. Power Consumption measurement with Cloud Reports

Power Consumption analysis is described in Fig4. Power consumption is very important issue from a provider point of you to make sure as a provider energy efficient service can attract more customers by offering a most competitive service price in the market.

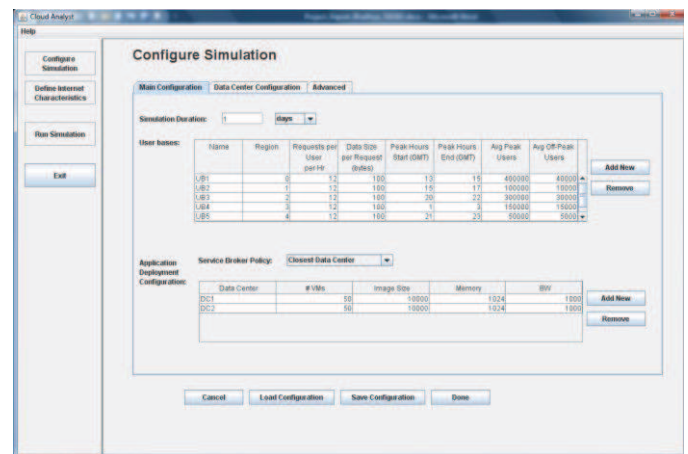


Fig 5. Cloud Analyst main Configuration screen

CloudAnalyst: This is a GUI tool for Cloud services Simulations to test and run various application loads in single or multiple Datacenters within local and global scale for multiple User bases. Cloud Service provider will customize users requirements as per user needs. Fig5. Depicts the main configuration screen to customize user bases versus application deployment in separate Datacenters.

IV. PROPOSED SOLUTION

Mobile Cloud objects such as smart phones, mobile network GSM, 3G and 4G, WiFi, WiMAX, RF Readers cannot be

simulated. Moreover any real time physical or virtual Cloud devices cannot be simulated.

Future Work:

As a matter of fact Simulation has a very limited scope of performance measurement of Cloud Technology. There is high demand to develop a matrix or trade off mechanism to measure live performance data with simulation results to enhance work performance of Cloud Architects and techies handling Cloud Infrastructure or Cloud Data Centers. Routing Schemes specially OSPF, EIGRP, BGP, MPLS and all Layer3 protocols need be tested in Simulation environment, addressing schemes, packet forwarding and shortest path and load balancing from traffic point of view are the essential elements. Similarly Layer2 schemes VLANs, Frame Relay, STP need be analyzed in detail plus a robust directory system designing testing feature will be an added advantage [10].

Beside core Data center Infrastructure testing Cloud Simulation should be able to transform performance replica of access technologies, trends, ideas and new applications on desktop and mobile platforms. Among most popular trend which is evolving is Internet of Things (IoT), new wireless access devices or data collectors or Wireless Sensors which can form a Wireless Sensor Network (WSN) similar to LAN, WAN or WLAN. Moreover Radio Frequency Identifiers (RFID) is becoming more suitable for variety of applications. In Saudi Arabia there four to five million people gather in holy cities of Makkah and its surrounding sacred valleys to perform Hajj pilgrimage every year which requires extensive use of huge crowd tracking, monitoring and effective management by using RFID wrist bands of ID tags attached to pilgrims bodies[11] [12].



Fig 6. A glimpse of a huge crowd in Makkah during Hajj [13] During peak Hajj time there extensive moments of crowd comprises of various nationalities, age and gender is depicted in Fig6 to understand the need of IoT things architecture to

manage this task with the help of IT and Networking resources.

As we see Cloud is becoming a more common platform for the delivery of various applications. Google, Amazon, Microsoft offers variety of services to normal end users through their massive Cloud Infrastructure throughout world. Many other technology giants offer their services on a commercial basis for small to large size of enterprises all around the globe. The most important thing is these Cloud Data centers and required test environments need be customized locally as per domestic needs, such as Aneka is designed by (Raj Kumar Buyya) in his Cloud labs in Australia [14]

V. CONCLUSIONS

This paper presented a simulation-based comparative study of Cloud datacenter scalability, robustness and complexity. In order to measure these performance aspects a comprehensive search and comparison of cloud simulation tools was performed. The performance aspects were then studied on the proposed system which caters to the information services for Hajj pilgrimage users. The study focused on analyzing various Cloud services scenarios using CloudSim, CloudReports and Cloud Analyst tools. The scalability study involved the simulation of number of user requests versus response time and the VMs created for service provisioning. The robustness study was simulated on request arrival rate variation versus the system response time and the number of VMs created. Finally, the complexity study involved the user requests frequency versus the CPU simulation time to gauge the complexity of the three simulation tools.

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REFERENCES

- [1] Mohammed Fazil Ali, Ahmed Muhammad Barnawi, and Abul Bashar. "Performance analysis framework to optimize storage infrastructure for cloud computing." *Innovative Computing Technology (INTECH)*, 2012 Second International Conference on. IEEE, 2012
- [2] Mohammed Fazil Ali, Ahmed Muhammad Barnawi, and Abul Bashar. "Modeling and Simulation Strategies for Performance Evaluation of Cloud Computing Systems." *International Journal of Information* 4.3 (2012): 149.
- [3] A. Bashar, "Modeling and Simulation Frameworks for Cloud Computing Environment: A Critical Evaluation," in *Proc. of International Conference on Cloud Computing and Services Science (ICCCSS 2014)*, pp. 1296-1301, 2014
- [4] Ranbhise, IProf SM, and K. K. Joshi. "Simulation and Analysis of Cloud Environment." *Simulation* 2.4 (2014).
- [5] Pakize, Seyed Reza, S. M. Khademi, and A. Gandomi. "Comparison Of CloudSim, CloudAnalyst And CloudReports Simulator in Cloud

- Computing." International Journal of Computer Science And Network Solutions 2.5 (2014): 19-27.
- [6] Wu, Linlin, Saurabh Kumar Garg, and Rajkumar Buyya. "SLA-based admission control for a Software-as-a-Service provider in Cloud computing environments." Journal of Computer and System Sciences 78.5 (2012): 1280-1299.
- [7] Kaiqi Xiong and Harry Perros. "Service Performance and Analysis in Cloud Computing". In proceeding of the Congress on Services, 2009.
- [8] Matthias Beckerm Sebastian Lehrig and Steffen Becker. In proceeding of the 6th ACM/SPEC International Conference on Performance Engineering (ICPE2015). Austin, Texas, USA, 2015.
- [9] Maram Falatah , Omar Batarfi. "Scalable Government Agencies Cloud Computing". It is accepted for publication in International Journal of Emerging Engineering Research and Technology (IJEERT).
- [10] Malhotra, Rahul, and Prince Jain. "Study and comparison of various cloud simulators available in the cloud computing." International Journal 3.9 (2013).
- [11] Greenberg, Albert, et al. "VL2: a scalable and flexible data center network." ACM SIGCOMM computer communication review. Vol. 39. No. 4. ACM, 2009.
- [12] Mohammed Fazil Ali, Abul Bashir, and Asadullah Shah. "SmartCrowd: Novel Approach to Big Crowd Management using Mobile Cloud Computing." ICC 2015 Riyadh KSA
- [13] Greenberg, Albert et al. "VL2: a scalable and flexible data center network." *Communications of the ACM* 54.3 (2011): 95-104.
- [14] Gubbi, Jayavardhana, et al. "Internet of Things (IoT): A vision, architectural elements, and future directions." *Future Generation Computer Systems* 29.7 (2013): 1645-1660.
- [15] Mitchell, Ricardo O., et al. "Hajj crowd management and navigation system: People tracking and location based services via integrated mobile and rfid systems." Computer Applications Technology (ICCAT), 2013 International Conference on. IEEE, 2013.
- [16] <http://newsreport.com.ng/index.php/2015/09/25/nigerians-among-717-killed-in-hajj-stampede/>
- [17] R. Buyya, et al., Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility, Future Generation Computer Systems (2009), doi:10.1016/j.future.2008.12.001