Fair Allocation of Multi-Resources for Multi-Class Users in Cloud Computing

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***Abstract*—Cloud computing is an on-demand growing technology. As we know the nature of cloud is heterogeneous and because of heterogeneous nature of cloud, it becomes very difficult to allocate resources to virtual machines. Using virtualization in cloud computing there is a disruptive change in satisfying the user quality of service (QoS).In this paper we have introduced a fairness function to solve the problem of multi-resource allocation (both physical and cloud) for multi-class users.**

***Keywords:Cloudcomputing,fairness,resourceallocation,heterogeneous system*.**

I. INTRODUCTION

We consider the problem of multi-resource (both physical and cloud resources) allocation for multi-class users in heterogeneous cloud system. In cloud computing, virtualization plays a vital role in satisfying the users QoS requirements. But there are two important unresolved challengesremains:(1) Isolation and (2) dynamic re allocation of multi-resource(physical and cloud resources)[2]. Isolation ensures greater performance for some users groups and applications and dynamic reallocation of resources according to requirements of users and network traffic. In heterogeneous system some users may access different types of resources using different resources such as 3G, 4G or Wi-Fi etc. while some other users are accessed limited resources that cannot satisfy their QoS requirement[2][3], e.g. large-scale cloud.

A new system called Pisces proposed by David sue et.al[10], to cloud storage that support multi-tenancy .This system have achieved better fairness and isolation performance in a shared key value per tenant. When the demand and contend of cloud resources increased, this system perform better than other with fairness approximate 0.99 which is greater than such as Min-Max.

II. RELATED WORK

In [4], R.Jain et al. introduced a fairness function called *Index of fairness,* aquantitative measure that is applicable to any resource allocation problem the properties of this function are: population size independent, scale and metric independent, bounded and continuity. They divided the question of fairness in to two parts, In first the needs to select a allocation metric which depends upon application and users needs and in another define a quantitative formula for allocation.

In [2], E.Patouni et al. proposed H-fairness function (*Hf*) for fair allocation of cloud and physical resources for multi-class users. This H-fairness function extends the classical definition of Fairness Index given by R.jain[4].

In[5], F.Wuhib et al. considered solution to the jointly allocating compute and network resources in large-scale clouds e.g. IaaS (Infrastructure as a service) cloud. They formulates optimal resource allocation problem to virtual data centers (VDC) with four main management objectives: balanced load, energy efficiency, fair allocation, service discrimination. In this paper they maximize the aggregate reservation of CPU and Memory of the virtual machines and resources are fairly shared among the virtual machines of users.

In[6], Wei Wang et al. designed a multi-resource allocation mechanism, called DRFH(dominant resource fairness in heterogeneous servers) and also designed a Best-Fit heuristic that implements DRFH in real world. Using DRFH mechanism, no user prefers the allocation of other user and cannot improve own allocation without decreasing the other users allocation. DRFH mechanism used weak sharing incentive that requires allocation of resource better off than one equal partition.

In[7], Han Zhao et al. proposed a multi agent based technique for efficient and fair resource trading in community-based cloud computing. This multi agent technique allows users of a community to reach an efficient and fair resource allocation. The aim of this technique is to find relationship and interaction between the users and to allocate resources in an optimal way with a novel directed hyper graph model. This model capturedthe impact of trading selection decisions effectively.

In[8], Weidong Li et al. introduced LMMDS (lexicographically max-min dominant share) fair allocation mechanism that is the generalization of DRF (dominant resource fairness) mechanism. This mechanism provides solution for the multi-resource allocation with bounded number of tasks in a single server cloud computing environment. This LMMDS satisfies all the fairness properties i.e. sharing incentive, group strategy-proofness, envy-freeness and pareto efficiency.

In [9], Ali Godis et al. proposed DRF(dominant resource fairness), which is the generalized form of Max-Min fairness to various type of resources. DRF satisfies all the important properties such as envy free, pareto

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efficiency, strategy proof and the same performance to all users when resources are equally distributed to all users.

In [11], G.Wei et al. proposed a game theoretical method for fair resource allocation in cloud environment. Using this method they have solved the problem of sophisticated parallel computing. This method consider two steps: in the first step the problem is solved by participants in optimal way independently and independent optimization is solved by a method called BIP(Binary Integer Programming). In next step, efficiency loss is minimized using an evolutionary technique.

III. PROPOSED APPROACH

The main contribution of our work is the definition of the *M-fairness function* (fairness of multi-resource for multi-users), for calculating fairness in multi-resource (both physical and cloud resources) allocation among multi-class users based on their requirements i.e. number of users task.

The proposed definition of fairness Index given by R.Jain [4], is:

$$f = \frac{\sum_{r=1}^{R} Ra_r}{R \sum_{r=1}^{R} {Ra_r}^2}$$

Where i is the resource allocation to user r=1,……,R.

And the fairness metric in[2] is given below:

$$Hf = \frac{\sum_{m=1}^{M} \quad \sum_{n=1}^{N} \quad \sum_{r=1}^{R} Ra_{nmr}}{N * R \sum_{m=1}^{M} \quad \sum_{n=1}^{N} \quad \sum_{r=1}^{R} Ra^2{}_{nmr}}$$

Where, M is the number of user class, N is the users in class m, R is available resource type and Ra_r is the allocation of r type resource to the nth user of class m.

We define the metric *Mf*, which extends *Hf*to multi-class users with number of a user tasks and resource types, as follows:

$$Mf = \frac{\sum_{m=1}^{M} \quad \sum_{n=1}^{N} \quad \sum_{t=1}^{T} \quad \sum_{r=1}^{R} Ra_{tnmr}}{N * R * T \sum_{m=1}^{M} \quad \sum_{n=1}^{N} \sum_{t=1}^{T} \quad \sum_{r=1}^{R} Ra^2{}_{tnmr}}$$

Where M is the number of user class, N is the users in class m, R is available resource type, T is the number of tasks of a user t and Ra_{tr} is the allocation of r type resource to the nth user of class m with task t.

The value of *Mf*lies between [0,1]. *Mf*=1 means totally fair and *Mf*=0 means unfair i.e. greater the value of function, the fairer the allocation. A service provider can use this fairness function to calculate the equality of the overall physical and virtual resource allocation to the multi-user in cloud environment. This measurement is very important in cloud environment for scheduling of user task and to prioritized resources for allocation to the cloud users.

To allocate resources to the users following steps are required,

(i) first, set a threshold value of *Mf*, then calculate Mf and compare it with threshold value.

(ii) if *Mf* ≥ threshold value, then allocate resources to the user.

(iii) Otherwise, resource reallocation action triggered, based on users task and users class and with the availability of resource types.

IV. CONCLUSION

In this paper, we study a multi-resource allocation problem in multi-user cloud computing system. Theproposed *Mf*fairness metric is very useful in cloud computing environment for scheduling and controlling the resource allocation to the multi-class users according to their number of tasks.

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