

UNIVERSITY OF SOUTH FLORIDA

Defense of a Doctoral Dissertation

Towards Safe Power Oversubscription and Energy Efficiency of Data Centers

by

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For the Ph.D. degree in Computer Science and Engineering

Data centers contribute to approximately 1% of the global electricity consumption, and billions of dollars are spent annually worldwide in construction of new data centers to meet the rising demand for cloud-based services. Given the high cost of construction, the power infrastructure in a data center is typically oversubscribed. Power overload situations can occur in oversubscribed data centers. Power overload can lead to power capping of servers or even power outages – both of which degrade the performance of the services offered by the data center. In this dissertation, we address key open problems in the area of safe power oversubscription of data centers. First, we quantify the level of safe power oversubscription possible for servers characterized by energy proportionality metric and workload distribution. Second, we develop a real-time dynamic power pricing mechanism to enable safe power oversubscription of multi-tenant data centers, an often neglected but important type of data center. Third, we propose a coordinated priority-aware battery charging algorithm to tackle the problem of distributed battery charging in oversubscribed data centers. Finally, we develop a new server energy efficiency metric that is both linear and reliable in ranking of server energy efficiency for a given workload. The findings presented in this dissertation, if widely used, can result in energy savings, as well as capital cost savings, of millions of dollars per year.

Examining Committee

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Publications

- 1) **S. Malla**, Q. Deng, Z. Ebrahimzadeh, J. Gasperetti, S. Jain, T. Ortiz, and D. Vieira, “Coordinated priority-aware charging of distributed batteries in oversubscribed data centers”, (To be submitted).
- 2) **S. Malla** and K. Christensen, “The effect of server energy proportionality on data center power oversubscription”, *Future Generation Computer Systems*, 104, pp. 119–130, 2020.
- 3) **S. Malla** and K. Christensen, “A survey on power management techniques for oversubscription of multi-tenant data centers”, *ACM Computing Surveys*, 52(1), pp. 1–31, 2019.
- 4) **S. Malla** and K. Christensen, “Choosing the best server for a data center: The importance of workload weighting”, *IEEE International Performance Computing and Communications Conference*, pp. 1–8, 2018.
- 5) **S. Malla** and K. Christensen, “Reducing power use and enabling oversubscription in multi-tenant data centers using local price”, *IEEE International Conference on Autonomic Computing*, pp. 161–166, 2017.

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