Energy efficient computing at the edge: from sensors to servers (Tajana Simunic Rosing)

The proliferation of personal computing and the advent of cheap, smallsensors have given the rise of computing at the edge of the traditional computational infrastructure. For example, the CitiSense project at UCSD provides unsurpassed visibility to individuals of what is going onin their immediate environment, and how their actions, and actions of others around them affecttheir long term health via smart phone interface. Concurrently it provides rich datasets that enable public health agencies, clinicians, educators,insurance companies and others a unique view of interaction between health, individual choiceand environment.While various technological components of the computing systems at the edge of internet already exist, the key to success ofthis new class of systems are advances in the abstractions that can support easyextensibility, and development of adaptive energy management strategies that ensure efficient system operation.

In this talk I give an overview of thesystems and algorithms we have developed at UCSD to enable the development of adaptive edge computing infrastructure along with strategies that significantly lower the energy consumption in sensing, mobile and edge server infrastructures. I will start with an example of CitiSense project, a new kind of “citizen infrastructure” that we have designed as an end-to-end health and environmental information system with near real-time data streams and feedback loops from the system to the sensing, processing, and actuation infrastructure. For this system we have developedan adaptive software infrastructure along with algorithms to tradeoff accuracy of computation versus the available energy for such systems, while taking into account the energy harvesting capabilities.

Next I will outline the advances to the state of the art in the area of energy optimization of edge server infrastructure needed to ensure reliable and effective operation in systems such as CitiSense. We developed low lever power gating architecture capable of saving up to 40% in energy with no performance penalty, along with software level

optimization capable of meeting performance targets in service time sensitive systems. We have also shown that integrating SLA management capabilities along symbiotic workload scheduling within virtualized edge computing systems enables 2x or higher increases in energy efficiency while meeting the SLA requirements. This is done by running a mix of SLA sensitive workloads typical of applications that interact with real world and batch jobs which are necessary to deliver analytics needed when interfacing with the environment and users.

Tajana Šimunic Rosing is currently an Associate Professor in the Computer Science Department at UCSD. She is currently heading the effort in energy efficient datacenters as a part of MuSyC center. Her research interests are energy efficient computing, embedded and wireless systems. Prior to this she was a full time researcher at HP Labs while working part-time at Stanford University. She finished her PhD in 2001 at Stanford University, concurrently with finishing her Masters in Engineering Management. Her PhD topic was Dynamic Management of Power Consumption. Prior to pursuing the PhD, she worked as a Senior Design Engineer at Altera Corporation. She is currently an Associate Editor of IEEE Transactions on Mobile Computing.