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#### Power Budgeting Techniques For Data Center

##### Abstract

The development of cloud computing and data science result in rapid increases of number and scale of data centers. Because of cost and sustainability concerns, energy efficiency has been a major goal for data center architects. Focusing on reducing the cooling power and making full use of available computing power, power budgeting is an increasingly important requirement for data center operations. In this paper, we present a framework of power budgeting, considering both computing power and cooling power, in data centers to maximize the system normalized performance (SNP) of the entire center under a total power budget. Maximizing the SNP for a given power budget is equivalent to maximizing the energy efficiency. We propose a method to partition the total power budget among the cooling and computing infrastructure in a self-consistent way, where the cooling power is sufficient to extract the heat of the computing power. Intertwinedly, we devise an optimal computing power budgeting technique based on dynamic programming algorithm to determine the optimal power caps for the individual servers such that the available power could be efficiently translated to performance improvements. The optimal computing budgeting technique leverages a proposed online throughput predictor based on performance counter measurements to estimate the change in throughput of heterogeneous workloads as a function of allocated server power caps. We demonstrate that our proposed power budgeting method outperforms previous methods by 3-4 percent in terms of SNP using our data center simulation environment. While maintaining the improvement of SNP, our method improve fairness at best by 57 percent. We also evaluate the performance of our method in power saving scenario and dynamic power budgeting case.