University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Doctor of Philosophy

of

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"Energy Adaptive Digital Ecosystems"

Department of Computer Science

Wednesday, November 29, 2017
9:30 A.M.
Engineering and Computer Science Building
Room 660

Supervisory Committee:
Dr. Hausi Müller, Department of Computer Science, University of Victoria (Co-Supervisor)
Dr. Yvonne Coady, Department of Computer Science, UVic (Co-Supervisor)
Dr. Stephen Neville, Department of Electrical and Computer Engineering, UVic (Outside Member)

External Examiner:
Dr. Niky Riga, Software Engineer, Facebook Inc.

Chair of Oral Examination:
Dr. Sara Ramshaw, Faculty of Law, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Since the turn of the century, the proliferation of virtualization and cloud computing has lead to an increase in data centres and consequently an increase in power consumption for computing. Today, approximately 2% of global energy consumption is attributed to data centres alone. As a result, optimizing power usage effectiveness in enterprise data centres has become a laudable goal and a critical requirement in IT operations all over the world. While a significant body of research exists to measure, monitor, and control the \greenness" level of hardware components, significant research is needed to relate hardware energy consumption to energy consumption stemming from (software) program execution. In this dissertation, we argue that the true energy cost of program execution must focus on the digital ecosystem within which a particular software program is executed. We investigate the interplay between energy consumption, task scheduling and execution decision making using dynamic runtime models of digital ecosystems based on the execution context of software.

Single instances of software applications are no longer confined to a single device or machine. Instead software commonly interacts with resources and services outside of its own hardware unit. The scope of this interaction defines the application's digital ecosystem. Smartphones interact with cloud resources; cloud resources include databases, specialized compute or storage clouds, specialized hardware and virtual machines (VMs). Combining processes of varying complexity with varying resource allocations produces different energy consumption levels. The challenge is to investigate the variability of software process orchestration based on a power consumption framework to accrue and optimize energy savings in digital ecosystems. The contributions of this dissertation include: i) an adaptive energy consumption framework; ii) self-adaptive energy management systems based on this framework; iii) deployment mechanisms for applications to use this framework; iv) models at runtime models for self-adaptive energy management systems. Our ultimate goal is to develop smart, self-adaptive, green computing techniques, such as adaptive job scheduling and resource provisioning, to reduce overall power consumption in data centres, on individual devices (e.g., mobile, desktop, laptop or server), and in digital ecosystems.