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# Job scheduling algorithm based on Berger model in cloud environment

Baomin Xu [a,*], Chunyan Zhao [b], Enzhao Hu [a], Bin Hu [c,d]

[a] School of Computer and Information Technology, Beijing Jiaotong University, Beijing 100044, China
[b] National Meteorological Information Center, China Meteorological Administration, Beijing 100081, China
[c] Department of Computing, Birmingham City University, Galton Building, Perry Barr, Birmingham B42 2SU, UK
[d] School of Information Science and Engineering, Lanzhou University, No. 222 Tianshui South Road, Lanzhou, Gansu 730000, China

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ABSTRACT

Considered the commercialization and the virtualization characteristics of cloud computing, the paper proposed for the first time an algorithm of job scheduling based on Berger model. In the job scheduling process, the algorithm establishes dual fairness constraint. The first constraint is to classify user tasks by QoS preferences, and establish the general expectation function in accordance with the classification of tasks to restrain the fairness of the resources in selection process. The second constraint is to define resource fairness justice function to judge the fairness of the resources allocation. We have expanded simulation platform CloudSim, and have implemented the job scheduling algorithm proposed in this paper. The experimental results show that the algorithm can effectively execute the user tasks and manifests better fairness.



## 1. Introduction

Cloud computing is the development of grid computing, parallel computing and distributed computing. It is a new pattern of business computing. Compared with grid computing, cloud computing has some new features, such as (1) grid computing is in general the integration of fragmented, heterogeneous distribution resources; cloud computing is the large-scale data center resources which are more concentrated. In addition, virtualization technology hides the heterogeneity of the resources in cloud computing, (2) grid is generally used in science computation, and for solving special-purpose domain problem; cloud computing is user-oriented design which provides varied services to meet the needs of different users. It is more commercialized, and (3) the resources in cloud computing are packed into virtual resources by using virtualization technology. This causes its resource allocation process, the interaction with user tasks and so on are different with grid computation.

The basic mechanism of cloud computing is to dispatch the computing tasks to resource pooling which constitutes by massive computers. It enables a variety of applications to gain computing power, storage and a variety of software services according to their needs [1,8]. The commercialization and the virtualization technology adopted by cloud computing has poured into new features for cloud architecture. For example, it leaves the job scheduling complexity of cloud computing to the virtual machine layer through resource virtualization. Further, it raised a number of new features for job scheduling, such as cloud computing needs pay more attention to the fairness of resources allocation.

The paper, from the fairness point of view, for the first time proposed and implemented the algorithm of job scheduling based on Berger model in cloud computing.

The paper is organized as follows: Section 2 gives related work. Section 3 gives some background knowledge. Section 4 gives detailed description of the algorithm of job scheduling based on Berger model. Section 5 describes the simulation experiment and experimental results. Section 6 gives the conclusions.

## 2. Related work

The relations between resource supply and demand in distributed system are similarities with commodity economy model. The resources provider is equal to the commodity supplier, and it provides a variety of resources for user. The resources users are equivalent to the commodity buyers. Users need to pay a fee in order to achieve the demands of their resources. The basic philosophy of the job scheduling algorithm based on economic models is to establish market mechanisms between resource providers and resource consumers. It uses price lever to adjust user needs and resource distribution.

The research on how to apply economic theory to resource distribution of distributed system can be traced back to an auction

* Corresponding author.
*E-mail address:* xubaomin@gmail.com (B. Xu).

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mechanism for resource allocation in the PDP-1 machine, which proposed by Sutherland in 1968 [2]. Most of the subsequent research focused on solving the load balancing of distributed system with the aid of price mechanism [3]. Along with the grid development, the researchers on how to apply the market mechanism to grid resources allocation have also carried out in-depth [4,5,12,13,16,17]. Among them, Popcon [6] and the Nimrod/G [7] are more influential. They all reveal the validity of grid resource allocation based on economics method. Ref. [18] has introduced market-oriented cloud. It is one of the first papers in the area. However, most of these studies did not involve the fairness of resources allocation under the market mechanism.

It is well known that high-quality service and fair competition are the foundation for commercial operations. In cloud computing, you need to face a variety of tasks from different users. With the number increase of users, cloud-scale expansion and so on, the key issues of cloud computing are to ensure the Quality of Service (QoS) and to provide, for different users, an equitable opportunity for the use of resources. The aim is to enable the user needs to get more satisfaction.

In sum, from the economic point of view, cloud computing is a new computing model which decided by economic principle. This enables the resources allocation of cloud computing to have an analogy with the distribution of social wealth. The vendor-provided computing resources-is equivalent to the social wealth. All needs of users, in the form of the task could be abstracted as social individual. The users use resources through payment. This is equal to each individual gains reward and the wealth through work in society.

Obviously, the resources allocation in cloud computing has a very good fit with the distribution theory (such as the Berger model of distributive justice) of social wealth. Namely, its emphasis on efficiency, while highlight the fairness in resources allocation.

## 3. Background knowledge

The Berger model of distributive justice is based on expectation states. It is a series of distribution theories of social wealth.

Expectation states formed by a series of theories are used to study actors and evaluate the impact of their behavior. Brief speaking, expectation states theories are to study the follow two issues [9]. First, actor how to generate expectations of itself and other individual's according to the information (such as status, reward, and performance differences) around the world; Secondly, these expectations how to affect the behavior (such as participatory, and decision-making influence) of actors and others.

Expectation states theories have been expanded and applied widely. State value theory of distribution justice is an important theoretical basis of the paper. It described that allocator how to use referential comparisons to establish the expectation for reward allocation. The expectations are used to evaluate the justice or injustice of distribution in a variety of circumstances.

Because computer resources can be quantified, the paper only discusses the quantified allocation principle (namely, the theory of distributive justice [10,14,15]) in Berger model. The basic idea of distributive justice is that individual in social system can judge its own gained resources to be fair or not through distribution relations comparison between itself and other ordinary person in referential structure. The distribution relation of other ordinary person in referential structure is well recognized as the general justice, i.e., fairness.

The Berger model of distributive justice is shown in Fig. 1. Characteristic C is any aspect of a person. A goal-object, *GO*, is any object that an actor might want, namely expectation. $C_x$/$c_x$ and $GO_X$/$go_x$ denote the state of a characteristic and a goal-object respectively. Seen from Fig. 1, the similarity condition is: (1) $c_x$ is similar to some state $C_x$; (2) $go_x$ is similar to some state $GO_X$. The structure condition is: (1) $c_x$ acquires the status value of $C_x$; (2) $go_x$ acquires the status value of $GO_X$.

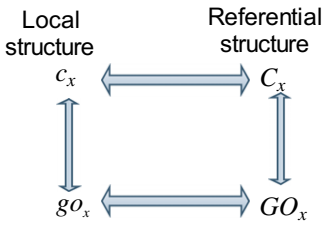


**Fig. 1.** Berger model.

Given the similarity and structure conditions, states in the local structure will acquire the status value of the states to which they are similar in the referential structure. In short, the justice of distribution can be judged through comparison between local structure and reference structure. Moreover, it is worth to mention that the definition of distributive justice evaluation function in Berger model [15].

$$JEF = \theta \ln(\mathrm{AR}/\mathrm{JR})$$

where $\theta$ denotes constant. AR (Actual Reward) is the social distribution which actor obtains actually. JR (Just Reward) is the expectation distribution which actor produces through comparison of the justice distribution of other ordinary person in referential structure.

The intuitive meaning of this function is that when actor's actual distribution (AR) and expectation distribution (JR) is equal, justice established. When actor's actual distribution is bigger than the expectation distribution, it is excessively distribution, i.e., non-justice. When actor's actual distribution is smaller than the expectation distribution, it is too little distribution, i.e., non-justice.

This paper is carried out mainly based on the distributive justice evaluation function.

## 4. Job scheduling algorithm based on Berger model

In cloud computing, entities are mainly users, resource providers, and scheduling system. The main body that corresponds with them is user tasks, the resources and the scheduling strategy.

As shown in Fig. 2, in order to be able to map the theory of distributive justice in Berger model to resource allocation model in cloud computing, it is need to carry on the task classification, fairness function definition of user tasks, the task and resource parameterization, the task and resource mapping, and etc.

### 4.1. Task classification based on QoS

The QoS stems from a parameter of Internet performance mechanism. In cloud computing, QoS is a metrics of user satisfaction with cloud services. Commercial characteristics of cloud computing

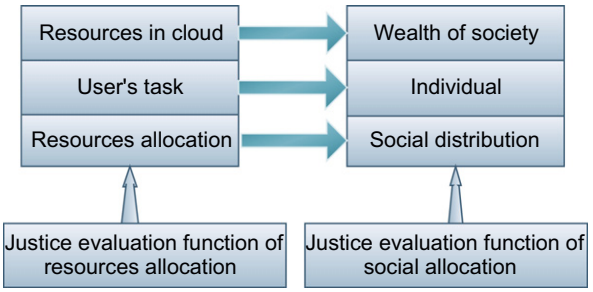


**Fig. 2.** Mapping between cloud and Bergh model.