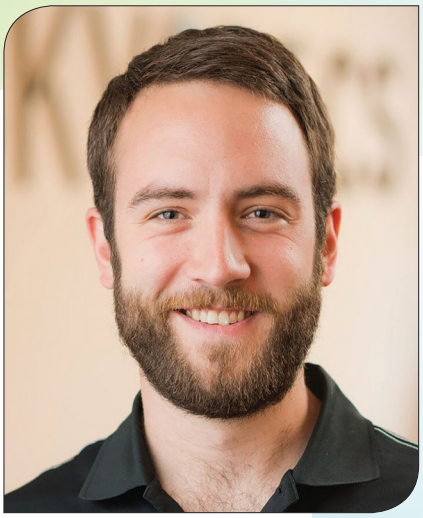
COLLEGE OF ENGINEERING
COMPUTER SCIENCE & ENGINEERING
UNIVERSITY OF MICHIGAN

CSE Dissertation Defense



Samuel DeBruin

Enabling Visibility into Building Energy Consumption Through Novel Metering Designs and Methods

ABSTRACT: Energy consumption in buildings is an area of growing national concern, with almost 3,000 TWh going to residential and commercial buildings in the United States annually. This figure represents 40% of total energy consumption, 70% of total electricity consumption, and these figures are representative of other countries as well. Even as improvements target certain obvious segments like HVAC, not all electrical devices are receiving the same level of treatment. In particular miscellaneous electrical loads (MELs) - plug-load devices like televisions, coffee makers, and cell phone chargers - are a growing segment of consumption about which less is understood than heating and cooling, lighting, etc. These devices are proliferating quickly, and although they individually draw moderate power, in the aggregate they represent a significant fraction (30%-60%) of the total. Complicating the problem, existing tools for gaining insight into this segment are either too expensive, too difficult to deploy, too cumbersome to operate, or of too low accuracy to provide sufficient benefit.

In this dissertation, we propose the design of an energy metering architecture that is low power, inexpensive, and scalable to the needs of the long tail of miscellaneous electrical loads. This platform affords unprecedented visibility into the energy consumption of these devices, which can be used to guide energy management policies and regulatory action, as well as enable targeted energy management applications, to curb this growing segment. Realizing this energy metering architecture, which is composed of both circuit-level and plug-load energy meters, requires revisiting all aspects of the AC meter design. In particular we design and implement novel ways to power the meters including energy harvesting from the AC, two different non-contact current measurement methods, a unique planar plug through form factor, and a new method for viewing and interacting with metering data on nearby smartphones. We deploy this metering platform alongside other sensors including light and occupancy, which allows us to generate unprecedented data on MEL energy consumption, illustrate how MELs can be identified from their electrical signatures, and identify faults in electrical appliances by detecting anomalies in their electrical fingerprints.

Chair: **Prof. Prabal Dutta**

Thursday, June 15, 2017 12:00 – 2:00 pm 1690 Beyster Building