Advanced Cloud Resource Consistency Service Using Virtual Migration in Big Data

G. Jeeva, V. Poongodi and Dr.K. Thangadurai

Abstract--- Infrastructure as a Service (IaaS) cloud computing has transform the way we think of acquiring resources by introducing a simple change: allowing users to lease computational resources from the cloud provider's datacenter for a short time by deploying virtual machines (VMs) on these resources. This new model raises new challenges in the design and development of IaaS middleware. One of those challenges is the need to deploy a large number (hundreds oreven thousands) of VM instances simultaneously. Once the VM instances are deployed, another challenge is to simultaneously take a snapping of many resources and transfer them to persistent storage to support management tasks, such as suspend-resume and migration. With datacenters growing rapidly and configurations becoming heterogeneous, it is important to enable efficient concurrent deployment and snapshotting that are at the same time hypervisor independent and ensure a maximum compatibility with different configurations. To intent addresses these challenges by proposing a virtual file system for load balancing algorithm specifically optimized for virtual machine image storage. It is based on a lazy transfer scheme coupled with object versioning that handles data in big data centers transparently in a hypervisor-independent fashion, ensuring high portability for different configurations.

Keywords--- Cloud Infrastructure, Big Data, Load Balancing Algorithm, Virtual System.

G. Jeeva, M.Phil., Research Scholar, Department of Computer Science, Thanthai Hans Roever College, Perambalur. E-mail: jeeva2016123@gmail.com

V. Poongodi, Assistant Professor, Department of Computer Application, Thanthai Hans Roever College, Perambalur.

Dr.K. Thangadurai, Head, PG & Research Dept. of Computer Science, Government Arts College, Karur. Tamil Nadu, India.

I. INTRODUCTION

Distributed computing gathers huge systems of virtualized ICT administrations, for example, equipment assets, (for example, CPU, stockpiling, and system), programming assets, (for example, databases, application servers, and web servers) and applications. In industry these administrations are alluded to as foundation as an administration (IaaS), stage as an administration (PaaS), and programming as an administration (SaaS). Standard ICT powerhouses, for example, Amazon, HP, and IBM are intensely putting resources into the procurement and backing of open cloud framework. Distributed computing is quickly turning into a famous foundation of decision among a wide range of associations. Regardless of some underlying security concerns and specialized issues, an expanding number of associations have moved their applications and administrations into "The Cloud". These applications range from nonspecific word preparing programming to online human services. The cloud framework takes advantage of the preparing force of virtualized PCs toward the back, in this manner altogether accelerating the application for the client, which just pays for the utilized administrations. Enormous Data applications has turned into a typical marvel in area of science, building, and trade. A portion of the delegate applications incorporate debacle administration, high vitality material science, genomics, connectomics, vehicles recreations, restorative imaging, and so forth.

The Outsized level, assorted, and uncertain Big Data submissions are becoming more and more widespread, up till now present obscure reserve provisioning techniques do not balance healthy and nor do they carry out well beneath highly changeable circumstances [information quantity, information assortment, information entrance speed and so on]. A great deal research attempt have been remunerated in the primary sympathetic, knowledge and perceptions connected to autonomic provisioning of cloud supplies for Big Data submissions, to construct cloud hosted Big Data submissions function more professionally, with condensed monetary and ecological expenses, condensed under consumption of possessions and superior presentation on period of changeable workload.

Autonomic Provisioning of Big Data submissions on Cloud system. Subsequent Study's position their focal point on communications height Cloud organization for optimizing big information pour dispensation. Virtualized clouds bring in presentation unpredictability in possessions, in that way impacting the submission's aptitude to get together its Quality of Service (QoS).

This encourages necessitate for autonomic techniques of provisioning expandable possessions as well as self-motivated commission assortment, for unremitting dataflow submissions on clouds. Kumbhare et al. extend unremitting data flows to the perception of "Dynamic Information Flows", which make the most of interchange commission's characterizations and proffer additional control over the data flow's cost and QoS. They celebrate an optimization predicament to computerize both consumption time and runtime cloud reserve provisioning of such self-motivated data a flow that consents to for tradeoffs between the submission's assessment and the reserve asking price. They recommend two greedy heuristics, national and communal, based on the changeable sized Bin Packing Algorithm [BPA] to get to the bottom of this NP-hard predicament. Supplementary, they also in attendance a Genetic Algorithm (GA) meta-heuristic that gives a near most favorable explanation by travel around a wide assortment of promising arrangement.

Suppleness has now turned out to be the rudimentary characteristic of cloud computing as it makes possible the aptitude to energetically append or take away virtual machine examples when workload transforms. On the other hand, effectual virtualized reserve administration is motionless one of the majority demanding errands. When the workload of an overhaul augments quickly, obtainable move towards cannot act in response to the mounting presentation obligation professionally because of moreover imprecision of altered copy conclusions or the unhurried procedure of alterations, both of which may consequence in inadequate reserves provisioning. As an outcome, the QoS of the hosted submissions may humiliate and the overhaul level intention will be thus dishonored. Liu et al. bring in SPRNT, a work of fiction resource administration construction, to make certain far above the ground height QoS in the cloud computing organization.

Load balancing based on processor load. A scheme for centralized utility maximizes process resource usage based on allocation. The authors present an optimal solution under the assumption that the demand of resources can be split over several machines. Their solution has limited applicability in context based multiple resources that need to be allocated on the same machine and the demand for further resources cannot be split on same machines when overloaded. Dynamic VM consolidation has been applied to minimize energy consumption in a data center. They explored the energy benefits obtained by consolidating VMs using migration and found that the overall energy consumption can be significantly reduced. Problem of dynamic VM consolidation proposed a heuristic that minimizes the data center's power consumption, taking into account the VM migration. However, the authors did not apply any algorithm for determining when it is necessary to optimize the VM placement.

Resource allocation for distributed systems are minimizes the migrations over consecutive load control. The study of physical resources and VMs non-stationary and unknown workloads, as observed in Infrastructure as a Service (IaaS) environments, power and performance costs of VM migrations and the large scale of Cloud data center infrastructures. An automated system improves the utilization of server resources, so that reduce the power consumption in virtualization of computing resources. Virtualization brings the hypervisor layer called abstraction layer between an OS and hardware to communicate between VM and PM. Physical resources are sliced into more number of logical slices called Virtual Machines. All Virtual Machine can hold an individual OS created for the users which ensures a view of a dedicated physical resource, so that increases the performance and reduces the failure isolation between VMs sharing with PM. Issue of host overload detection as a part of VM consolidation by dynamic move. Identify which VMs are migrating from an overloaded host for VM consolidation by migrating dynamically which directly improves the resource utilization and Quality of Service delivered to end users.

II. Related Work

Cloud Computing: Methodology, Systems, and Applications, L. Wang,R. Ranjan, J. Chen(2011) workflows demand massive resources from various computing infrastructures to process massive amount of big data.Virtual clusters (VCs) are elastic resources that can dynamically scale up or down. In general, scheduling multitask workflows on any distributed computing resources (including clouds) is an NP-hard problem. The main challenge of dynamic workflow scheduling on virtual clusters lies in how to reduce the scheduling overhead to adapt to the workload dynamics with heavy fluctuations. In a cloud platform, resource profiling and stage simulation on thousands or millions of feasible schedules are often performed, if an optimal solution is demanded.

R. Pepper and J. Garrity, The internet of everything: How the network unleashes the benefits of big data (2015) An optimal workflow schedule on a cloud may take weeks to generate. Proposed the ordinal optimization (OO) method for solving complex problems with a very large solution space. Subsequently, the authors demonstrated that the OO method is effective to generate a soft or suboptimal solution for most of the NP-hard problems. As an example, optimal power flow is an NP-hard problem that was handled by the OO method with some success.

Bringing Big Data to the Enterprise,(2015) Cloud computing is growing rapidly as an extremely successful paradigm offering on-demand infrastructure, platform and software services to end users. Cloud computing, with its on-demand elasticity, and pay-as-you-go model, enables data intensive applications to dynamically provision resources and process large data sets in parallel, which was not economically feasible in a traditional data management systems.

J. Gantz et al., The Digital Universe in 2020: Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East, (2015)cloud inference is the process of mapping a set of control inputs to a set of control outputs through fuzzy logic rules and operations. This mapping provides a basis from which control output can be derived. The key benefit of fuzzy controllers is for types of problems that cannot be represented by explicit mathematical models due to high non-linearity of the system. Instead, the potential of fuzzy logic lies in its capability to approximate that non-linearity by expressing the knowledge in a similar way to the human perception and reasoning. The key benefit of fuzzy controllers is for types of problems that cannot be represented by explicit mathematical models due to high non-linearity of the system.

Tomorrow's Internet Today (2015) lies in its capability to approximate that non-linearity by expressing the knowledge in a similar way to the human perception and reasoning. The explicit knowledge base component is one of the unique aspects of such type of controllers. Instead of sharp switching between modes based on thresholds, control output changes smoothly from different region of behavior depending on the dominant rule. Since our goal is to build a cloud controller to adjust the number of computing machines with regard to the response time and workload, our fuzzy controller is designed based on a model that a set of input signals are mapped on an output control action.

R. Ranjan, “Streaming Big Data Processing in Datacentre Clouds 2014 Today, many sectors of the global economy are guided by data driven decision processes and applications, which have caused the analysis of large amounts of data to become a high priority task for many companies. The expectation is that the knowledge obtained from new large datasets, now readily available, can enhance the efficiency of many industry and service sectors and thus improve the quality of our lives.

L. Wang and R. Ranjan, “Processing distributed internet of things (2015) data in clouds, many big data applications are under development to support data analyses that have resource requirements which exceed the processing capacity of conventional computing systems. The development of massively parallel and scalable systems has therefore raised a considerable amount of interest in both industry and academia. This in turn has exacerbated the many challenges in the areas of performance evaluation, capacity planning, dynamic resource management, and scheduling for large-scale parallel computing environments.

L. M. Vaquero, F. Cuadrado, and M. Ripeanu, “Systems for near real-time analysis of large-scale dynamic graphs(2014) Datacenters are standard IT (Information Technology) platforms, which consume a significant amount of energy to host a wide variety of conventional and emerging workloads, such as web services vs. Map Reduce, featuring different performance requirements and workload characteristics. Typically, web services interact with clients, who require stringent response times and thus real time processing. To guarantee the throughput of large-scale data processing, Map Reduce Hadoop is a simple yet powerful framework to process large amounts of data chunks organized in distributed file systems, Hadoop Distributed File Systems (HDFS).

L.G. Valiant.A bridging model for parallel computation. Commun.(2011)In the past few years, performance modeling and simulation of MapReduce environments has received much attention, and different approaches were offered for predicting performance of MapReduce applications, as well as optimizing resource provisioning in the Cloud. A few MapReduce simulators were introduced for the analysis and exploration of Hadoop cluster configuration and optimized job scheduling decisions. The designers of MRPerf aim to provide a fine-grained simulation of MapReduce setups. We do not simulate details of the Task Trackers (their hard disks or network packet transfers) as done by MRPerf.

K. Shvachko, H. Kuang, S. Radia, and R. Chansler. The hadoop distributed file system 2010With prodigious growth in Web and social network data, more than ever before, it is clear that big data is coming. The big data wave is going to surface new opportunities for enterprises although constitutes series of challenges. The key issues is how to ingest Big Data and convert it to information and knowledge that possesses business value. However, this conversion is not economically viable for small to medium enterprises in a traditional infrastructure setting.

E. Solomonik and L. V. Kale, “Highly scalable parallel sorting,” in Parallel & Distributed Processing (IPDPS), 2010 Internet of Things (IoT), a part of Future Internet, comprises many billions of Internet connected Objects (ICOs)or `things' where things can sense, communicate, compute and potentially actuate as well as have intelligence, multi-modal interfaces, physical/ virtual identities and attributes. The IoT vision has recently given rise to emerging IoT big data applications e.g. smart energy grids, syndromebio surveillance, environmental monitoring, emergency situation awareness, digital agriculture, and smart manufacturing that are capable of producing billions of data stream from geographically distributed data sources.

Wagar, “Hyperquick sort: A fast sorting algorithm for hypercube(2006) Cloud computing is the delivery of computer resources through a Web service interface on anas needed basis. The term “cloud” refers to the organization of the underlying physical infrastructure remaining opaque (not visible) to the end user. In other words, cloud computing gives a user access to computer resources (i.e. machines, storage, operating systems, application development environments, and application programs) Over a network through Web services. The cloud computing will not merely become an enormous data storage, but it can achieve high-performance and high-computing capability.

A. Problem Definition

Automatic provisioning of such big data applications on the cloud platform is challenging since current resource management and scheduling approaches may not be able to scale well, especial under highly dynamic conditions, Large-scale, heterogeneous, and uncertain Big Data applications are becoming increasingly common. Yet current cloud resource provisioning methods do not scale well and nor do they perform well under highly unpredictable conditions (data volume, data variety, data arrival rate, etc). In the past system implementations it is very Complex to maintain the large set of data into server. There are no organized procedures for formatting the data and identifying the data duplication is so difficult. In large cloud computing environments, existing range-aggregate queries are insufficient to quickly provide accurate results in big data environments. The scheduling of multitask jobs on clouds is an NP-hard problem. The problem becomes even worse when complex workflows are executed on large elastic clouds,

- Search Space is large in cloud systems, so there is a complexity of users to search for the exact things in cloud.
- High overhead for generation of optimal schedules in Cloud streams.
- Based on the Workload Complexity, sometimes the server may hang up and it will be released after certain period interval.
- Cannot guarantee for QoS (Quality of Service) while communication between user and server.
- To give an less performance and storage space. Network traffic consumption also very high due to non-concentrating on application status.
- It is not possible to build a scalable, high-performance distributed data-storage service that facilitates data sharing at large scale.

For big data process there is limited scalability. Mining operations are not integrated. For proximity-aware the problem is privacy preserved big data mining operations are not supported.

III. PROPOSED SOLUTION

The proposed presents our steps towards innovative autonomic resource load provisioning and management techniques for supporting SaaS applications hosted on Clouds. Steps towards this goal include (i) development of an autonomic management system and load balancing algorithms for dynamic provisioning of resources based on users' QoS requirements to maximize efficiency while minimizing the cost of services for users and (ii) creation of secure mechanisms to ensure that the resource provisioning system is able to allocate resources only for requests from legitimate users. We present a conceptual model able to achieve the aforementioned goals and present initial results that evidence the advantages of autonomic management of Cloud infrastructures. The current technologies such as grid and cloud computing have all intended to access large amounts of computing power by aggregating resources and offering a single system view. Among these technologies, cloud computing is becoming a powerful architecture to perform large-scale and complex computing, and has revolutionized the way that computing infrastructure is abstracted and used. In addition, an important aim of these technologies is to deliver computing as a solution for tackling big data, such as large-scale, multi-media and high dimensional data sets.

A. *Cloud Resource Consistency Service in Resource Provisioning*

The development of autonomic resource provisioning and management techniques for supporting SaaS applications hosted on Clouds, the following aspects were identified as essential Development of an autonomic management system and algorithms for dynamic provisioning of resources based on users QoS requirements to maximize efficiency while minimizing the cost of services for users.

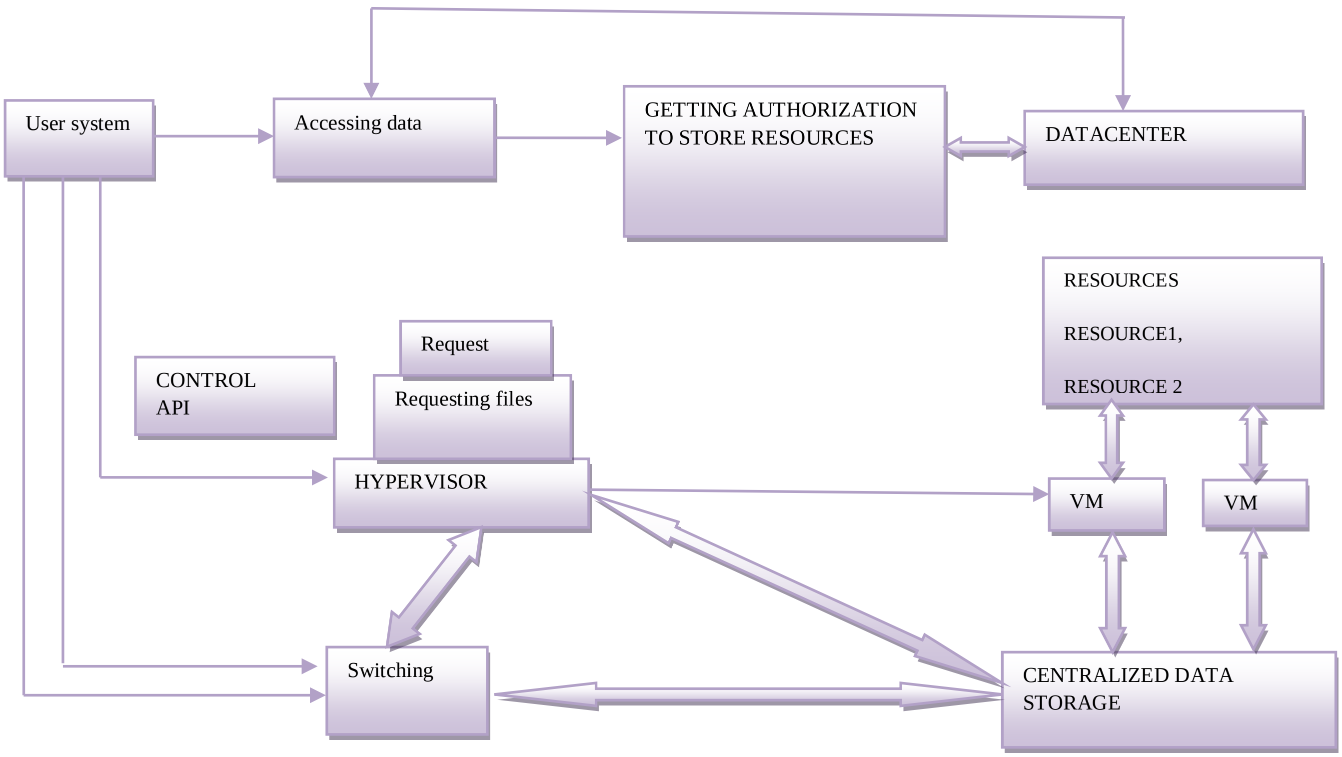

Figure 3.1: Architecture Diagram for Advanced Cloud in Cloud Predictive Model

B. *Application Scheduler*

The scheduler is responsible for assigning each task in an application to resources for execution based on user QoS parameters and the overall cost for the service provider. This scheduler is aware of different types of applications such as independent batch applications (such as Bag of Tasks), web multi-tier applications, and scientific workflows (where tasks have dependencies that have to be managed) executed in Clouds. Depending on the computation and data requirements of each application, it directs the dynamic resource-provisioning component to instantiate or terminates specified number of compute, storage, and network resources while maintaining a queue of tasks to be scheduled. Execution of the application also may require data transfer between Clouds, which is also handled by this component. This logic is embedded as multi-objective application scheduling algorithms. This heuristic-based algorithm focuses on QoS parameters such as response time, cost of service usage, energy consumption, maximum number of resources available per unit price, and penalties for service degradation.

C. *Energy-efficient Scheduler*

One of the main objectives to be optimized during the application scheduling process is energy utilization. Applications need to be scheduled in Resources in such a way that their total energy consumption is minimized. However, the algorithm has to achieve this goal without compromising SLAs and cost. This is a multi-objective optimization problem with conflicting goals. An aspect of this problem that makes it even more challenging is the fact that energy consumption holds a non-linear relationship with cost and performance. Search for a solution for such a challenging and relevant problem is one of the main challenges of this research.

D. Primary Resource Provisioning Algorithms

This component implements the logic for provisioning and managing virtualized resources in private and public Cloud environments based on the resource requirements as directed by the application scheduler. This is achieved by dynamic negotiation with Cloud IaaS providers for the right type of resource for a certain time and cost by taking into account the past execution history of applications and budget availability. The resource-provisioning module is complemented with prediction-based algorithms that rely on market-oriented provisioning practices, for handling any change in spot prices. In particular, these algorithms perform the following tasks:

E. Secondary Resource Allocation

Scaling in/out (expanding/shrinking of resources) will be carried out using an online instantiation mechanism where compute, storage and network services will be leased on the fly. Resources are terminated once they are no longer needed by the system.

F. Prediction for Resource Selection

As the cost of using resources depends on the duration and type of resources provisioned, a prediction mechanism will be implemented that takes into account historic execution statistics of SaaS applications. Based on prediction of time and cost, this component will control the resource plug-in component to allocate either the spot instances or the fixed price instances of IaaS resources. We also plan to conduct resource pricing design based on these predictions. The prediction will be based on the supply and demand for resources, similar to market-oriented principles used for reaching equilibrium state.

- *Security and Attack Detection:* This component implements all the checks to be performed when requests are received in order to evaluate their legitimacy. This prevents the scaling-up of resources to respond to requests created with the intention of causing a Denial of Service or other forms of cyber-attacks. The module must be able to distinguish between authorized access and attacks, and in case of suspicion of attack, it can either decide to drop the request or avoid excessive provision of resources to it. To achieve it, techniques already in use for detection attacks need to be adapted to be able to handle exclusive characteristics of Cloud systems.

The predictive model utilized is based on a sliding window, where parameter variables are adjusted periodically through the comparison of real migrate cases with the prediction results. Such interactive analytics model can be mapped to the workflow in above Figure3.1 .The iterative scheduling algorithm searches the suboptimal solutions aggressively by using information of previous iterations of the workflow execution. As a consequence of the iterative loop, tasks labeled from B to G are re-executed as each new iteration starts, with information related to a different time window being used as tasks input.

Load Prediction Algorithm

```
Algorithm 1 local sort (each process uses one CPU device)
Input: A (unsorted), size A
Output: A (sorted)
 Start :device d ( GetNumDevice()
        d →id ( p id%n and SetDevice(d id)
        if size A and  chunk size then
Memcpy(d A;A)
Sort(d A)
 Memcpy(A; d A)
Else
 This case assumes that size A%cs = 0
 while !(all chunks are sorted) do
          Memcpy(d A;A[i *cs; (i + 1) * cs - 1])
Sort(d A)
          Memcpy(B[i* cs; (i + 1) * cs - 1]; d A)
          i -> i + 1
```

end while

MergeArrays(B;A)

end if ;return A

As each of the iterations completes, the workflow system computes the expected execution time of tasks and the cost of keeping the current amount of resources for execution. If changes in the number of available resources can lead to substantial improvement in either make span or cost, the number of provisioned resources is scaled up or down. This enables the system to fine-tune and adapt the provisioning and scheduling according to the characteristics of the workflow tasks and the execution environments. Following Figure presents the results of variation of number of resources provisioned by the workflow engine in different iterations of the execution of the prediction model. After collecting information about the actual execution time of the tasks at the first iteration, the number of provisioned resources was corrected so that the tasks were consolidated in fewer Cloud resources. Further corrections where applied between iterations 2 and 3. Overall, the autonomic iterative optimization feature of the workflow engine enabled a reduction of execution time of 48% and reduction of cost of public Cloud utilization in 70% compared to a greedy solution for provisioning and scheduling of workflow applications in Clouds.

IV. RESULT AND DISCUSSION

The processing time required to extract the data, model it, and interpolate for visualization is about 30 minutes in total for processing 1-day data set on a workstation with an Intel dual core 2.93GHz CPU and 4GB of memory. Moreover, in order to be of practical value in the case of dengue outbreak, the system must be able to dynamically allocate resources and optimize the application performance on Cloud infrastructures (private, public, or hybrid Clouds) to reduce the processing time and enable real-time spatial and temporal analysis with shorter turnaround time.

The autonomic adaptive workflow engine design allows the system to select the most suitable resources according to the user requirements (e.g., update frequency, cost, etc), schedule the privacy-sensitive data in private resources, and tolerate faults when failure happens.

Provisioning of Cloud resources and scheduling of workflow tasks are automatically performed based on a budget constraint, and the system schedules tasks to resources that can optimize the performance in terms of the total execution time while satisfying eventual budget requirements for application execution.

The proposed dynamic data distribution on demand service in cloud datacenters using virtual resources approach has been implemented and tested for its efficiency and accuracy. The method has shaped good consequences on constraint accuracy and has produced well-organized results with less period complexity.

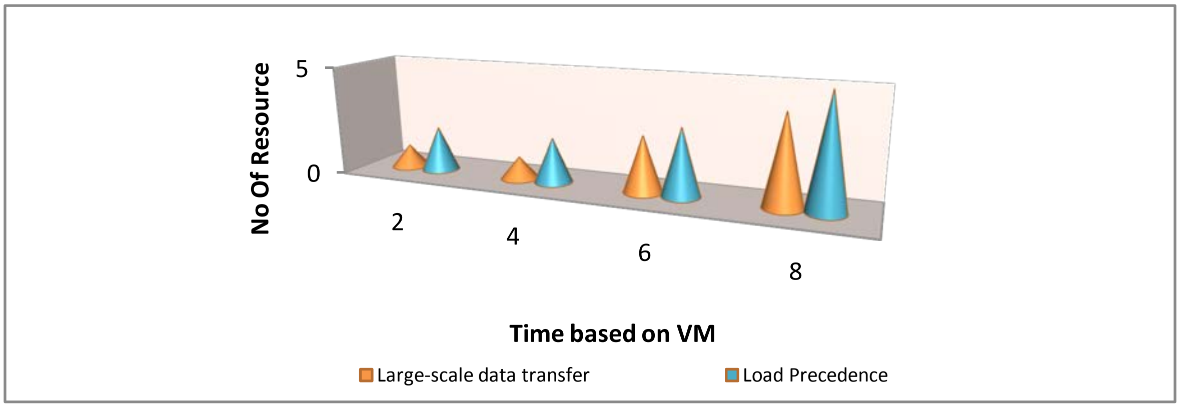

Figure 4.1: Time Response on VM

Figure 4.1 shows the server virtualization of resources in the server itself are hidden, or masked, from users, and VM is used to divide the physical server into multiple virtual environments, produce higher performance ratio on time sharing.

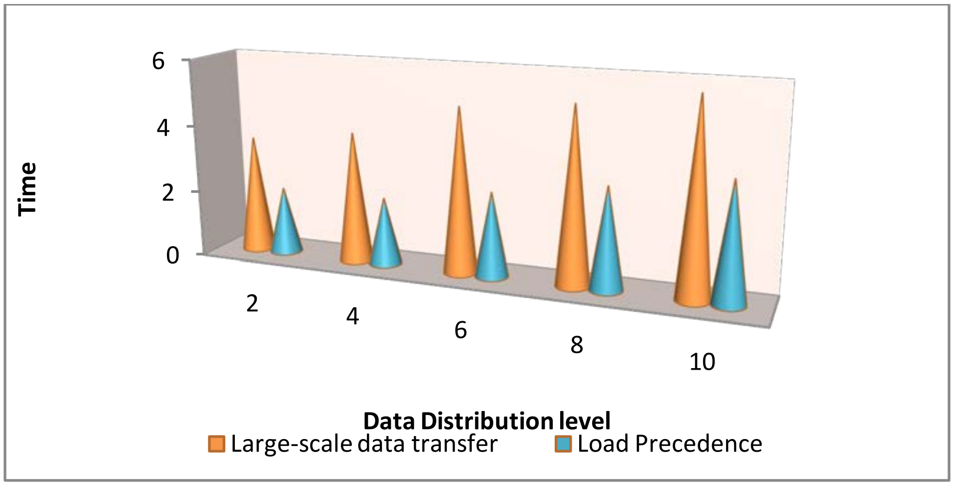

Figure 4.2: Average Data Distribution

Figure 4.2 shows the VMs is randomly chosen to be the master and the others become slaves of the application. The highest-priority of visualization queue and can preempt data in other queues based on selection of cloud data providers Server virtualization is the partitioning of a physical server into smaller virtual servers to help maximize your server resources.

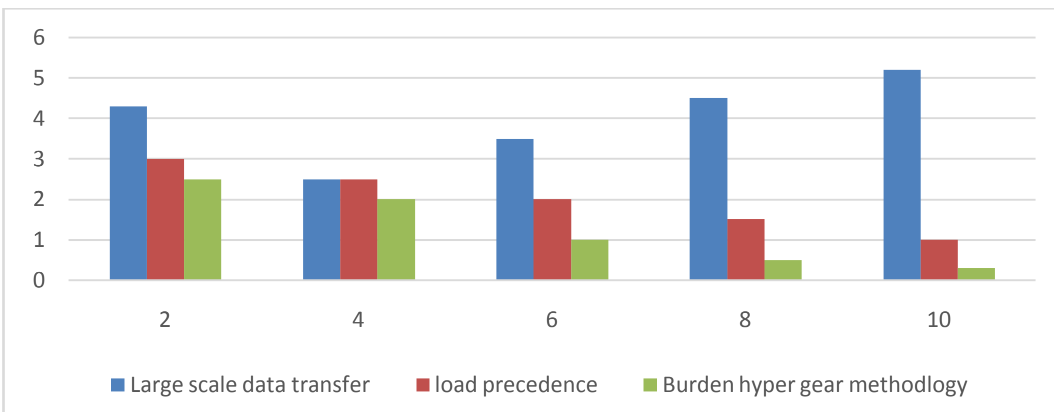

Figure 4.3: Comparison of Scheduling Process

Figure 4.3 shows the scheduling cloud resource that Reduce applications run out-of-the-box in an environment where cloud as a storage backend, just like in the original, unmodified environment of cloud service.

V. CONCLUSION

A big data provisioning facility has remained obtainable that combines hierarchical then peer-to-peer data delivery techniques to speed up data loading into the VM is used for data dispensation. The technique is founded on an adapted VM is dynamically arranged by the multilevel priority scheduling combines the features of the maximum precedence algorithm that adapting distribute the data to make it send periodic data. These algorithms increase a high processing overhead and long end-to-end data transmission delay due to the starvation of high priority real-time data packets due to the transmission of a large data packet in non-preemptive priority scheduling, and improper allocation of data packets to queues in multilevel distribution data.

REFERENCES

[1] L. Wang, R. Ranjan, J. Chen and B. Benatallah Eds, "Boca Raton, FL Cloud Computing: Methodology, Systems, and Applications", CRC Press, 2011.

[2] R. Pepper and J. Garrity, "The internet of everything: How the network unleashes the benefits of big data", CISCO [Online].Available: http://blogs.cisco.com/wp-content/uploads/GITR-2014-Cisco-Chapter.pdf, 2015.

[3] Bringing Big Data to the Enterprise, IBM [Online]. http://www-01.ibm.com/software/in/data/bigdata/, 2015.

[4] J. Gantz and D. Reinsel, "The digital universe in 2020: Big data, bigger digital shadows, and biggest growth in the far east", IDC iView: IDC Analyze the future, Pp. 1-16, 2007.

[5] Tomorrow's Internet Today, CISCO. Available: http://www.cisco.com/c/dam/en/us/products/collateral/routers/asr-9000-series-aggregation-services-routers/brochure_tomorrows_internet_today.pdf, 2015.

[6] R. Ranjan, "Streaming Big Data Processing in Datacentre Clouds", IEEE Cloud Computing, BlueSkies Column, Vol. 1, No. 1, Pp. 78–83, 2014.

[7] L. Wang and R. Ranjan, "Processing distributed internet of thingsdata in clouds", IEEE Cloud Computing, BlueSkies Column, Vol. 2, No. 1, Pp. 76–80, 2015.

[8] L. M. Vaquero, F. Cuadrado and M. Ripeanu, "Systems for near real-time analysis of large-scale dynamic graphs", arXiv preprint arXiv:1410.1903, 2014.

[9] L.G. Valiant, "A bridging model for parallel computation", ACM, Vol. 33, No. 8, 2011.

[10] K. Shvachko, H. Kuang, S. Radia and R. Chansler. "The hadoop distributed file system", IEEE 26th symposium on mass storage systems and technologies (MSST), Pp. 1-10, 2010.

[11] K.E. Batcher, "Sorting networks and their applications", Spring joint computer conference, Pp. 307–314, 1968.

[12] H. Shi and J. Schaeffer, "Parallel sorting by regular sampling", Journal of Parallel and Distributed Computing, Vol. 14, No. 4, Pp. 361–372, 1992.

[13] D.R. Cheng, V.B. Shah, J.R. Gilbert and A. Edelman, "A novel parallel sorting algorithm for contemporary architectures", ALENEX, 2006.

[14] E. Solomonik and L.V. Kale, "Highly scalable parallel sorting", International Symposium on Parallel & Distributed Processing (IPDPS), Pp. 1–12, 2010.

[15] B. Wagar, "Hyper quicksort: A fast sorting algorithm for hypercube", Hypercube Multiprocessors, Pp. 292–299, 2006.