Energy-Aware Information Modeling and Management for e-Infrastructures

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e-Infrastructures incur tremendous energy costs and CO2 emissions. However, energy monitoring and management tools for commercial data center owners like Google only work in the local domain. Their technologies are not suitable for scientific e-Infrastructures that run across multiple administrative domains. In e-Infrastructures, the information on the footprint needs to be exchanged and energy management techniques need to span across multiple domains.

In this thesis, we set out to define a semantic information model, which represents concepts and the relationships for capturing the knowledge using the Semantic Web. The Semantic Web provides an effective mechanism for data interoperability and knowledge sharing in e-Infrastructures. Based on the information model, we explore a distributed information system to organize and provide the knowledge for energy management. With the energy knowledge of infrastructures, we then design energy management strategies. We design and evaluate a set of non-linear approaches to estimate the power consumption of servers in a computing cluster. We propose an efficient framework for green routing in software-defined data center networks based on OpenNaaS and then evaluate the effect of algorithms which consider both flow routing and flow scheduling.