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An Implementation of Divide and Conquer Clustering Technique for Improving the Interoperability in Hybrid Cloud Environment

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Abstract
Cloud computing provides users with pool of resources ubiquitously on demand. While the resources are provided to the users, interoperability needs to be considered. Interoperability is the ability of the cloud environment to transfer the data internally or between the data centers seamlessly. Interoperability is the least studied issue in the field of cloud computing. This paper implements hybrid cloud as a solution to interoperability. Hybrid cloud is chosen for its powerful combination of high configured and secured private clouds and fast accessible and scalable public clouds. The interoperability is then proposed to be enhanced by implementing divide and conquer algorithm of clustering in hybrid cloud.

Keywords: Cloud Computing, Interoperability, Hybrid Cloud, Private Clouds, Scalability, Clustering.

1. Introduction

Cloud computing is designed to be ubiquitous for the user's easy and fast access. The users according to their need use the resources and have to pay on pay per use basis. Cloud computing is getting very popular and all the companies are adopting cloud for its numerous advantages provided to the users. It is a concept in which all the resources like storage, processors, software's etc. are provided under one umbrella. It allows multiple servers to be connected and thus allow the data to be shared my multiple clients. [1] The resources are shared by multiple users and allocated dynamically on demand. So, there has to be effective resource scheduling mechanism in cloud environment. [2]

Cloud Computing acquires it power thorough the use of virtualization. Virtualization is the base technology of cloud computing. This technology can be viewed as power house technology to deploy IAAS. It provides numerous benefits to cloud architecture through its abstraction technique. The virtualization divides the architecture in physical and logical view. A cloud works as an umbrella where under a physical machine various dissimilar virtual machines work parallely. Virtualization reduces number of physical components thereby less number of components to manage and maintain. [3]

Interoperability is a need of hour in recently booming cloud computing environment. Interoperability is the concept where two or more data centres can send or receive data seamlessly. Standardization is one of the solutions to interoperability up till now. Data that resides in one cloud provider can be moved to another cloud provider. A standardization effort that supports this use case is cloud data management interface. Although SOAP and REST are not data-specific standards, multiple cloud storage providers support data and storage management interfaces that uses simple object access protocol (SOAP) and representational state transfer (REST). [4] [5] [6]

National Institute Of Standards & Technology defined cloud computing as a model for enabling convenient, on-demand network access to a shared pool of computing resources which can be rapidly provisioned and released with minimal management efforts or service provider interaction. NIST, Object Management Group(OMG), Distributed Management Task Force as a part of their efforts related to standardization for cloud interoperability have developed use cases for cloud computing. These use cases are divided into cloud management, cloud interoperability and cloud security. Here the focus is mainly on interoperability related issues and so we would consider the interoperability use cases which are as follows:

1. User Authentication
2. Workload Migration
3. Data Migration
4. Workload Management [7] [8]

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Clustering:

Cloud computing deals with enormous amount of data and this data is accessed and processed simultaneously. If this huge data is processed in unscheduled way the performance of cloud may degrade. The main effect is degraded response time and processing time. In view of interoperability in hybrid cloud, the interoperability adds an overhead of the data migration and management and ultimately the effect is seen on the performance of hybrid cloud in terms of response times and processing times. Thus, to avoid this overhead the solution is to put clustering into operation to reduce the response time and execution time and thereby increase the efficiency of hybrid cloud. The technique applied is divide and conquer rule. [9]

2. Literature Review

Rajkumar Buyya, Chee Shin Yeo, Shrikumar Venugopal, James Broberg, Ivona Brandic, in the paper "Cloud Computing And Emerging IT Platforms: Vision, Hype, Reality For Delivering Computing as the 5th Utility" propose to define cloud computing and provide an architecture for creating clouds with market-oriented resource allocation by leveraging technologies such as virtual machines. The paper also provides insights on market based resource management strategies that encompass customer driven service management and computational risk management to sustain Service Level Agreement oriented resource allocation. The paper also compares the earlier and new thoughts on interconnecting clouds for dynamically creating global cloud exchanges and markets. [10]

Mihaela-Andreea Vaile, Florin Pop et. al. in their paper "Resource Aware Hybrid Scheduling Algorithm in Heterogeneous Distributed Computing" propose an algorithm which considers hierarchical clustering of the available resources into groups in the allocation phase. They propose to carry out task execution in two phases where the first phases consists of tasks assigned to form a specific group and then in the second phase the classical scheduling algorithm is used for each group of resources . This algorithm is suitable for Heterogeneous Computing where the loads are of different types. The paper studies the effect of clustering in heterogeneous cloud environment and their performance with respect to load balancing, cost, and dependency in CloudSim. [11]

Mrs. Parekh Madhuri and Mr. Ishan Rajani in their paper "Improve Performance Of Clustering On Data Sets With Improved Agglomerative CURE Algorithm" proposes a model that improves the performance of cloud environment with the use of Agglomerative Hierarchical Clustering algorithm to the heterogeneous data generated in cloud. The research work carries out a study on the clustering techniques available and focuses on the hierarchical clustering technique to be implemented in heterogeneous cloud environment. [12]

3. Proposed Methodology:

The proposed research work focuses on Hybrid cloud as the best and optimised solution to interoperability. Interoperability in public clouds is difficult due to security aspects whereas in private clouds the access restriction and availability of limited resources remains a big issue. The idea behind the interoperability solution is that along with standardization there is need to for ideal solution to the issues like security, ease of access and mobility, resource reuse, efficient resource utilisation, throughput, and cost.

Thus to overcome the problems of public and private clouds with respect to interoperability, this research work proposes Hybrid cloud as a powerful solution. Hybrid cloud is a powerful combination of public and private clouds so that we overcome all the issues along with the package of advantages of both the clouds.

Working on the clouds in the real world is not possible due to huge cost involved along with other factors, so the cloud modelling and interoperability is studied using cloud simulators like Cloudsim, Cloud Analyst toolkit.

The hybrid cloud Interoperability methodology was designed keeping the focus on the following parameters:

1. Throughput(In terms of low response time for more work done)
2. Execution Time of Data Centre (in terms of data centre processing time)
3. Cost Efficiency(In terms of Grand total Cost for cloud modelling)
4. Heterogeneity of Hybrid clouds

4. Modelling Of Hybrid Interop Cloud

Modelling Hybrid cloud methodology involves following steps:

1. Model a Hybrid cloud with a combination of private and public cloud data centres.
2. The modelling mainly depends on the idea that the private clouds are smaller, limited accessible and of higher configuration whereas the public clouds are bigger in size and of lower configuration.
3. The size of the public or private cloud would be decided by number of virtual machines in the clouds and the configuration would be decided by the number of hosts in that cloud.
4. Private cloud would have more number of hosts and public cloud would have less number of hosts.

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5. Private cloud would be accessible to the users of that specific region only whereas public cloud would be accessible to the users of any region.
6. The request sent by the user or customer is first by default sent to the private cloud and then on reaching a threshold is dynamically sent to public cloud if need be.
7. The basic hybrid cloud framework involves initially a private cloud with higher number of hosts and lower number of virtual machine and two public clouds with more number of virtual machines and lower number of hosts per region.
8. The most important part of hybrid cloud is the service broker policy which is the key role player which enables interoperability.
9. The last component of hybrid interop framework is the VM load balancing algorithm which selects the ideal virtual machine for allocation of job according to the need of the user.
10. The hybrid interop framework is mainly modelled region wise that is across the world and hence the region wise time slot is varying.

The proposed framework was designed in cloud analyst in view of solution to the interoperability problem in cloud computing. [13] The hybrid cloud was modelled with combination of one private and two public cloud data centres where private clouds are small and of higher configuration and public clouds are big but of lower configuration. Then successively adding sequentially private and public data centres in similar way in different regions. The key driving factor in interoperability implementation in hybrid clouds is the application of service broker policy in hybrid clouds. To make comparison we see the difference by modelling private and public clouds independently in different cases and then compare the hybrid cloud performance with public and private data centres. [14]

5. Experimental Work

A private data centre is modelled with more number of hosts and less number of virtual machines to a region. Two public data centres are added with less number of hosts but more number of virtual machines to the next region. The combination of these two is a hybrid cloud with one private and two public data centres. The hybrid data centre is set with optimised response time policy and throttled algorithm for resource allocation and load balancing. The next step comes to focus on parameters like average peak users and peak hours start and peak hours end. The private cloud is having more number of processors and hence process more number of user requests. The public cloud is set to have less number of average peak users. The clustering is done by setting the parameters peak users and peak hours start and peak hours end. The private data centres are set to have a different region i.e either 0-3 and 3-6 whereas all public data centres are set to have time slot of 6-9.

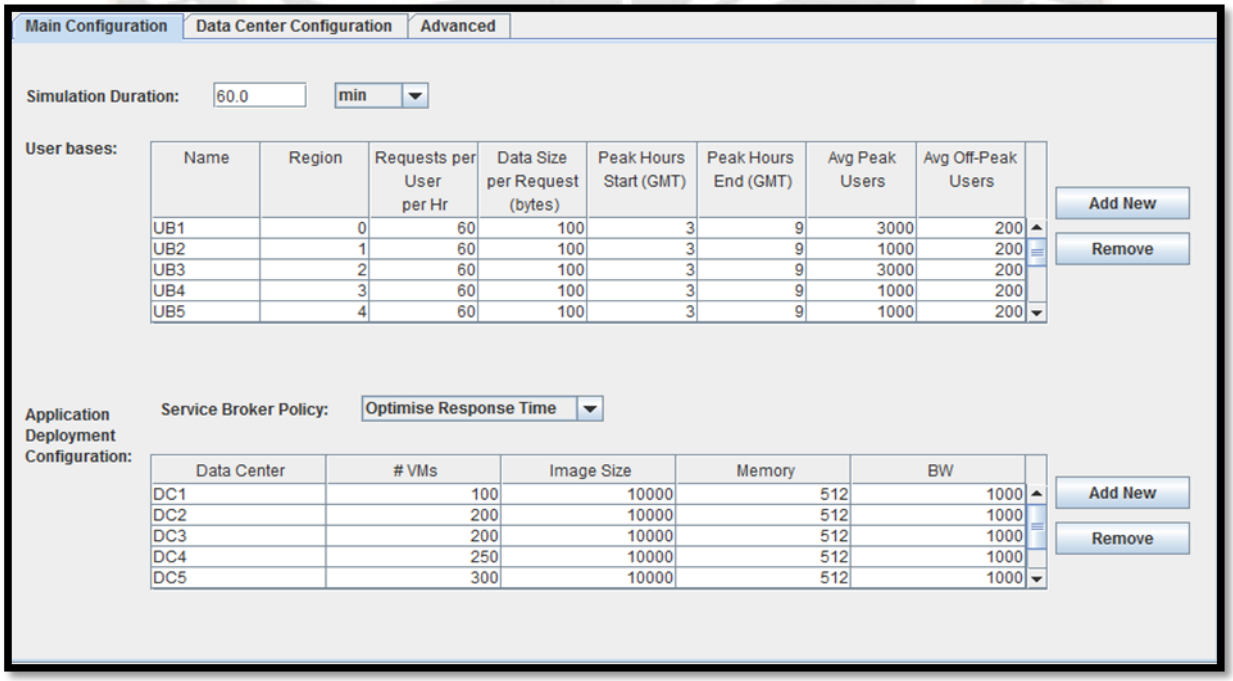

Figure 1: Snapshot of Hybrid Cloud Without Clustering

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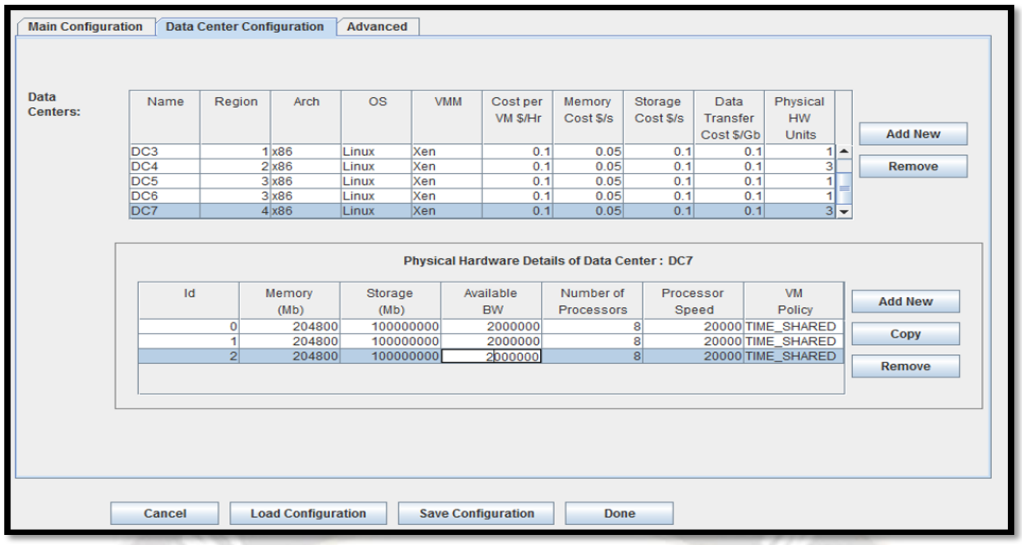

Figure 2 : Snapshot of Hybrid Data Centre Configuration

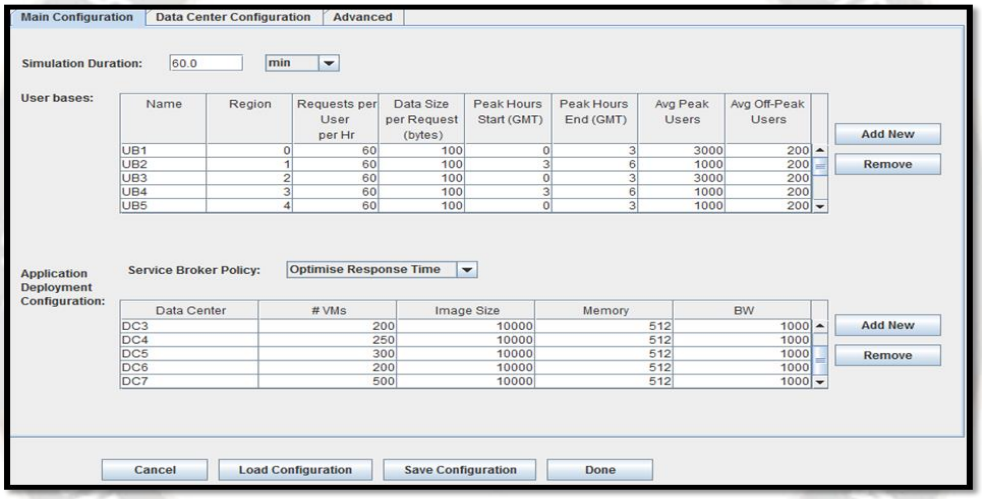

Figure 3: Snapshot of Hybrid Cloud Interoperability With Clustering

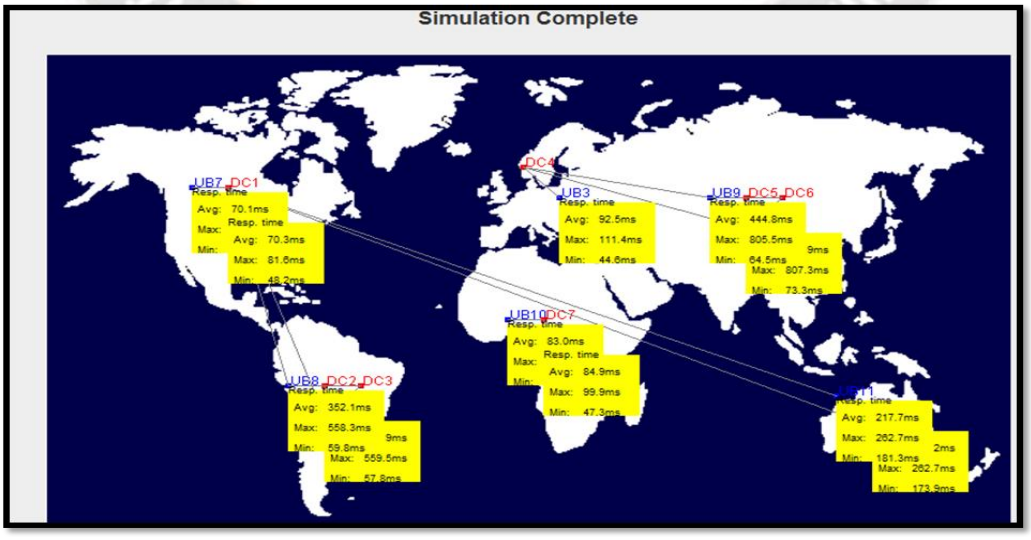

Figure 4 : Snapshot of Hybrid Cloud Without Clustering 1

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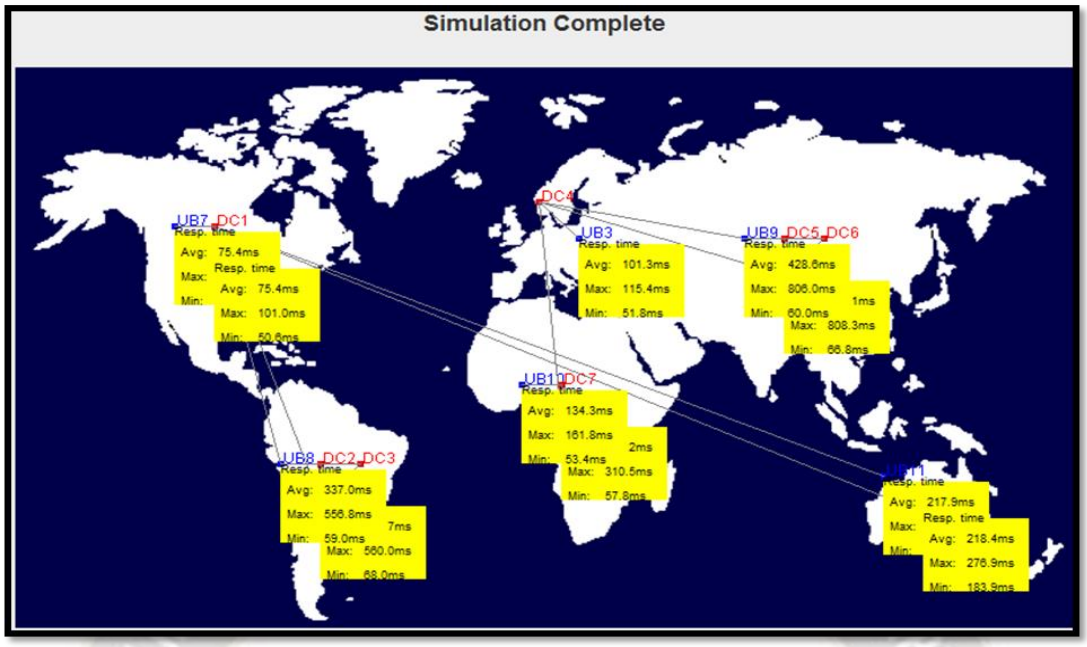

Figure 5: Snapshot of Hybrid Cloud With Clustering 2

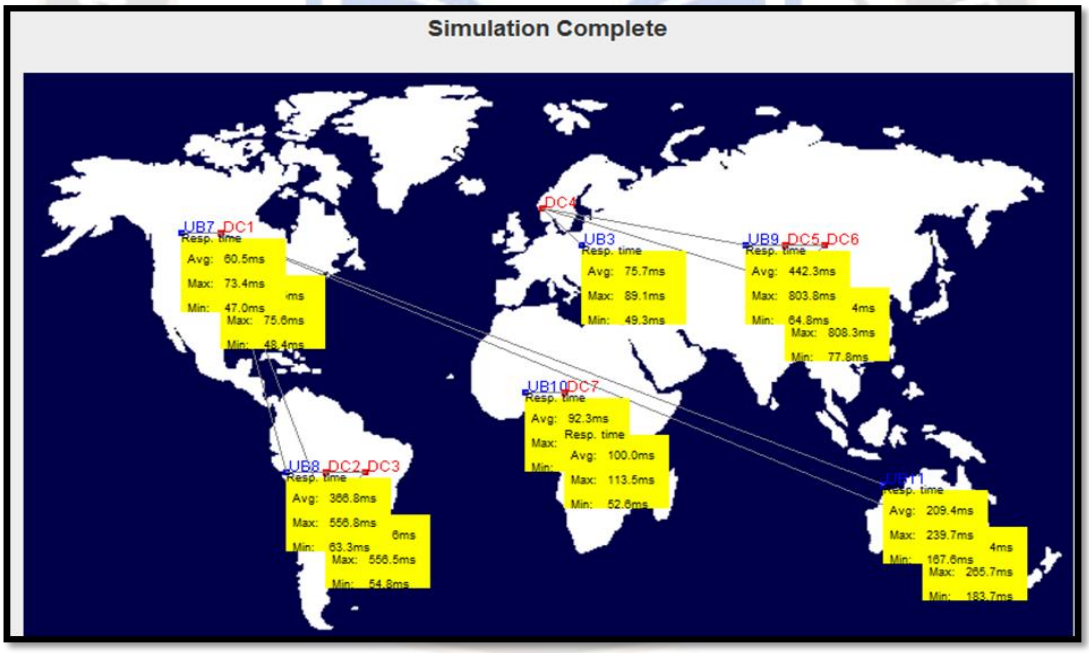

Figure 6: Snapshot of Hybrid Cloud With Clustering And Enhanced Inteoperability Time 3

6. Results and Discussions

Hybrid cloud was modelled towards a solution to interoperability. All the issues of interoperability were studied with respect to hybrid cloud. Hybrid cloud takes a combination of private and public cloud for enhanced interoperability but it has been observed that the interoperability time and other parameters also not much less even on taking any combination of broker policies and scheduling algorithm. So, the next step implemented was to enhance the interoperability time and other parameters related to it. Cloud clustering was proposed as a probable solution to reduce interoperability time. The idea was to group the private and public jobs in three time slots of parameters "Peak Hours Start and "Peak Hours End" i.e. from 0-3, 3-6, 6-9. We would group private cloud jobs in slots 0-3 and 3-6 but the public clouds would specifically be put in slot 6-9. The regrouping of private and public data centres in two different regions showed a huge reduction in

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interoperability time. Towards more enhancement of interoperability time the processing speed of private data centres was increased and the results were again giving a substantial reduction in interoperability time.

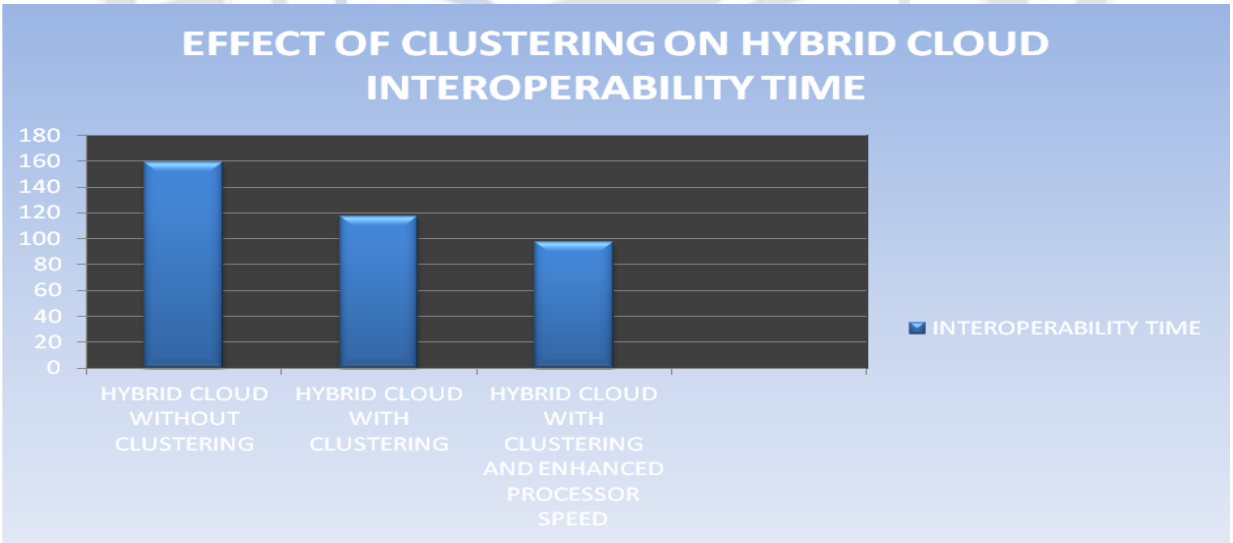
Table 1: Impact of Clustering On Hybrid Cloud Interoperability Time

S.NO	PARAMETERS	INTEROPERABILITY TIME IN MS	EXECUTION TIME IN MS
Case 1	HYBRID CLOUD WITHOUT CLUSTERING	159.14	75.87
Case 2	HYBRID CLOUD WITH CLUSTERING	117.27	55.23
Case 3	HYBRID CLOUD WITH CLUSTERING AND ENHANCED PROCESSOR SPEED	97.30	35.87

Table 1 shows the impact of clustering on hybrid cloud with respect to interoperability time and execution time. In case 1 the hybrid cloud was modelled and the Peak hours Start and Peak Hours End were kept in constant range i.e. 3-9. In this case the interoperability time obtained is 159.14 ms and the execution time is 75.87 ms.

Case 2 shows that the hybrid cloud is modelled with clustering of public and private data centres in different peak hours clusters. In this case a major reduction can be observed in interoperability time and execution time. The interoperability time in this case id 117.27 ms and the execution time comes out to be 55.23 ms.

Case 3 shows that the hybrid cloud after clustering shows a substantial reduction in interoperability time and execution time. The next step of increasing the processor speed enhanced the interoperability time and execution time drastically. Thus the interoperability time observed here was 97.30 ms where as the execution time was 35.87. Thus in case 3 there is a huge reduction in interoperability time and also the execution time as a consequence of clustering followed by increase in processor speed.



Graph 1: Graph for Effect of Clustering on Hybrid Cloud Interoperability 1

The above graph shows that interoperability time shows a substantial reduction in interoperability time subsequently by introducing clustering technique and thereafter increasing the processor speed. In case of hybrid cloud without clustering the interoperability time was 159.14 ms and when the clustering was implemented in hybrid cloud the interoperability time reduced to 117.27 which is a substantial reduction. Furthermore the when the clustered hybrid cloud was modified by increasing the processor speed there was a huge reduction in interoperability time up to 97.30.

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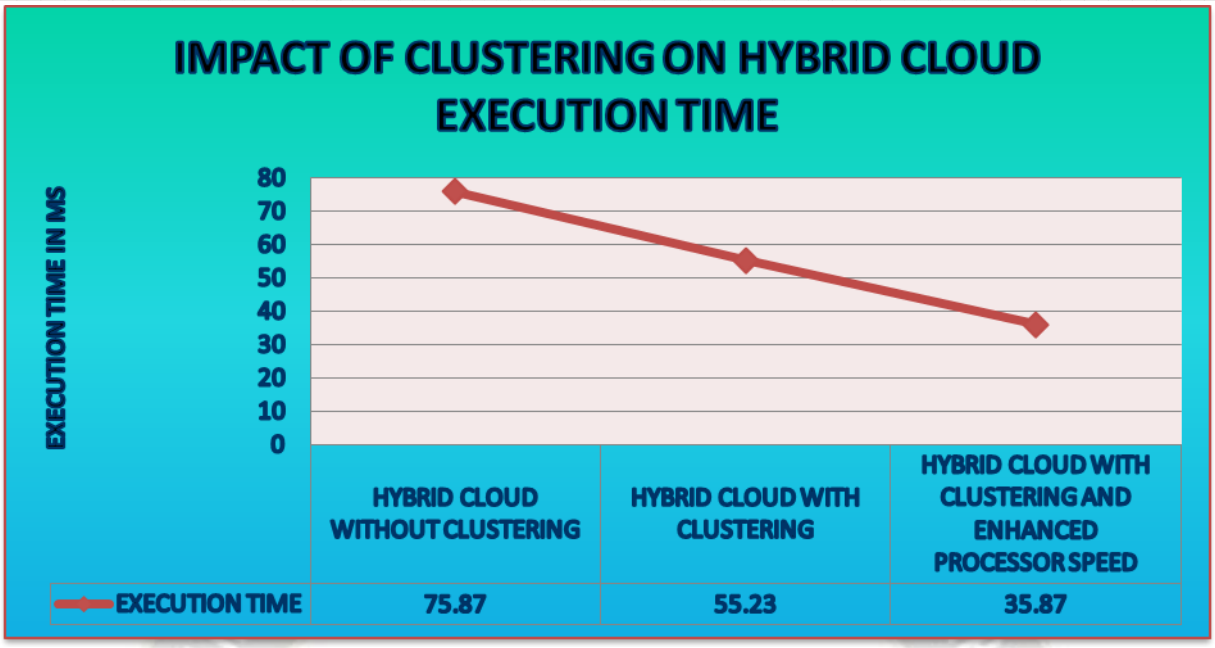

Graph 2: Graph for Clustering Impact on Execution Time in Hybrid Cloud Interoperability

The above graph shows the impact of clustering of hybrid cloud on execution time while implementing interoperability. In first case where the hybrid cloud was modelled without any clustering implemented the execution time was 75.87 MS. When clustering was implemented to hybrid cloud a substantial decrease in execution time was observed which comes out be 55.23 MS. In the last step the processor speed was increased to observe a huge decrease which comes out to be 35.87 MS.

7. Conclusions:

Interoperability issue in cloud environment is very well addressed by using hybrid cloud framework. The hybrid cloud enables interoperability using the security of private clouds and the high accessibility of public clouds. It can be concluded that the clustering the private and public clouds in cloud environment has a immense impact on the interoperability in terms of interoperability time. Thus it can be concluded that when the private and public data centres are clustered, the interoperability time is reduced thereby enhancing the interoperability in hybrid cloud. Further enhancement of interoperability can be done in hybrid cloud by increasing the processor speed of all the data centres in the cloud environment. Thus finally it can be concluded that interoperability issues can be solved using hybrid cloud and further be enhanced by increasing the processor speed of all the data centres in hybrid cloud.

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