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A Simulation Based Analysis and Classification of Workload For Resource Allocation

Chethan N[1] , Mrs.Pushpalatha R [2] and Dr.Ramesh Boraiah[3]

[1,2]Department of Computer Science and Engineering, VTU PG Centre, Mysuru, Karnataka, India.

[3]Department of Computer Science and Engineering, Malnad college of engineering, Hassan, India.

ABSTRACT

Cloud computing is changing our lives in many ways. Cloud computing offers high scalability, flexibility and cost-effectiveness to meet emerging computing requirements. User who is going to adopt cloud computing services will certainly expect the kind of improved performance compared to other cloud computing environment. There are several factors available to improve the performance in cloud. Workload can be considered as one of the key factor to achieve high performance in Cloud. Classifying the workload would be a good solution to improve the performance. Analysing different characteristics of workload and classifying them within a Cloud computing environment is critical. As there is lack of support for analysis and classify the workload for various reasons like insufficient availability of real-world datacenter tracelogs, complexity in analysing workloads and virtualization layer overhead. These elements adds lack of methodologies to analyse different characteristics of workload in cloud. To tackle the above issues, we propose a simulation model, to capture the behavioural patterns of different user profiles and to support analysis and classification of workload for resources utilization in cloud environments. This paper presents a novel approach for characterizing workloads in the context of both user and task in order to derive a model to capture resource estimation and utilization patterns. The proposed model is implemented as an by extension of the CloudSim simulator.

KEYWORDS: *Cloud Computing, Workload Classification ,Workload Analysis, Characterization of Workload ,Cloud trace.*

1. INTRODUCTION:

Cloud computing refers to applications and services offered over the Internet. User can access your data from a smartphone, a tablet, a laptop or a desktop wherever you have an Internet connection. Examples of cloud computing include online backup services, social networking services, and personal data services such as Apple's Mobile_Me. Dropbox: One of the most popular options, this service lets you share files and photos . Cloud computing is being driven by providers including Google, Amazon.com, and Yahoo. Cloud service can adopted by all kinds of users, be they individuals or large enterprises. Cloud computing provides several benefits such as dynamic scalability, rapid elasticity and pay per use feature.

Virtualization technology has become fundamental in modern computing environments such as cloud computing[10]. By running multiple virtual machines on the same hardware, virtualization allows us to achieve a high utilization of the available hardware resources. Moreover, virtualization brings advantages in security, reliability, scalability and resource management.

Workload is defined as:" The amount of work performed by an entity in a given period of time ". The amount of work handled by an entity gives an estimate of the efficiency and performance of that entity. In computer science, the term workload refers to computer systems ability to handle and process work. Running a web server or a web server farm, or being a Hadoop data node - these are all valid workloads. table 1 will give some of the common workload in cloud computing environment.

Workload	**Description and Examples**
Server Centric Web sites	Freely available web sites for social networking, informational web sites large number of users
Enterprise software	Email servers, SAP, enterprise content management
Online financial services	Online banking, insurance
Storage and backup services	General data storage and backup
E-commerce	Retail shopping

table 1:Common Workloads in Cloud Computing

Workload in cloud comprises of two components: tasks and users. Tasks are defined as the fundamental unit of computation assigned or performed in the Cloud and User is defined as the actor responsible for creating and configuring the volume of tasks to be processed. The workload comprises of a set of tasks, where every task belongs to a single job. A job may have multiple tasks. In order to better understand and describe tasks and improve the ability of Cloud, the analyzing of tasks is essential. The aim of workload analysis is to look at different aspects or characteristics of an enterprise application to determine the feasibility of moving the application in the Cloud. Even though there is a growing need for universal accessibility of real-data centre tracelogs , but still such data is not easily available. There might be several reasons for it, such as confidentiality of organizations data, confidentiality of client's data and organizational policies.

CloudSim is a simulation tool that allows cloud developers to test the performance of their provisioning policies in a repeatable and controllable environment[17]. CloudSim is a library for the simulation of cloud scenarios. It provides essential classes for describing data centers, computational resources, virtual machines, applications, users, and policies for the management of various parts of the system such as scheduling and provisioning. Using these components, it is easy to evaluate new strategies governing the use of clouds, while considering policies, scheduling algorithms, load balancing policies, etc. It is flexible enough to be used as a library that allows cloud developers to add a desired scenario by writing a Java program. By using CloudSim, organizations, R&D centers and industry-based developers can test the performance of a newly developed application in a controlled and easy to set-up environment.

1.1 Available Cloud Tracelogs:

The workload can be either the synthetic or genuine workload. The synthetic workloads are valuable to carry out the controlled experiment. For performance evaluation of complex multitier applications, the synthetic workload generation methods are required for example, in Banking, E-Commerce, Business deployed in the cloud computing environments. The important is that, the produced workload called synthetic workload should maintain the same attributes and behaviour of genuine workload [14]. At the present, there are a limited number of certifiable Cloud computing tracelogs are accessible This is generally because of the business and confidentiality concerns of users and providers in commercial Clouds. The cloud vendors that has provided dataset from their Cloud computing clusters are GOOGLE, YAHOO, PlanetLab etc . As of late, Google has contributed by contributed two versions of tracelogs from their Hadoop MapReduce clusters[11]. Yahoo! which was made accessible for selected universities from their M45 Hadoop cluster.

The paper is organized as follows: Section II provides an insight into the related work. Section III and IV present the existing and proposed systems respectively. Section V presents the Simulation setup and configurations. Results are presented in Section VI. Finally, Conclusion and Future Work are given in Section VII.

2. RELATED WORK:

A substantial amount of research has been devoted to the problem of analysis and classification of workload in cloud computing environment. In this section, the most relevant approaches are described, their limitations and gaps are also discussed.

Mishra, et al. [1] describe an approach to construct Cloud computing workload classifications based on task resource consumption patterns. It is applied to the first version of Google tracelogs . The proposed approach identifies the workload characteristics, constructs the task classification, identifies the qualitative boundaries of each cluster, and then reduces the number of clusters by merging adjacent clusters. The approach presented is useful to create the classification of tasks. However it does not perform intra-cluster analysis to derive a detailed workload model. Finally, it is entirely focused on task modeling, neglecting the user patterns which are as important as the tasks in the overall workload model.

Aggarwal et al. [5] describe an approach to characterize Hadoop jobs. The analysis is performed on a data set spanning 24 hours from one of Yahoo!'s production clusters. This data set features metric generated by the Hadoop framework. The main objective of this work is to group jobs with similar characteristics using clustering to analyze the resulting centroids. This work only focuses on the usage of the storage system, neglecting other critical resources such as CPU , Memory , Disk space and network.

Xiaoyang et al[8]. In this paper, diverse sort of analysis such as coarse-grained analysis, cluster analysis and inner-cluster analysis were used to analyze task as well as task modeling. For analysis of workload they have utilized dataset from the second version of the Google MapReduce Cloud tracelog that features traces from over 12,000 servers over period of a month , which provides the normalized CPU, Memory and disk utilization per task in a timestamp every 5 minutes. Additionally, they have chosen CPU and Memory utilization attributes as dimensions of task model and compared it. And they have used k value of k-means clustering and some proper attributes can improve the accuracy of model. The experiment was done using MATLAB.

Solis et al. [11] provides an approach for characterizing Cloud workload based on user and task patterns using the second version of the Google tracelog. It presents coarse-grain statistical properties of the tracelog. This work has a number of limitations; the analysis performed is confined to only 2 days as opposed to the entire tracelog time span. Also, the cluster analysis and intra-cluster analysis do not contain sufficient detail to quantify the diversity of workload, instead presenting high-level observations. Finally, the validation of the simulated model against that of the empirical data is based only on a visual match of the patterns from one single execution, and does not consider more rigorous statistical techniques.

Kuvulya et al. [12] present a statistical analysis of MapReduce traces. The analysis is based on 10 months of MapReduce from the yahoo M45 supercomputing cluster . Here, the authors present a set of coarse-grain statistical characteristics of the data related to resource utilization, source of failures, and job patterns. This work provides a detailed description of job completion times, but only provides very general information about the resource consumption and user behavioural patterns.

Sudha Pelluri et al[14] In this paper the real workload characteristics are used to generate the synthetic workload such that, the generated workload has similar characteristics and behavior as the real workload. The characteristic of real workload has been analyzed in IBM SPSS. The analyzed result was placed in the VMware workstation with Faban running on it.They have been able to generate synthetic workload which we are going to use in resource provisioning , load balancing energy management and other related research problems.

Rasheduzzaman et al.[15] This paper presents task shape and workload characterization of Google's compute cluster. The methodology for workload characterization consists of: (1) presenting the state of transitions of different job and how they are scheduled, failed, finished, and killed, (2)analyzing resource requests of memory, disk space and CPU-core using statistical tool, (3) showing the behaviour of different task type using cumulative distribution function, and (4) identifying the common job groups from resource usage table by using bisecting k-means algorithm. The results of clustering analysis show that the largest clusters are very short time low memory core active jobs , while the smallest clusters are very long active jobs. This means that cluster management system do not need to keep inactive jobs in memory.

From the study of the related work it is clear that there are few available production tracelogs to analyze workload patterns in Cloud environments. By analysing these related work, we can identify the gaps that need to be addressed in order to achieve more realistic workload patterns. The analysis need to be other than croase-grain statics and cluster analysis. The workload is driven not only by task characteristics but also include the user behavioral patterns.

3. Problem statement and motivation:

Workload analysis and characterization problems have been addressed over the last years, resulting in models for generation of synthetic workloads similar to those observed on real systems .

3.1 Challenges in Analysis and Classification of Workload:

Analysis and classification of workload is especially challenging when applied in a highly dynamic environment such as cloud computing environment for various reasons[9]:

1. Only limited genuine cloud tracelogs available for analysis. This is Due to business and confidentiality reasons.
2. Due to the massive size and complexity of workload, in-depth statistical analysis and classification of workloasd, within a large-scale production Cloud is complex.
3. There is a lack of methodologies to characterize the workload, due to behavioural patterns of workload in cloud computing environment.

3.2 Significance of Workload Classification in Cloud:

Classification of workload in cloud computing environment benefits both cloud suppliers and researchers, as it enables a more in-depth understanding of the entire system as well as offering a practical way to improve data center functionality.

- Cloud suppliers can enhance the resource management mechanisms to effectively improve the productivity and maintain Quality of Service of their systems. For example, identifying the heterogeneity of task to reduce performance interference of physical servers or analyzing the correlation of failures to resource consumption.
- For researchers, simulation of Cloud workload enables evaluation of theoretical mechanisms supported by the characteristics of Cloud data centers. Nowadays, simulation-based approaches become popular in industry and academy to evaluate cloud computing systems, application behaviours and their security, the evaluation of these policies without deployment and execution of the applications in expensive large-scale environments.

Advantages of Workload Classification:

- Different patterns of Workload can be identified like different attribute, constraints etc.
- Understanding the different characteristics of workload, leads to better resources management, so that performance is improved.
- Workload can be analyzed at the group level, rather than at the individual server level.

4. METHODOLOGY:

Although previously approaches offer some insights about workload characteristics, they do not provide a structured model which can be used for conducting simulations. The approaches, previously described completely focus on tasks, neglecting the impact of user behaviour. The workload is always driven by the users, therefore realistic workload models must include both user behavioural patterns and tasks characteristics. Only some of the workload characteristics like cpu, memory, network were considered.

The proposed system, it aims to provide a validated simulation model that includes parameters of tasks and users. It used the data from the Planetlab trace log. The proposed model is implemented as an by extension of the CloudSim simulator.

4.1 Proposed system architecture:

The proposed methodology ,begins with creation of cloud environment like creating Datacenters, Brokers, Accessing tracelogs. After accessing the tracelogs, the required resources are predicted and classification of workload is performed. Here we are using the Planetlab tracelogs as dataset. Cluster analysis is the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups. Here, tasks with similar resource consumption are grouped together and required resources are allocated to complete the process. Finally performance model like time taken to complete the process is shown in chart. figure 1: proposed system architecture

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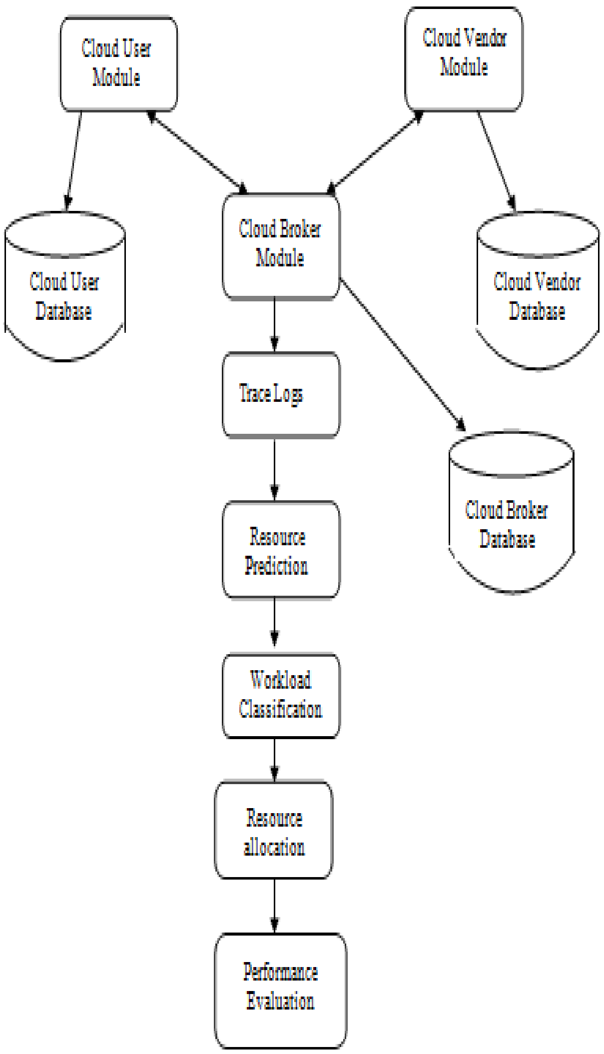

figure 1: proposed system architecture

4.2 Parameters estimation:

As mentioned earlier workload in cloud comprises of two components: tasks and users[1].

Users are responsible for driving the volume and behaviour of tasks based on the amount of resources requested for their execution. Therefore, three important characteristics that will refer to as dimensions are fundamental to describe the users shape: the submission rate (α), Memory (ϕ) and the estimation ratios for CPU (β).

Tasks are defined by the type and amount of work dictated by users, resulting in different duration and resource utilization patterns. Consequently, essential dimensions to describe tasks are: Memory (π), length (χ) and average resource utilization for CPU (Υ) .

The Cloud workload can be described as a set of users with profiles U submitting tasks classified in profiles T, where each user profile u_i is defined by the probability functions of α β and ϕ, and each task profile t_i by χ , Υ and π determined from the tracelog analysis. The model components are formalized as below:

K-means clustering algorithm follows the partitioned clustering approach. It involves the partitioning of given data set into the particular number of groups called clusters. Each cluster is associated with a center point called centroid. Each cluster point is assigned to a cluster with the closest centroid.

4.3 Modules:

There are 5 modules present in the proposed system,

- **Cloud Environment Generator:** In this, we create the cloud environment parameters such as creation of Datacenters, Brokers, Hosts, VM's, Cloudlets .
- **Cloud User Model:** The cloud users will consider the file storage process in the cloud vendors.
- **Analysis and workload classification:** The analysis of user and task characteristics within the tracelog and classify the workload based on threshold value.
- **Clustering and resource allocation**: Here, cluster the workload as low loaded and high loaded workload. By clustering we can group the wotkload instances, based on

similar resource consumption. After that the required resources are allocated.

- **Performance Evaluation: By** plotting charts, time efficiency for classifying and allocating resource can be found.

4.4 Simulation:

In order to characterize and analyze the workload of similar large-scale Cloud data centers under a projected set of operating conditions, we implemented the task and user model parameters as an extension to the CloudSim framework. CloudSim is a Java based framework that enables the simulation of complete Cloud Computing environments.

NetBeans is used to develop the application which is simulated in the CloudSim simulator. 20 data centers, 25 data centre brokers and 40 virtual machines were created. The virtual machines are then allocated to the brokers, and 40 jobs or cloudlets were provisioned to these brokers. The workload is classified as Low and High workload. Finally, the resources are collected and clustering is performed to allocate the required resources.

4.5 Result :

The following results were obtained after the simulation. Figure 2 shows the graph obtained after simulation. It shows the time taken to execute the proposed system and percentage of cpu utilization.

Figure 3 shows the percentage of workload on VM.

Conclusion and Future Work:

This paper presents an examination that quantifies the diversity of Cloud workloads and derives a workload model from a large-scale construction Cloud datacenter. The obtainable examination and model captures the distinctiveness and behavioral patterns of user and task . The derivative model is implemented by means of the CloudSim construction and comprehensively validated during empirical comparison and statistical tests.

Future research includes extending the model to include tasks constraints based on server characteristics; this will allows us to analyze the impact of hardware heterogeneity on workload behaviour. Other extensions include analyzing the workload from the jobs perspective specifically modelling the behaviour and relationship of users and submitted jobs, analyzing workload energy consumption.

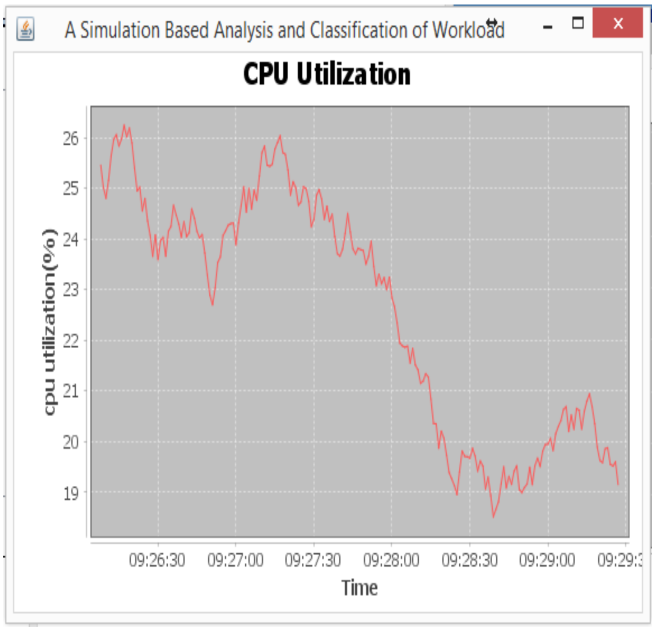

figure 2: percentage of cpu utilization

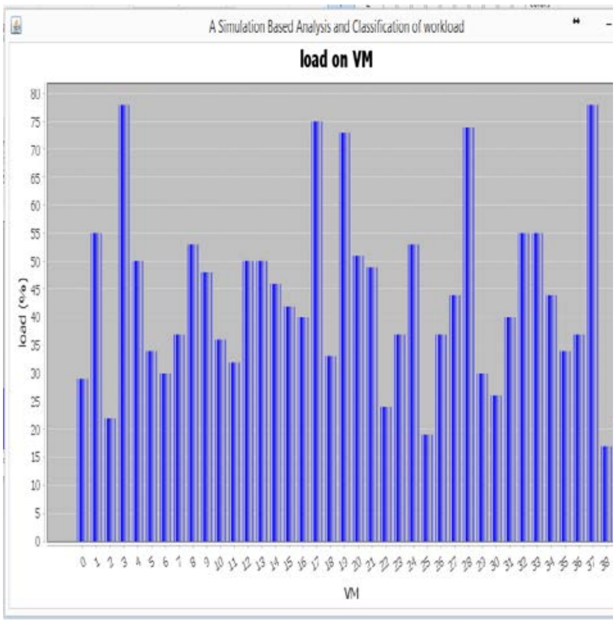

figure 3: percentage of workload on VM

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