Optimizing a Divisible Load Nonlinear Cost Function

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Abstract — **The behavior of load distribution for loads with nonlinear monetary computing cost is studied.**

I. Introduction

Companies are using third party machines as a result of a corporate interest to create computer utilities for leasing. This tendency may lead researchers and developers to use high performance parallel devices and algorithms while paying some monetary charge. The monetary cost associated with the production and operation of such machines leads to a requirement to lease their processing in a time efficient manner. Indeed, there is an intrinsic relationship between the cost and the sequencing problem [1]. This problem involves optimizing the order in which a root processor should distribute divisible processing load to its processors. In [2] the scheduling of nonlinear loads was studied. In this paper we explore the monetary cost as a function of nonlinear processing loads.

II. The model

Consider a single level tree (star) network consisting of N+1 processors and N links which have related corresponding computation c_n^p and communication cost c_n^l. Here the c_n's are linear monetary cost coefficients. The root processor will receive all the load and distribute to each child processor their assigned fraction of load sequentially.

A Notations and Definitions

α_i: The load fraction assigned to the i^{th} link-processor pair.
w_i: The inverse of the computing speed of the i^{th} processor.
z_i: The inverse of the link speed of the i^{th} link.
T_{cp}: Computing intensity constant: the entire load is processed in $w_i T_{cp}$ seconds by the ith processor.
T_{cm}: Communication intensity constant: the entire load can be transmitted over the bus in $z_i T_{cm}$ seconds over the ith link.

III. Total Monetary Cost

Total monetary cost is the linear summation of the individual costs incurred at each processor-link pair. This individual cost depends on the assigned fraction of load. The monetary cost expression found in [1] was modified expressing the load as a function of β, equation(1). Here β is a parameter needed to express the nonlinearity characteristic of the load.

$$C_{total} = \alpha_0^\beta c_0^p w_0 T_{cp} + \sum_{n=1}^{N} \alpha_n^\beta (c_n^p w_n T_{cp} + c_n^l z_n T_{cm}) \quad (1)$$

In order to get a solution for the sequencing problem the Best Swap Algorithm presented in [3] was chosen due to its consistency in finding an optimal solution and was modified to include the β parameter.

IV. Results

A heterogeneous single level tree network with N=4 processors was modeled. Random values were chosen and fixed for different parameters in the network. An algorithm was run changing the β parameter (β>1 and β<1). The distribution of load in the network may explain the total monetary cost behavior. In Figure (1) is shown that for large values of β an almost equal load distribution is generated. As consequence, it is expected that the minimum total monetary cost grows with an almost constant rate for large values of β. It was found that for values of β approaching 0 most of the load is assigned to the processor (P3).

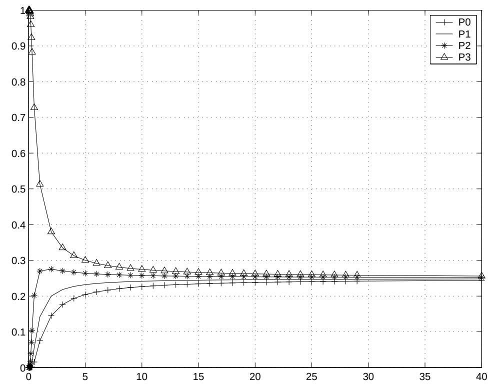

Figure 1: Load distribution for a single level tree network Beta >0

V. Conclusions

This load distribution behavior is related to the convexity and concavity of (1) for different values of beta.

References

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