

Alanson P. Sample

alanson@u.washington.edu
www.alansonsample.com
(Full version of C.V. available upon request)

Disney Research, Pittsburgh
4720 Forbes Avenue
Lower Level, Suite 110
Pittsburgh, PA 15213

PERSONAL STATEMENT

My research interests lie broadly in the areas of zero power computing, wirelessly powered systems, and the design of novel sensing circuits. My background is in RF engineering and integrated circuit design, including: antenna theory and design, energy harvesting, wirelessly powered systems, transceiver design, and the design of sensing systems.

EDUCATION

- | | |
|--|----------------|
| Ph.D. in Electrical Engineering
University of Washington
Dissertation Title: "Cutting the Last Cord With Wireless Power" | 6/2011 |
| M.S. in Electrical Engineering
University of Washington
Thesis Title: "Design of a Battery Free Wireless Identification and Sensing Platform" | 12/2008 |
| B.S. in Electrical Engineering
University of Washington
Area of Concentration: Integrated Circuit Design | 6/2005 |

NOTABLE RESEARCH PROJECTS

- | | |
|--|-------------------------|
| Wireless Identification and Sensing Platform (WISP)
While at Intel and the UW, I developed the hardware for the UHF and NFC versions of the WISP, which are programmable, battery-free sensing and computational platforms designed to explore sensor-enhanced RFID applications. WISPs are powered exclusively from harvested RF energy. The UHF WISP has an operating range of over 9 meters, while the NFC version is compatible with many smart phones. To date, over 400 WISPs have been donated to 30 universities around the world. | 6/2005 - Present |
| Free-Range Resonant Electrical Energy Delivery (FREE-D)
Working with the Yale School of Medicine, our UW team developed a completely wirelessly powered left ventricular assist device (LVAD), commonly known as a heart pump. As a Postdoc, I developed a complete, end-to-end system that uses magnetically coupled resonators, as well as a custom designed transmitter and receiver, to safely power and communicate with the LVAD, which was used in preliminary animal trials in March of 2013. | 1/2011 – 8/2012 |
| Wireless Resonant Energy Link (WREL)
In this project, magnetically coupled resonators were used to safely and efficiently transmit large amounts of power wirelessly over a range of several feet. I formulated the theoretical background for this work, as well as demonstrated the ability to automatically adapt to changes in receiver position and/or orientation and still achieve a near constant efficiency of over 85% for a range of several feet. | 1/2007 – 8/2012 |
| Wireless Ambient Radio Power (WARP)
The WARP project harvested ambient RF energy and converted these signals into power for a variety of applications. I demonstrated a wirelessly powered temperature and humidity sensor with LCD display, as well as custom sensor nodes that run off of harvested TV signals at a distance of 10.4 km. | 1/2009 – 6/2011 |
| Autonomous Robotic Mobile Monitoring
As part of a diverse team of graduate and undergraduate students, I led efforts to complete the autonomous robotic cable inspection project. The goal was to develop a robotic platform capable of monitoring the health of power distribution cables. In December of 2006, our team deployed the robot at a NASA facility to inspect power cables for damage caused by Hurricane Katrina. | 7/2005 – 12/2006 |

 TEACHING EXPERIENCE

BEE 215: Fundamentals of Electrical Engineering**1/2012 - 3/2012**

University of Washington – Bothell

 GRANTS AWARDED

"Development of the NFC-WISP as a standardized framework for wireless power delivery and bidirectional communication with neural implants." Awarded as a seed grant from the Center for Sensorimotor Neural Engineering (NFS Research Center), on September 15, 2011.

**Amount:
\$12,000**

 EMPLOYMENT

Disney Research, Pittsburgh**12/2013 - Present***Research Scientist*

I lead the Wireless Systems group, which focuses on enabling new guest experiences and sensing and computing devices by applying novel approaches to electromagnetics, RF and analog circuits, and embedded systems.

Intel Labs**8/2012 – 10/2013***Research Scientist*

My research focus is developing novel energy harvesting techniques and systems for wearable devices and power autonomous sensor nodes.

Computer Science and Engineering Department, UW**6/2011 - 8/2012***Post-Doctoral Research Associate, Sensor Systems Lab*

Led research efforts and supervised graduate students on a number of wirelessly power projects including FREE-D, WREL, WARP, and WISP, as well as taught an introductory electrical engineering class.

Intel Labs**9/2010 - 10/2011***Graduate Intern*

I developed a semi-passive RFID tag reference design for encrypted electronic tolling and security applications. Additionally, I supported efforts to transfer WREL technology from the research lab to internal Intel business groups.

Intel Research, Seattle**9/2008 – 9/2010***Contract Research Scientist*

As part of a two year contract with Intel Labs Seattle, I created methods for wirelessly powering devices at a range of several feet, at high power levels, and with an efficiency >85% using magnetically coupled resonators. These efforts directly led to a spin-off project, which focused on developing a proof of concept for wirelessly powered applications.

Intel Research, Seattle**9/2007 – 9/2008***Graduate Intern*

I was the lead researcher on the Wireless Resonate Energy Link project. The goal of this project was to investigate the feasibility of wirelessly transmitting large amounts of power safely and efficiently using magnetically coupled resonators.

Intel, DEG Architecture and Planning**6/2007 – 9/2007***Graduate Intern*

I was an analog and digital integrated circuit designer for the Ozette test chip, which used a CMOS compatible magnetic layer to enable a high power, on die voltage regulator for microprocessors. My primary responsibility was to design a digital control block for an ADC, which continuously monitored the system and reported an interrupt if limits were met.

 EMPLOYMENT (CONTINUED)

MITRE Corporation **2/2007 – 7/2007**
Part Time Contractor

I developed an ambient RF energy harvesting device for a demonstration application. This included working with the customer and third party vendors to define system specifications. I independently designed, manufactured, assembled, and tested several prototype devices capable of continuously harvesting RF power and storing DC energy for the customer's application.

University of Washington **1/2007-6/2007**
Research Assistant, Silicon Systems Research Lab

Designed and taped out a 130nm CMOS RF rectifier and RFID EPC Gen 1 state machine.

Intel Research, Seattle **6/2006-1/2007**
Graduate Intern

Designed and prototyped the first working versions of the Wireless Identification and Sensing platform, which had a wirelessly powered range of 4.1 meters from a commercial UHF RFID reader.

University of Washington **1/2006-6/2006**
Research Assistant, Sensor Energy and Automation Lab

Led efforts to complete the autonomous robotic cable inspection project that was developed to monitor the health of power distribution cables.

Intel Research, Seattle **6/2005-1/2006**
Graduate Intern

Designed and taped out a UHF power harvester and RFID demodulating circuit in 180nm CMOS.

 JOURNAL PUBLICATIONS

- [J7] "Resonant Cavity Mode Enabled Wireless Power Transfer"; Matthew J. Chabalko and Alanson P Sample; *Applied Physics Letters*; 105, December 2014
- [J6] "Enabling Seamless Wireless Power Delivery in Dynamic Environments"; Alanson P. Sample, Benjamin H. Waters, Scott T. Wisdom, Joshua R. Smith; *Proceedings of the IEEE*; vol.101, no.6, pp.1343-1358, June 2013
- [J5] "Evaluation of Wireless Resonant Power Transfer Systems with Human Electromagnetic Exposure Limits"; Andreas Christ, Mark G. Douglas, John Roman, Emily B. Cooper, Alanson P. Sample, Benjamin H. Waters, Joshua R. Smith, and Niels Kuster; *IEEE Transactions on Electromagnetic Compatibility*; vol.55, no.2, pp.265-274, April 2013
- [J4] "Powering a Ventricular Assist Device (VAD) With the Free-Range Resonant Electrical Energy Delivery (FREE-D) System"; Benjamin H. Waters, Alanson P. Sample, Pramod Bonde, and Joshua R. Smith; *Proceedings of the IEEE, Special issue on Cyber-Physical System*; vol.100, no.1, pp.138-149, January 2012
- [J3] "Analysis, Experimental Results, and Range Adaptation of Magnetically Coupled Resonators for Wireless Power Transfer"; Alanson P. Sample, David T. Meyer, and Joshua R. Smith. *IEEE Transactions on Industrial Electronics*; vol.58, no.2, pp.544-554, February 2011
- [J2] "RFID: From Supply Chains to Sensor Nets"; Sumit Roy, Vikram Jandhyala, Joshua R. Smith, David Wetherall, Brian Otis, R. Chakraborty, Michael Buettner, Daniel J. Yeager, You-Chang Ko, and Alanson P. Sample. *Proceedings of the IEEE*; vol.98, pp.1583-1592, September 2010
- [J1] "Design of an RFID-Based Battery-Free Programmable Sensing Platform"; Alanson P. Sample, Daniel J. Yeager, Pauline S. Powledge, Alexander V. Mamishev, and Joshua R. Smith. *IEEE Transactions on Instrumentation and Measurement*; vol.57, no.11, pp.2608-2615, November 2008

 CONFERENCE PUBLICATIONS

- [C24] "WINDWare: Supporting ubiquitous computing with passive sensor enabled RFID"; Asanga Wickramasinghe, Damith C. Ranasinghe, and Alanson P. Sample; *IEEE International Conference on RFID*; April 8-10, 2014
- [C23] "Wirelessly Powered Bitstable Display Tag"; Jeremy Gummeson, Aaron Parks, Artem Dementyev, Deepak Ganesan, Joshua Smith, and Alanson P. Sample; *ACM International Joint Conference on Pervasive and Ubiquitous Computing (UbiComp 2013)*; September 8-12, 2013
- [C22] "Sensor Enabled Wearable RFID Technology for Mitigating the Risk of Falls Near Beds"; Roberto L. Shinmoto Torres, Qinfen Shi, Alanson P. Sample, and Damith C. Ranasinghe; *IEEE International Conference on RFID*; April 30 – May 2, 2013
- [C21] "A Wireless Sensing Platform Utilizing Ambient RF Energy"; Aaron Parks, Alanson Sample, Yi Zhao, and Joshua R. Smith; *IEEE Topical Meeting on Wireless Sensors and Sensor Networks (WiSNET)*; January 20-23, 2013
- [C20] "Towards falls prevention: A wearable wireless and battery-less sensing and automatic identification tag for real time monitoring of human movements"; Damith C. Ranasinghe, Roberto L. Shinmoto Torres, Alanson P. Sample, Joshua R. Smith, Keith Hill, and Renuka Visvanathan; *International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*; August 28 - September 1, 2012
- [C19] "Adaptive Impedance Matching for Magnetically Coupled Resonators"; Benjamin H. Waters, Alanson P. Sample, and Joshua R. Smith; *Proceedings of PIERS*; August 19-23, 2012
- [C18] "Optical Localization of Passive UHF RFID Tags with Integrated LEDs"; Alanson P. Sample, Craig Macomber, Liang-Ting Jiang, and Joshua R. Smith; *IEEE International Conference on RFID*; April 3-5, 2012
- [C17] "Toward Total Implantability Using Free-range Resonant Electrical Energy Delivery System: Achieving Untethered Ventricular Assist Device Operation over Large Distances"; Benjamin H. Waters, Alanson P. Sample, Joshua R. Smith, and Joshua Smith; *Cardiology Clinics*, November, 2011
- [C16] "Promise of unrestricted mobility and freedom with wireless powering of a Ventricular Assist Device (VAD)"; Benjamin Waters, Alanson Sample, Joshua Smith, Pramod Bonde; *19th congress of the International Society of Rotary Blood Pumps*; September 8-10, 2011 Winner of the Sezai Innovation Research Award
- [C15] "Wireless Power for Ventricular Assist Devices: Innovation with the Free-Range Resonant Electrical Energy Delivery System (FREE-D) for Mechanical Circulatory Assist"; Pramod Bonde, Alanson Sample, Benjamin Waters, Emily Cooper, Yoshiya Toyoda, Robert Kormos, Joshua R. Smith; *Proceedings 91st Annual Scientific Meeting of American Association of Thoracic Surgeons*; May 7-11, 2011
- [C14] "Photovoltaic Enhanced UHF RFID Tag Antennas for Dual Purpose Energy Harvesting"; Alanson Sample, Jeff Braun, Aaron Parks, and Joshua Smith; *IEEE International Conference on RFID*; April 12-24, 2011
- [C13] "Innovative Free-range Resonant Electrical Energy Delivery System (FREE-D System) for a ventricular assist device using wireless power", Joshua Smith, Alanson Sample, Benjamin Waters, Yoshiya Toyoda, Robert L Kormos, and Pramod Bonde; *American Society for Artificial Internal Organs Journal*; March 2011
- [C12] "Numerical Electromagnetic Analysis of Human Exposure for Wireless Power Transfer Systems"; Andreas Christ, Mark G. Douglas, John Roman, Emily B. Cooper, Alanson P. Sample, Joshua R. Smith, and Niels Kuster; *Proceedings of the Tenth International Congress of the European Bioelectromagnetics Association*; February 21-24, 2011

 CONFERENCE PUBLICATIONS (CONTINUED)

- [C11] "Freeing the LVAD Patient from Drivelines Using Wireless Resonant Electrical Transfer"; Benjamin Waters, Alanson Sample, Joshua Smith, and Pramod Bonde; *Society of Thoracic Surgeons 48th Annual Meeting*; January 30 - February 1, 2011
- [C10] "A Capacitive Touch Interface for Passive RFID Tags"; Alanson P. Sample, Daniel J. Yeager, and Joshua R. Smith; *2009 IEEE International Conference on RFID*; April 27-28, 2009. Winner of Best Paper Award
- [C9] "Experimental Results with Two Wireless Power Transfer Systems"; Alanson P. Sample and Joshua R. Smith; *2009 IEEE Radio and Wireless Symposium*; January 18-22, 2009
- [C8] "Demonstration: RFID Sensor Networks with the Intel WISP"; Michael Buettner, Ben Greenstein, Richa Prasad, Alanson P. Sample, Joshua R. Smith, Daniel J. Yeager, and David Wetherall; *6th ACM Conference on Embedded Networked Sensor Systems (Sensys)*; November 5-7, 2008 Winner of Best Demo award
- [C7] "Revisiting Smart Dust with RFID Sensor Networks"; Michael Buettner, Ben Greenstein, Alanson P. Sample, Joshua R. Smith, and David Wetherall; *Seventh ACM Workshop on Hot Topics in Networks*; October 6-7, 2008
- [C6] "A Passive Sensing and Programmable Computational Platform for UHF RFID Systems"; Alanson P. Sample, Daniel J. Yeager, Pauline S. Powledge, and Joshua R. Smith; *IEEE International Conference on RFID*; March 26-28, 2007
- [C5] "A Wirelessly-Powered Platform for Sensing and Computation"; Joshua R. Smith, Alanson P. Sample, Pauline S. Powledge, Sumit Roy, and Alexander V. Mamishev; *8th International Conference on Ubiquitous Computing*; September 17-21, 2006
- [C4] "Energy Harvesting in RFID Systems"; Alanson P. Sample, Daniel J. Yeager, Joshua R. Smith, Pauline S. Powledge, and Alexander V. Mamishev; *IEEE International Conference: Actual Problems of Electronic Device Engineering*; September 2006.
- [C3] "Sensor Application in RFID Technology"; Daniel J. Yeager, Alanson P. Sample, Joshua R. Smith, Pauline S. Powledge, and Alexander V. Mamishev; *IEEE International Conference: Actual Problems of Electronic Device Engineering*; September 21-22, 2006
- [C2] "Mobile Monitoring for Distributed Infrastructures"; Bing Jiang, Alanson P. Sample, and Alexander V. Mamishev; *IEEE International Conference on Mechatronics & Automation*; July 29 - August 1, 2005
- [C1] "Autonomous Robotic Monitoring of Underground Cable Systems"; Bing Jiang, Alanson P. Sample, Ryan Wistort, and Alexander V. Mamishev; *IEEE International Conference on Advanced Robotics*; June 17-20, 2005

 BOOK CHAPTERS

- [B4] "The Wireless Identification and Sensing Platform"; Alanson P. Sample and Joshua R. Smith; *Wirelessly Powered Sensor Networks and Computational RFID*; Pages 33-57; Springer, 2013
- [B3] "Wireless Ambient Radio Power"; Alanson P. Sample, Aaron N. Parks, Scott Southwood, and Joshua R. Smith; *Wirelessly Powered Sensor Networks and Computational RFID*; Pages 223-234; Springer, 2013 edition
- [B2] "A Portable Transmitter for Wirelessly Powering a Ventricular Assist Device Using the Free-Range Resonant Electrical Energy Delivery (FREE-D) System"; Benjamin H. Waters, Jordan T. Reed, Kara R. Kagi, Alanson P. Sample, Pramod Bonde, and Joshua R. Smith; *Wirelessly Powered Sensor Networks and Computational RFID*; Pages 235-350; Springer, 2013 edition
- [B1] "WISP: A Passively Powered UHF RFID Tag with Sensing and Computation"; Daniel J. Yeager, Alanson P. Sample, and Joshua R. Smith. Chapter 14 in the *RFID Handbook: Applications, Technology, Security, and Privacy*, Boca Raton: CRC Press, 2008.

 PATENTS (ISSUED)

- [P3] US-8,827,889: "Method and system for powering implantable devices"; Joshua R. Smith, Pramod Bonde, Benjamin H. Waters, Alanson P. Sample; September 9, 2014
- [P2] US-8,446,045: "Flat, asymmetric, and E-field confined wireless power transfer apparatus and method thereof"; Joshua R. Smith, Alanson P. Sample, and Emily B. Cooper; May 21, 2013
- [P1] US-8,299,652: "Wireless power transfer apparatus and method thereof"; Alanson P. Sample and Joshua R. Smith; October 30, 2012

 PATENTS (PENDING)

- [PA7] WO-2013-177205: "Wireless power delivery in dynamic environments"; Joshua R. Smith, Benjamin Waters, Scott Wisdom, Alanson P. Sample; November 28, 2013
- [PA6] WO-2012-087444: "Range adaptation mechanism for wireless power transfer"; Emily Cooper, Songnan Byang, Charles J. Bonsavage, Joshua R. Smith, Alanson P. Sample, and Anand S. Konanur; December 21, 2012
- [PA5] US-2012-0234922: "Solar powered RFID tags and method of manufacture therefore"; Alanson P. Sample and Yuri A. Sylvester; September 20, 2012
- [PA4] WO-2012-061766: "Extendable wireless power delivery for small devices"; Emily B. Cooper, John C. Neumann, Alanson P. Sample, Joshua R. Smith; August 2, 2012
- [PA3] WO-2011-037777: "Wirelessly Powered Speaker"; Emily B. Cooper, Joshua R. Smith, and Alanson P. Sample; July 21, 2011
- [PA2] US-2010-0045114: "Adaptive Wireless Power Transfer Apparatus and Method Thereof"; Alanson P. Sample and Joshua R. Smith; February 25, 2010
- [PA1] WO-2008-076547: "Dynamic Radio Frequency Power Harvesting"; Alanson P. Sample and Joshua R. Smith; June 26, 2008

 INVITED TALKS

- "Evolving Passive RFID Beyond the Supply Chain with the Wireless Identification and Sensing Platform"; Alanson P. Sample and Joshua R. Smith; *IDTeckEx: Wireless Sensor Networks & RTLS Summit Europe*; June 21, 2011; Munich, Germany
- "WISP Architecture and Programming Model"; Alanson Sample, as part of the workshop on "Reader Essentials: Learn how to build your own RFID Reader", *Workshop at the IEEE International Conference on RFID*; April 12-24, 2011; Orlando, FL
- "WISP & WARP: Far Field Wirelessly Powered Sensing"; Alanson P. Sample. *University of Washington Computer Science & Engineering Affiliates*; October 27, 2010; Seattle, WA
- "RF Energy Harvesting Techniques and Applications" Alanson P. Sample. *MEMS International / Sensor Symposium 2009*; May 27, 2009; Tokyo, Japan
- "Crossing the Chasm Between Humans and Machines"; Alanson P. Sample; *Intel Developers Forum (as part of Kevin Kahn's R&D Key Note)*; October 21, 2008; Taipei, Taiwan
- "Cutting the Last Cord - Wireless Power Transfer"; Alanson P. Sample; *Intel Developers Forum (as part of Justin Rattner's R&D Key Note)*; August 21, 2008; San Francisco, CA
- "Wireless Identification and Sensor Platform (WISP)"; Alanson P. Sample. *Texas Instruments Advanced Technical Conferences*; November 9, 2006; Dallas, TX

NOTABLE PRESS COVERAGE

- The Economist Blog: "A Wireless Heart"; April 12, 2011
- The New York Times: "Bye-Bye Batteries: Radio Waves as a Low-Power Source"; June 18, 2010.
- The Economist: "Power from Thin Air"; June 10, 2010.
- New York Times: "Smart Dust? Not Quite, but We're Getting There"; January 30, 2010.
- BBC News: "An End to Spaghetti Power Cables"; August 22, 2008.
- New York Times: "Intel Moves to Free Gadgets of Their Recharging Cords"; August 20, 2008.

HONORS & AWARDS

- | | |
|--|---------------------------|
| • Intel: IPR Recognition Award | Second Quarter 2013 |
| • Intel: Nominated for an Intel Labs Academy Award | August 2013 |
| • Sezai Innovation Research Award | September 2011 |
| • ASAIQ: Willem J. Kolff & Don B. Olsen Award | June 2011 |
| • Intel: Intel Labs Divisional Recognition Award | Fourth Quarter 2009 |
| • Intel: Intel Labs Divisional Recognition Award | Second Quarter 2009 |
| • IEEE RFID 2009: Best Paper Award | April 2009 |
| • Intel: CTG Divisional Recognition Award | Fourth Quarter 2008 |
| • SenSys 2008: Best Demo Award | November 2008 |
| • Intel: CTG Divisional Recognition Award | Third Quarter 2008 |
| • Grainger Foundation Fellowship | Autumn 2005 – Winter 2006 |
| • Mary Gates Research Assistantship | Winter 2005 – Spring 2005 |
| • Mary Gates Research Assistantship | Spring 2004 – Autumn 2004 |
| • EEIC Undergrad Research Assistantship | Winter 2004 |
| • EE Bergseth Scholarship | Autumn 2003 |

REFERENCES

References provide upon request