BRAD CAMPBELL

http://bradcampbell.com
(616) 450-6019 ⋄ bradjc@umich.edu
2260 Hayward Street, 4908 BBB, Ann Arbor, MI 48109

EDUCATION

University of Michigan, Ann Arbor *Sep 2011 - Present*
Ph.D. candidate in Computer Science & Engineering
Advisor: Prabal Dutta

University of Michigan, Ann Arbor *May 2011*
B.S.E. in Computer Engineering

RESEARCH INTERESTS

Energy-harvesting sensing systems, intermittent building monitoring sensors, local-only and Internet-connected gateway architectures and protocols, cloud architectures for real-time streaming sensor data, accurate indoor localization

PUBLICATIONS

1. Bradford Campbell, Meghan Clark, Samuel DeBruin, Branden Ghena, Neal Jackson, Ye-Sheng Kuo, and Prabal Dutta. Perpetual sensing for the built environment. *IEEE Pervasive Computing*
2. Bradford Campbell, Joshua Adkins, and Prabal Dutta. Cinamin: A perpetual and nearly invisible BLE beacon. In *NextMote: Next Generation Platforms for the Cyber-Physical Internet*, Feb 2016
3. Amit Levy, Michael P Andersen, Bradford Campbell, David Culler, Prabal Dutta, Branden Ghena, Philip Levis, and Pat Pannuto. Ownership is theft: Experiences building an embedded OS in Rust. In *Proceedings of the 8th Workshop on Programming Languages and Operating Systems*, Oct 2015
4. Bradford Campbell, Pat Pannuto, and Prabal Dutta. Interfacing the internet of a trillion things. In *2nd International Workshop on the Swarm at the Edge of the Cloud*, SWEC '15, 2015
5. Nicola Dell, Trevor Perrier, Brad Campbell, Noah Klugman, and Thomas Zachariah. DEV 14 and HotMobile 15. *IEEE Pervasive Computing*, 14(2):90–c3, 2015
6. Thomas Zachariah, Noah Klugman, Bradford Campbell, Joshua Adkins, Neal Jackson, and Prabal Dutta. The internet of things has a gateway problem. In *HotMobile'15: Proceedings of the 16th International Workshop on Mobile Computing Systems and Applications*, January 2015
7. Bradford Campbell and Prabal Dutta. Gemini: A non-invasive, energy-harvesting true power meter. In *RTSS '14: IEEE Real-Time Systems Symposium*, December 2014
8. Bradford Campbell, Branden Ghena, and Prabal Dutta. Energy-harvesting thermoelectric sensing for unobtrusive water and appliance metering. In *ENSsys '14: Proceedings of the 2nd International Workshop on Energy Neutral Sensing Systems*, November 2014
9. Bradford Campbell and Prabal Dutta. An energy-harvesting sensor architecture and toolkit for building monitoring and event detection. In *BuildSys '14: Proceedings of the 1st International Conference on Embedded Systems for Energy-Efficient Buildings*, November 2014
10. Meghan Clark, Bradford Campbell, and Prabal Dutta. Deltaflow: Submetering by synthesizing uncalibrated pulse sensor streams. In *e-Energy '14: Proceedings of the 5th International Conference on Future Energy Systems*, June 2014

11. Samuel DeBruin, Bradford Campbell, and Prabal Dutta. Monjolo: An energy-harvesting energy meter architecture. In *SenSys '13: Proceedings of the 11th ACM Conference on Embedded Networked Sensor Systems*, November 2013

12. A. E. Xhafa, B. Campbell, and S. Hosur. Towards a perpetual wireless sensor node. In *SENSORS, 2013 IEEE*, pages 1–4, Nov 2013

13. Lohit Yerva, Bradford Campbell, Apoorva Bansal, Thomas Schmid, and Prabal Dutta. Grafting energy-harvesting leaves onto the sensornet tree. In *IPSN '12: Proceedings of the 11th international conference on Information processing in sensor networks*, April 2012

POSTERS AND DEMOS

1. Lohit Yerva, Bradford Campbell, Thomas Schmid, and Prabal Dutta. Poster: A versatile gateway architecture for city-scale sensing. In *MSR Student Summit on Mobility, Systems, and Networking 2016*, February 2016

2. Joshua Adkins, Bradford Campbell, Samuel DeBruin, Branden Ghena, Benjamin Kempke, Noah Klugman, Ye-sheng Kuo, Deepika Natarajan, Pat Pannuto, Thomas Zachariah, Alan Zhen, and Prabal Dutta. Demo: Michigan's iot toolkit. In *Proceedings of the 13th ACM Conference on Embedded Networked Sensor Systems*, SenSys '15, pages 485–486, New York, NY, USA, 2015. ACM

3. Benjamin Kempke, Pat Pannuto, Bradford Campbell, Joshua Adkins, and Prabal Dutta. Demo: PolyPoint: High-precision indoor localization with UWB. In *Proceedings of the 13th ACM Conference on Embedded Networked Sensor Systems*, SenSys '15, pages 483–484, New York, NY, USA, 2015. ACM

4. Bradford Campbell, Prabal Dutta, Benjamin Kempke, Ye-Sheng Kuo, and Pat Pannuto. DecaWave: Exploring state of the art commercial localization. In *Microsoft Indoor Localization Competition*, April 2015

5. Noah Klugman, Bradford Campbell, Thomas Zachariah, Neal Jackson, and Prabal Dutta. Open gateway architecture for the Internet of Things. In *HotMobile'15: Proceedings of the 16th International Workshop on Mobile Computing Systems and Applications*, January 2015

6. Meghan Clark, Bradford Campbell, and Prabal Dutta. Demo abstract: Submetering by synthesizing side-channel sensor streams. In *IPSN '14: Proceedings of the 13th International Symposium on Information Processing in Sensor Networks*, April 2014

7. Bradford Campbell, Samuel DeBruin, and Prabal Dutta. Demo abstract: Disambiguating household energy-harvesting energy meter data streams. In *SenSys '13: Proceedings of the 11th ACM Conference on Embedded Networked Sensor Systems*, November 2013

8. Brad Campbell, Zakir Durumeric, and Prabal Dutta. Poster: Ipv6 at the edge of the cloud. In *Swarm at the Edge of the Cloud Workshop '13*, September 2013

9. Pat Pannuto, Brad Campbell, and Prabal Dutta. Poster: Gatd: A robust, extensible, versatile swarm data-plane. In *Swarm at the Edge of the Cloud Workshop '13*, September 2013

10. Lohit Yerva, Bradford Campbell, Thomas Schmid, and Prabal Dutta. Demo: Grafting energy-harvesting leaves onto the sensornet tree. In *SenSys '11: Proceedings of the 9th ACM Conference on Embedded Networked Sensor Systems*, November 2011

PRESENTATIONS

Cinamin: A Perpetual and Nearly Invisible BLE Beacon February 2016
NextMote'16 *Graz, Austria*
Bluetooth Low Energy beacons are enabling the pervasive blending of digital and physical spaces, by allowing smartphones and wearable devices to get small digital hints about nearby resources. To make these beacons easier to deploy and more prolific, this talk explores the design of an energy-harvesting beacon in less than 100 cubic millimeters built with off-the-shelf components. The beacon, designed to be put near or inside a light source, shows promise towards making these beacons essentially invisible—if we can find a suitable power supply.

Interfacing the Internet of a Trillion Things April 2015
SWEC'15 *Seattle, Washington*
The Internet of Things is gaining a tremendous amount of momentum. While smart devices continue to advance in both number and capability, the applications for using them are typically limited, and center around a single device or manufacturer. This talk explores the much more compelling—and useful—applications that exist when multiple smart things work together. In particular, it outlines a framework for encompassing complex and variable device interfaces into a single JavaScript files that can then be leveraged to describe and build applications. These wrappers and interfaces encourage application design and creation while simultaneously allowing applications to be deconstructed, implemented, and optimized in ways that currently are not possible.

Gemini: A Non-Invasive, Energy-Harvesting True Power Meter December 2014
RTSS'14 *Rome, Italy*
Reducing building energy consumption is an issue of national importance, yet the tools needed for even the first step of the problem—understanding where energy goes in a building—are significantly lacking. Ranging from too expensive to too hard to install, current power meters are inadequate, and as a result are not employed today. To fill this void, this talk describes Gemini, a non-invasive power metering solution that easily clips around the wires in a circuit panel box and accurately measures each circuit, while powering itself, without requiring an electrician. Calculating true power requires knowledge of the voltage signal, and Gemini wirelessly synchronizes and reports the voltage signal in a single wireless packet. By combining energy-harvesting with a virtualized voltage signal, Gemini is a truly deployable circuit-level power meter.

An Exploration of Energy Harvesting and Visible Light Communications September 2014
QInF'14 Winners Day *San Diego, CA*
In this talk we present our recent work on two different vectors: energy-harvesting and visible light communication. We describe an architecture for building composable energy-harvesting systems and an indoor positioning system based on LED luminaires and mobile phones. Finally, we note how principles of each vector can help enable a new class of ultra-low power sensing hardware.

GATD: Universal Streaming Sensor Data Storage System May 2014
Swarm OS Workshop *Berkeley, CA*
This presentation overviews my cloud-based system for collecting, managing, and disseminating streaming data from distributed sensors and other sources. I highlight GATD's guiding principle: flexibility and versatility to adapt to any sensing hardware, no matter how constrained.

Respawn: A Distributed Multi Resolution Time Series Datastore March 2014
Software Reading Group *Ann Arbor, MI*
This presentation for an audience of graduate students from a range of areas highlights work from Carnegie Mellon related to storing sensor data in both the cloud and at strategic gateways in the sensor network.

GATD: Enabling Applications with Streaming Data January 2014
USAID/Development Impact Lab Meeting *Portland, OR*
This presentation starts by describing GATD, a cloud-based system for organizing streaming sensor data from a wide range of sources. Further, it highlights the applications currently using the system, and the design choices of GATD that make adding new applications as straightforward as possible.

Monjolo: An Energy-Harvesting Energy Metering Architecture November 2013
SenSys'13: Embedded Networked Sensor Systems *Rome, Italy*
In this talk I describe a new sensing technique for energy-harvesting devices. In lieu of a traditional sensor, these devices meter energy based on the performance of the energy-harvesting power supply, allowing for smaller and lower power sensors. I show the performance of our AC power metering design and describe the potential of this architecture for other sensing domains.

Approximate Sensing at Scale with Energy-Harvesting Nodes November 2013
TerraSwarm Annual Review *Berkeley, CA*
This talk describes recent work on wireless sensors that avoid periodic maintenance overhead by swapping batteries for energy-harvesting power supplies. The trade-off is reduced accuracy from using an approximate sensing technique that is well suited to energy-harvesting power supplies. I describe the sensing technique and our current work to improve accuracy with post-processing.

Jackit: A Hardware/Software Tool Kit for Mobile Phone Audio Jack Peripherals May 2013
CSE Preliminary Exam *Ann Arbor, MI*
For this presentation I detail an architecture that aids the creation of smartphone peripherals that are powered from and communicate over the audio headset port. I show how this architecture uses a software library and a hardware platform to mask underlying power and communication issues and aids the development of phone peripherals.

Decoupling Synchronization from Communication to Scale Down Indoor Wireless Sensors March 2013
QInF'13 Finalists Day *Santa Clara, CA*
In this talk we propose a solution for the wireless synchronization problem: using visible light to synchronize transceivers instead of RF communication. We expect this technique to enable smaller, and correspondingly less capable, sensor nodes to mesh network to relay packets throughout a building.

Perpetual Sensing: 802.15.4e TSCH Protocol for Energy-Harvesting Nodes August 2012
Texas Instruments R&D Center *Dallas, TX*
This talk describes the modifications required to the 802.15.4e specification to support extremely low duty cycle nodes powered by indoor solar based energy-harvesting power supplies. I also present the status of our MSP430F5438 based prototype and outline the remaining research needed to realize the goal of a perpetual sensor node.

RESEARCH EXPERIENCE

Ph.D. Candidate, University of Michigan, Ann Arbor *May 2013 - Present*

Ph.D. Student, University of Michigan, Ann Arbor *September 2011 - May 2013*

Research Assistant, University of Michigan, Ann Arbor *May 2010 - June 2011*
I designed, developed, and tested a new circuit board with temperature, light, and motion sensors.

INDUSTRY EXPERIENCE

Texas Instruments May 2012 - August 2012
Embedded Processing R&D Intern *Dallas, TX*
I adapted the 802.15.4e TSCH (time slotted channel hopping) MAC layer protocol to run with an energy harvesting power supply. Harvesting an unreliable 30 uA of indoor solar necessitated reducing the radio and CPU duty cycle to minimum levels while maintaining functionality with the existing TSCH network.

AWARDS

Fellowship Finalist *2014*
Microsoft Research Fellowship finalist

Fellowship *2013-14*
Qualcomm Innovation Fellowship

Fellowship *2011-12*
University of Michigan CSE Department First-year Fellowship

SERVICE

ENSsys 2015 TPC Member & Publicity Chair *2015*
2015 Workshop on Energy Neutral Sensing Systems

Graduate Student Representative *2013 - Present*
Computer Science and Engineering Graduate Student Organization

TEACHING

ENGIN 100, University of Michigan, Ann Arbor *Fall 2010*
Lab IA for an introductory computer engineering course