

Providing Green SLAs in High Performance Computing Clouds

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Abstract

Demand for clean products and services is increasing as society is becoming increasingly aware of climate change. In response, many enterprises are setting explicit sustainability goals and implementing initiatives to reduce carbon emissions. Quantification and disclosure of such goals and initiatives have become important marketing tools. As enterprises and individuals shift their workloads to the cloud, this drive toward quantification and disclosure will lead to demand for *quantifiable green cloud services*. Thus, we argue that cloud providers should offer a new class of green service, in addition to existing (energy-source-oblivious) services. This new class would provide their clients with explicit service-level agreements (which we call Green SLAs) for the percentage of renewable energy used to run their workloads.

In this paper, we first propose an approach for High Performance Computing cloud providers to offer such a Green SLA service. Specifically, each client job specifies a Green SLA, which is the minimum percentage of green energy that must be used to run the job. The provider is penalized if it accepts the job but violates the Green SLA. We then propose (1) a power distribution and control infrastructure that uses a small amount of hardware to support Green SLAs, (2) an optimization-based framework for scheduling jobs and power sources that maximizes provider profits while respecting Green SLAs, and (3) two scheduling policies based on the framework. We evaluate our framework and policies extensively through simulations. Our main results show the tradeoffs between our policies, and their advantages over simpler greedy heuristics. We conclude that a Green SLA service that uses our policies would enable the provider to attract environmentally conscious clients, and especially those who require strict guarantees on their use of green energy.