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Simulation of a Content-Based Cloud Artifact for Collaborative Resource Sharing in Tertiary Institutions

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ABSTRACT
Cloud computing is a relatively novel concept that promises among other things an ubiquitous provisioning of both hardware, software and other resources in a metered fashion along with other extra capabilities. However, like the internet, it has certain challenges which are not tractable. For instance, the designer of cloud computing artifact has no way of determining certain network and internet conditions and constraints of the artifact when in operation at design stage to enable efficient control of these resourcesfor effective operation. This calls for an effective means of simulating and evaluation of these cloud artifacts during development stage, so that the behavior will be gauged and predicted at any point of development and use. The researcher adopted a cloud simulation tool called CloudAnalyst- a graphical user interface tool from Cloudsim. The simulation considered two categories: The data centre distribution and make up; and the user group distribution and make up. By manipulating the parameters that make up these categories, useful relationships were realized and plotted in a graph using MS Excel spreadsheet application. Some of the useful results realized suggested that increasing the number of data centres beyond a limit does not improve efficiency, rather, it increases delays and costs. Hence, increasing the power and speed of data centres does not add to quality of servivce of the system and so should find a trade-off between response and user types.

Keywords: Domain (Cloud Computing) Performance Metrics, Modeling and Simulation, Response time, Processing time,servicing time,

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I. INTRODUCTION

Cloud computing is an on demand service model whose resources are highly virtualized, distributed and scalable, in that, its resources can be acquired with minimal effort and time or burstible to utilize extra resources not pre-assigned to it. In its generic form, it provides the following service models:Software as a Service (SaaS), where scarce/rare software may be had as a service.(that is , metered) reminiscent of electric power or telephone pay as use model; there is also Platform as a Service (PaaS), this time APIs are made available for developers to develop and run applications in the cloud; and Infrastructure as a Service (IaaS); where computer infrastructure, such as memory, storage, network and processors may be provided as a service to be subscribed to. By extension, cloud computing can offer many more things as a service, such as, database, security, bandwidth, etc.

Cloud computing also has the following delivery models:The private cloud - cloud service that mirrors the operations of a cloud but restricted to private use, such as, a company or corporation; Public cloud, cloud services that is made available for public utilization and hybrid cloud, exhibiting both public and private cloud features. There are other less popular delivery models, such as, partner cloud, for a group of organizations that come together to share and collaborate resources in the cloud. Example of typical partner cloud is cloud-based resource sharing for higher education institutions in Nigeria.

Up till now, resource sharing in higher education is achieved through hard-wired fibre optics cable technology with its attendant very high cost of ownership. Cloud computing provides easier facilities to share resources in higher institutions. Resources that can be shared include: courseware, staff publications e-books, theses, etc. Simulation enables the developer to assess/gauge the different range of possibilities for an optimal utilization of the cloud infrastructures prior to deployment. Many cloud simulation tools exist, such as, Cloudsim, CloudAnalyst, open cloud, Green cloud, Cirrus, icanCloud and Open Stack, [1].This simulation is based on CloudAnalyst tool and the target is to simulate the data centres, storage, memory, networks, groups and geographical regions of these infrastructures.

CloudAnalyst is a tool to simulate large-scale cloud applications with the purpose of studying the behavior of such applications under certain minimum deployment configurations, [2]. It helps developers gain insight on how to distribute applications among cloud infrastructures and other services, such as, optimization of application performance. It is based on cloudsimplatform and provides GUI features to perform easier study of cloud applications.

II. RELATED WORKS

Simulation is usually applied to distributed systems of which cloud computing is one. In studying cloud computing performance evaluation, some criteria, such as, average waiting time, load balancing and number of requests, [3], cost and throughput, [4], workload, [5], response time, [8], budgeted resources, time constraints, and/or the desired quality of service [6], effectiveness and general productivity, the rate of input and output operations in the network, [10], are looked at.

There are many methods and simulation tools, such as, Pareto traffic method, [3], fuzzy system, [7], a discrete event simulation,eg.,simjava or JAPROSIM, [5], CloudAnalyst (a subset of Cloudsim), [9], etc. Big organizations like Oracle, IBM, Google and Open Shift, etc., provide cloud environment to be used by different users. The performance evaluation in this work is based on the combination of the above categories, and it is performed with the help of CloudAnalyst software.

A. Modeling and Simulation of Cloud Computing System:

One of thequalities of cloud computing is high performance of services,hence the need for performance evaluation of cloud providers and users. There are many methods used for performance gauging and evaluation. The researcher used the following methods in the evaluation:

- Evaluation based on criteria and characteristics.
- Evaluation based on simulation

Factors affecting performance include: reliability, energy efficiency, scalability, availability, security, etc. Some other important factors include:

- Recovery
- Service level agreement
- Network bandwidth
- Storage capacity
- Buffer capacity
- Disk capacity
- Availability/Number of users
- Location

These factors below are subsumed from earlier factors affecting performance

- Usability
- Work load
- Repetition and Redundancy
- Processor power
- Latency [9], [2]
-

i) Criteria for Simulation: The following Simulation criteria are admitted for cloud based systems:

(i) Average response time per unit time.
(ii) Network capacity per second (Mbps) or per unit time.
(iii) The number of I/O commands per second (IOPS) or per unit time.
(iv) Average waiting time per unit time
(v) Work load/requests to be serviced per second (Mbps) or a unit time.
(vi) Throughput, thiscriteria will be processing power factor for this study, [10].
(vii) Average time of processing
(viii) Percentage of CPU utilization, [10],
(ix) The number of requests executed per unit time.

These criteria can be coded and embedded in the system to be analyzed as profiler. It will be noted that research on such infrastructure like internet and cloud is difficult, involving interaction with multiple computers and network elements, which may not be directly under the control of the developer/analysts. More so, network conditions may not be easilycontrollable/predictable, and this will affect evaluation. In this study, CloudAnalyst will be used as a graphical user application tool for simulation.

ii) Simulation Constituents: The following components are considered when simulating with CloudAnalyst

- Data centres (DC), this is the hardware. Theseinclude, processor, storage media, internal memory bandwidth, etc. Data centres can exist in the 6 different geographical areas covering all regions. The number of data centres, VM speed are also manipulatable.

- Users, users may be distributed across the geographically areasas user groups. User groups are distributable by geographical areas, number of request per hour, etc., [10]. Users can mean a person, an organization, or group of persons.
- There are different policies of scheduling of these tools, such as, closest data centre, response time optimization and dynamic manipulations.

Assumptions made in the simulation are:

- Type of request based on data size is assumed.
- 6 geographical regions are defined covering the regions of the world as contained in CloudAnalyst.
- Total number of users can tend to infinity but 60 is assumed. Simulation time is 24 hours to provide enough time for real values to emerge.
- Data centre policy is based on closest link to data centre.

The following measures were used in the simulation:

- Data transfer cost per dollar per hour
- Minimum, maximum, average overall response time.
- Processing time for the overall datacentre.
- Response time per user .
- Time per data centre.
- Cost per VM of data centre per dollar per hour
- Cost per memory per dollar per hour
- Storage cost per dollar per hour

For simulation and evaluation based on data centres, evaluation is done by manipulating the virtual machines, memoryand bandwidth parameters. Based on users, Change in the number of users and volume of work are evaluated,based on geographical location between users and data centres. Proximity of users to data centresare evaluated.

III. SIMULATION AND EVALUATION BASED ON DATA CENTRES

Scenario 1:,The number of users is assumed equal to 60, they are distributed in 6 different regions and requests are between 50 to 100.Data centresettings arenot manipulated and only the number of datacenters is changed from 1 to 20centres. The simulation is performed 24 hours.

Figure 1, the average time Is shown. There is a little reduction in response time after 10 data centres , so putting more than 10 data centres only increases the cost. It can be concluded that increasing the number of data centres is not a sign of minimization of response time.

Figure 2 shows the processing time in data centres.The rate is fixed for minimum and average state. However, for maximum, after 10 data centres the rate is fixed and will not have positive impact and will only increase cost.

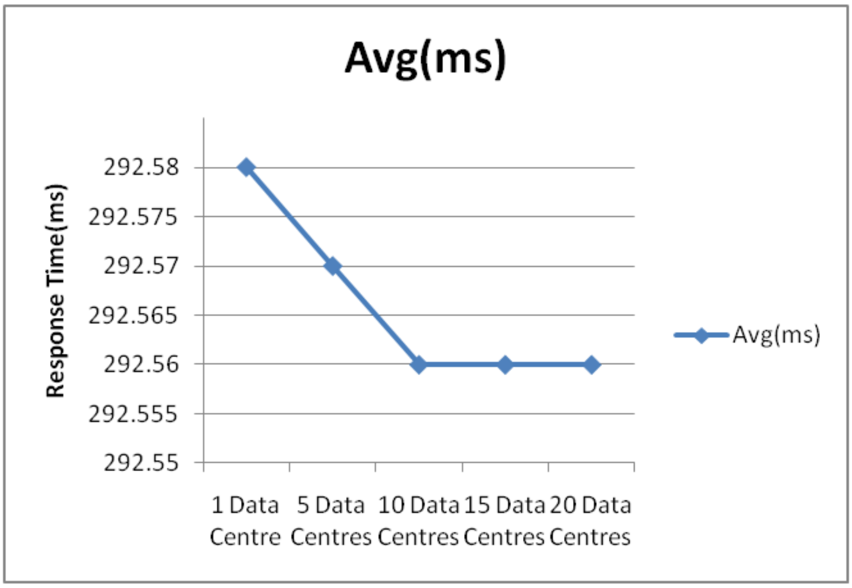

Figure 1: Overall response time in scenario 1

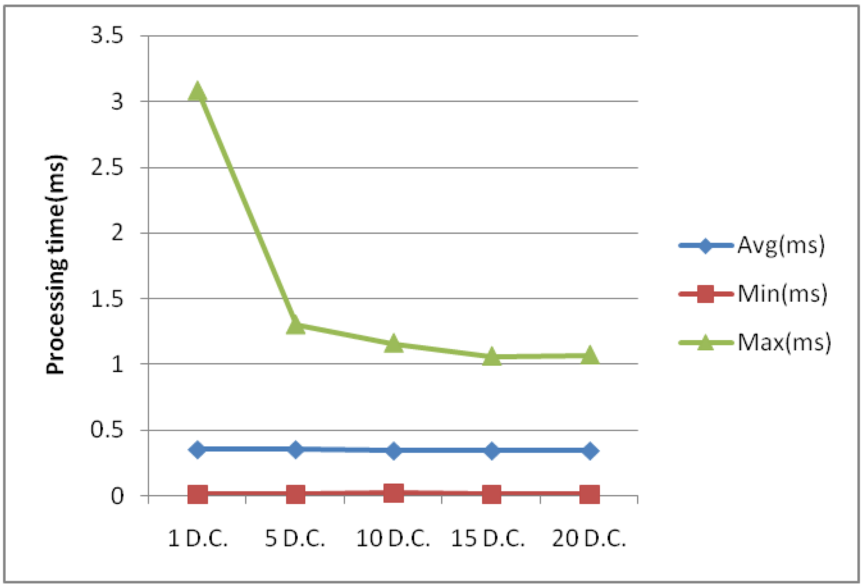

Figure 2 Processing time in data centres

Figure 3, shows the average, minimum and maximum service time per request in data centres. It also proved to be similar to previous values after the same number of data centres. This shows that the average service time is increasing with the increasing number of centres and cost is too high.

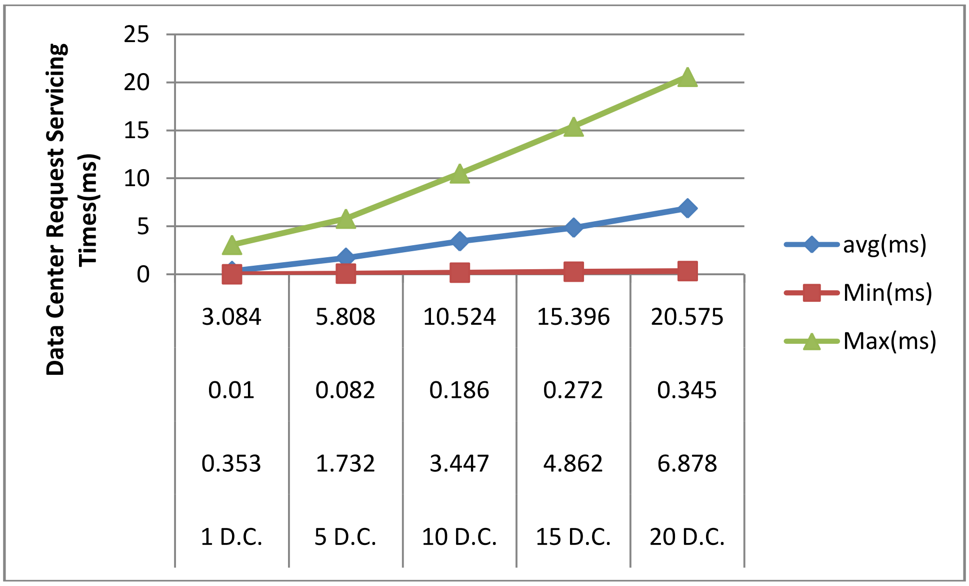

Figure 3 Servicing time in data centres

Figure 4 depicts the total cost and the cost of the virtual machine. With the increase of data centres ,cost increases and since rate of other criteria remains static after some number, this cost is useless.

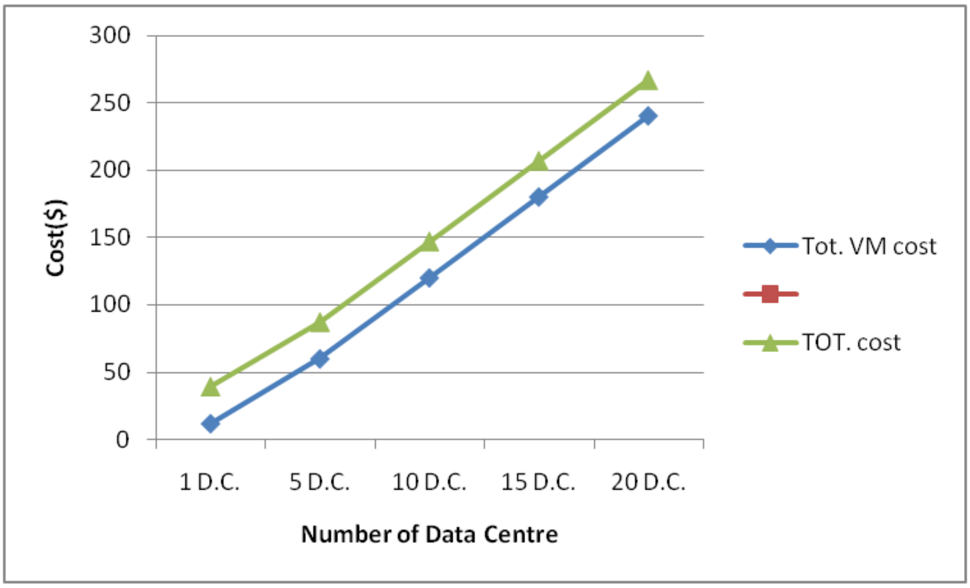

Figure 4: Total and VM Costs

Scenario 2: This scenario's goal is to evaluate criteria by considering a fixed number of data centres and changing number of its constituents, like, processors, memory, storage medium in simulation. The number of users is 60, and the number of data centre is 6. At first we increase memory from 1DC to 6DC, then, we perform the same manipulation for storage media and processing of 1DC to 6DC. The results are shown in figure 5 and interpreted as follows;

It can be seen that change in number of processors of the data centres has the greatest impact on processing time, and has the greatest impact on cost as can be seen in figure 6.

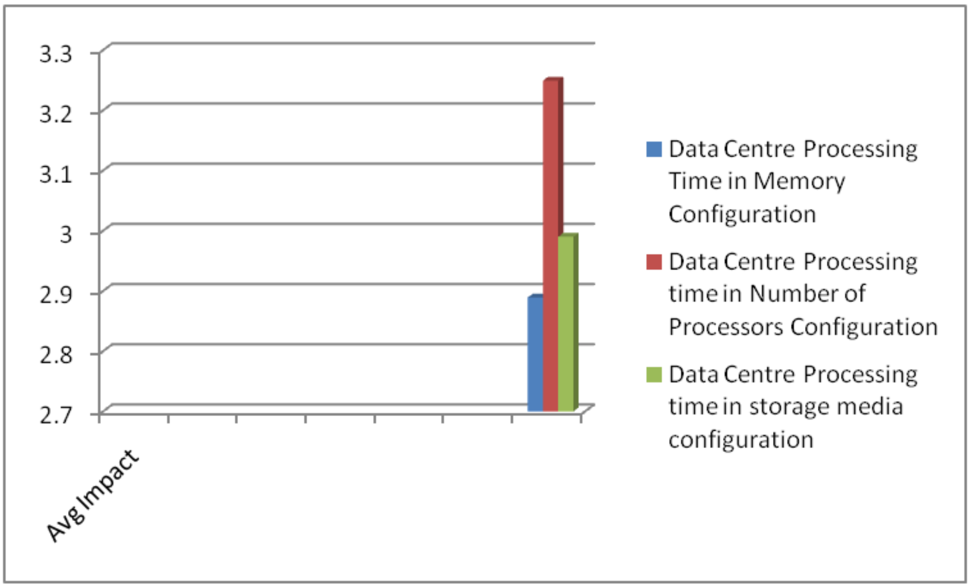

Figure 5: Data Centre Processing in Changes in Scenario 2

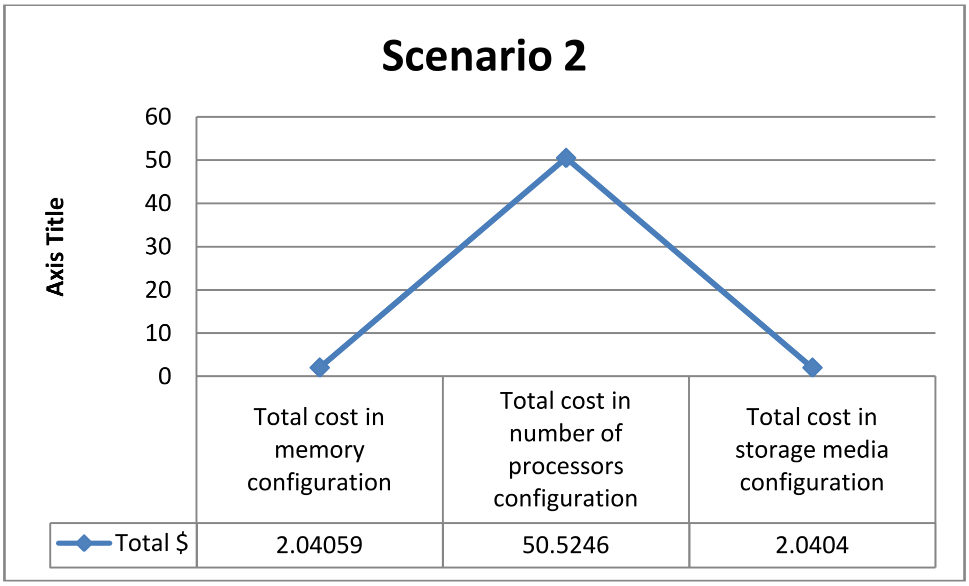

Figure 6: Total cost in scenario 2

IV. SIMULATION AND EVALUATION BASED ON USERS

Scenario 3: The goal in this scenario is to change the number of users and obtain the results. To simplify the scenario, only one data centre was considered and the number of users increased to 10, 20, 30, 40 and 50, located in the same area with data centre. The capacity of authorized users was considered as 50 for each data centre. Figure
7 shows the processing time of the data centre based on number of users. Increasing the number of users increases processing time. Figure 8
shows the total cost and the data transmission costs, the cost will increase strongly with increasing number of users which are not affordable. Finally, if a data centre has overrated capacity, it will not be economical and also lower efficiency of that centre.

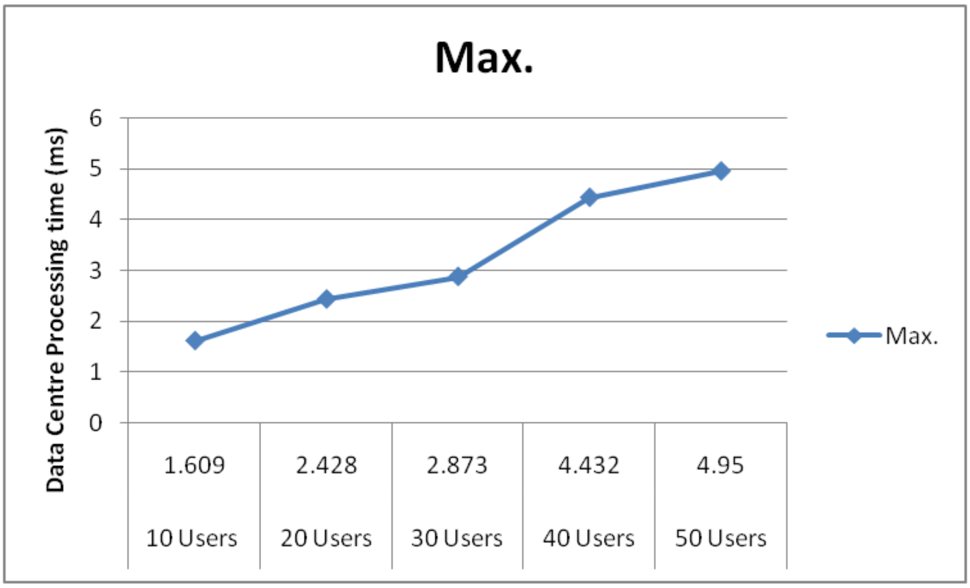

Figure 7:Max Data Centre processing time

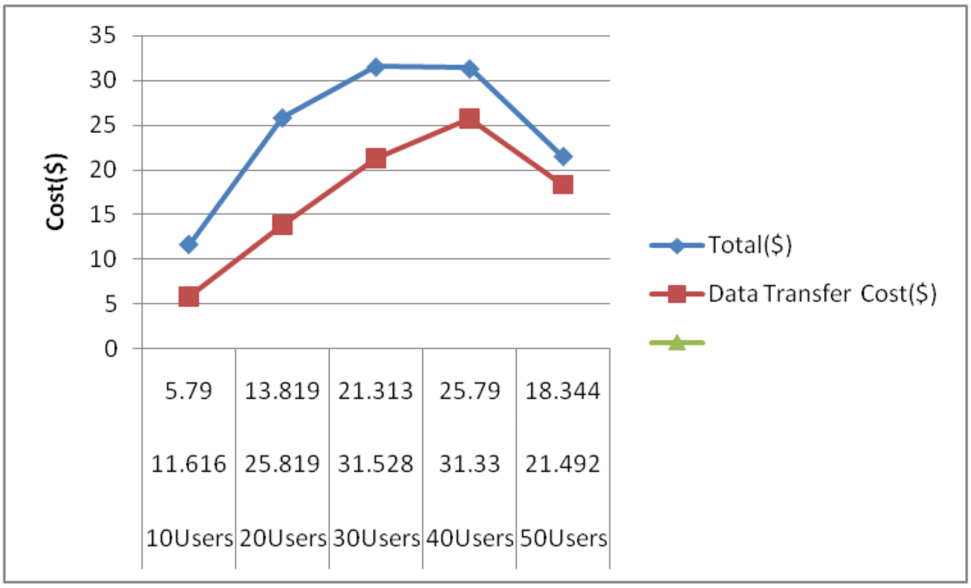

Figure 8: Total Cost in Scenario 3

Scenario 4: In this scenario, 18 users are assumed and every 3 users have 100, 500, 1000, 1500, 2000, or 2500 requests per 24hours. Users with the same number of requests are connected to same data centre. Other configurations remain unchanged. The result shows that increasing the number of requests per unit times have little impact on response time, on processing time, data centres. But unlike other measures, it is effective on data transfer and thus the cost of data transfer. Furthermore, increasing the size of the overall response time is also relatively effective. This result is shown in figure 9.

Figure 9: Average response time based on request size

D. Simulation and Evaluation Based on Geographical Regions

Scenario 5: This scenario evaluates the position of data centre and users. For this section we have considered 21 users and 3 data centres, which are placed in three regions.

Firstly, all users are placed in a single region and all three data centres are in another region separate from the users. In the second case, users and data centres are in the same region and distributed users and data centres have been distributed in the third case.

The results show that these changes cost and other measures. The overall response time is shown in figure 10. The result shows that it is better for the user and data centres to be in the same region or have the least distribution.Figure10, also shows that processing rate in data centres will be reduced when user is away from the centre, because the response time increases so users may have fewer requests from the data centre.

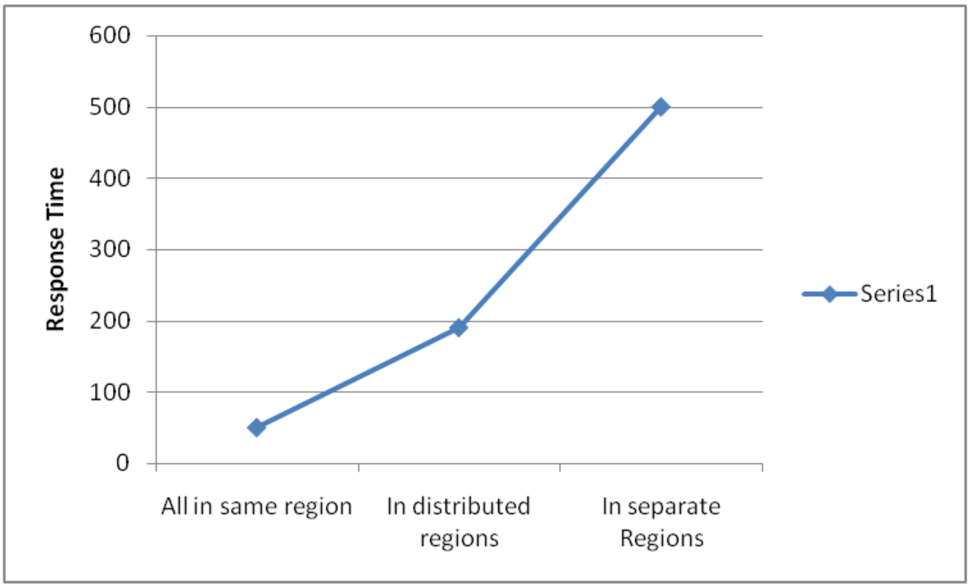

Figure 10 Response time based on geographical Region

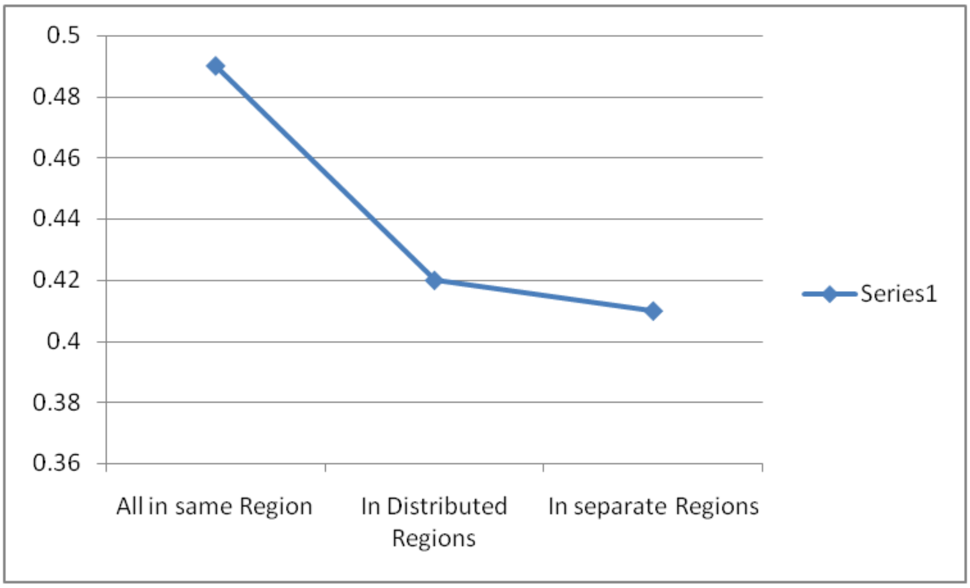

Figure 11: Process time of data centre based on geographical region

V. CONCLUSION

According to the prediction from the scenarios considered, the following conclusions were reached:
Improving the power and speed of data centres does not add to quality of service of the system and so should find a trade-off between response and user.So, it is recommendedthat efficiency may not be increased beyond a certain limit more than what was required and should find standard based on requests and user types.That the distribution of data centres and use of closest data centre is better and more optimal.

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