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Research on the Utility Max-min Fair Algorithm of Resource Allocation*

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Abstract: In this paper, the Utility Max-Min (UMM) fairness criteria is analyzed, and a general algorithm of resource allocation based on UMM fairness is provided, named system-scale, which can be applied in various problems of resource allocation in the field of computer and communication. This algorithm supports the upper and lower bounds of resource allocation; it also supports various utility functions that are strictly increasing and continuous. The result of the algorithm is pareto-efficient and UMM fair. Because of the avoidance of iterative procedure, system-scale is less complex than water-filling, a well-known UMM fair algorithm. Moreover, the generalized system-scale can also act as a utility min-max fair algorithm and be applied in environments such as load balancing and fair job allocation.
Keywords: Utility, Max-min Fairness, Resource Allocation, Water-filling Algorithm, System-scale Algorithm

1. INTRODUCTION

In the field of computer and communication, it's a general problem to properly allocate resource such as bandwidth, links, buffer storage, CPU time, balance etc. In this problem, there are two main targets: efficiency and fairness. Most of the existing works concentrate on efficiency. In recent years, research has been done on some scenarios of resource allocation that take fairness for the main target [1]. Some fairness criterions were proposed, including the max-min fairness [2], proportional fairness [3], harmonic mean fairness [4] etc. Among them, max-min fairness was proved to be the fairest criteria [5,6], and was widely applied in the allocation of bandwidth, wireless links and so on.

The aim of max-min fairness is to allocate "as much as possible to the poor users" [7]. It has several variations: the original max-min fairness [8] supports neither the lower/upper bounds nor the priority or weight of service; the generalized max-min (GMM) fairness [9] and the general weighted (GW) fairness [10] improve the above two aspects respectively. However, the common drawback of the above max-min fairness is that all of them support only the resource for the criterion of fairness. When take the income of resource for the criterion, they

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