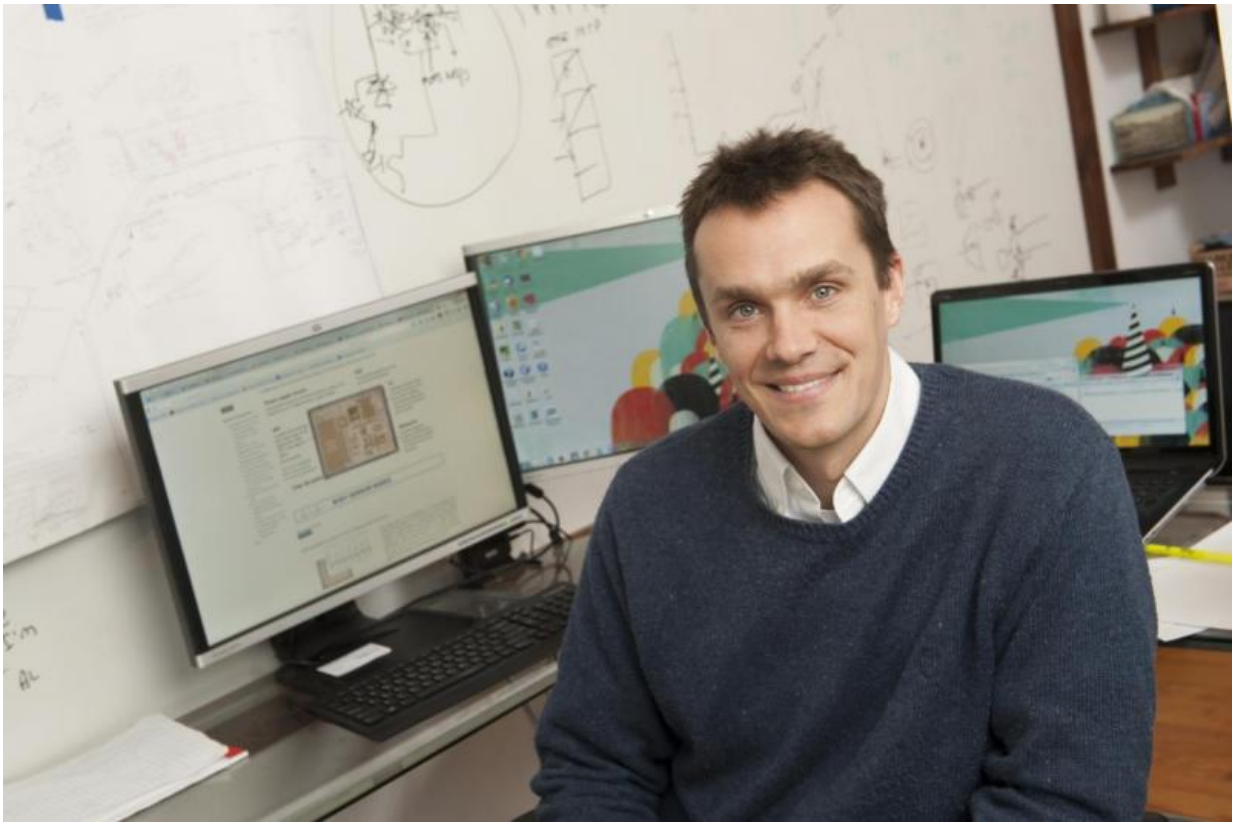
How can we really get to a trillion sensors to power the Internet of Things?

April 6 2015, by Chiara Canzi



Benton Calhoun Credit: Stephanie Gross)

Benton N. Calhoun, Commonwealth Associate Professor of Electrical and Computer Engineering, has been selected as the co-winner of the 2015 Edlich-Henderson Innovator of the Year Award, given by the

University of Virginia's Licensing & Ventures Group.

He is the co-founder of one of the most talked about start-ups in Charlottesville, PsiKick. The company focuses on ultra-low-power wireless sensors, developed by Calhoun and his team at U.Va., and has been regarded by industry experts at the forefront of the generational phenomenon called "The Internet of Things."

He recently sat down to talk about the technology he developed and his vision for how it will impact the future.

Q. What is your technology?

A. My research is primarily in integrated circuit design, essentially a computer chip. Most chips over the last four decades have been driven by the need of higher performance and most people are familiar with chips in the context of desktop computers, laptops or more recently, cell phones and mobile devices. We are building chips that are designed to be extremely low power and the specific applications that we focus on primarily are wireless sensor nodes: a small, battery-powered or otherwise remotely powered device that is stand-alone, not connected to anything else, that communicates wirelessly and senses information from its environment and sends that information wirelessly to some existing structure, like a cell phone or an existing network. That information, then, gets sent back to the stakeholders through the Internet or the cloud.

Q. What is the "Internet of Things" and how do you translate that into something concrete?

A. The "Internet of Things" means a lot of different things to a lot of different people. It essentially refers to the idea that devices and objects on and around people are connected to the Internet and its network. This

idea is very powerful, because it allows machines to communicate with other machines and, in turn, they interact with people in a way that is extremely sophisticated. The vision for the "Internet of Things" is that we will grow to hundreds of billions or even trillions of sensors in the next decade or so and that those sensors will be mostly invisible; they will be integrated into the things that we wear, things that we use, or in our environment in a way that we don't really notice, but they will be collecting useful information and getting that information back in such a way that it creates value for people.

One example is wearable devices – devices that masquerade as jewelry, but actually provide some function, such as measuring a person's heart rate. Our technology is allowing us to prove the capabilities of all of these different applications. Right now, these applications need to either be wired to an outlet or they need to be run from a battery. It's easy to calculate that if there are a trillion sensors, even if you give each of them a battery that lasts for 10 years, you will still need to change 270 million batteries a day. We look at that and think, 'How can we solve the problem? How can we really get to a trillion sensors?'

That was a big driving motivation for developing technology that allows us to provide these useful functions, but in such a way that we can get rid of the battery, harvest energy from the environment, through solar or thermal radiance or other mechanisms, and then use that harvested energy.

Q. What is your vision for the future of your field and this technology in particular?

A. The future of this technology is surrounding this "Internet of Things" idea and scaling to trillions of sensors. It's easy to think that that could happen, because a cell phone already has six to 10 sensors in it; you

probably drive a car with 40 to 60 sensors in it and your house has sensors in it. The number of sensors per person in a developed country is already high and that is set to explode in the future. If we fast-forward a decade, I would envision smart systems that not only collect information, but actively change the environment in ways that would keep people safe and more informed.

We started looking at wearable body sensors with the idea that we wanted to take the technology we were working on and immediately add value to it. The first systems-on-chip that we built were in body-sensor nodes: they measured electrocardiogram signals and were capable of measuring brain waves and muscle activity. "System-on-chip" is simply the placement of a lot of different pieces on one chip – they include parts that harvest the energy, the circuits that measure signals of the body, the radios that communicate and all the processing that happens to collect the data, process it, extract information and dissipate it. Our goal is to allow for improved medical and clinical applications enabling continuous and longitudinal access to information. Instead of wearing a device that would collect information about your heart for a day, you can potentially have a device that harvests energy from the body, is worn in clothing and keeps continuous monitoring. This kind of technology can revolutionize health care.

Q. What has been the impact of New Enterprise Associates' contribution to PsiKick?

A. After I received tenure, I decided it was time to commercialize the technology I had been working on. The work we are doing at the University has real potential to affect people in a positive way.

I got together with David Wentzloff, who is an old friend from graduate school who is now a professor at the University of Michigan; we had

been collaborating on academic projects for a long time, but we decided that we wanted to start a company. PsiKick is commercializing the very low-power wireless systems-on-chip that we have been building in the universities. The idea is to provide a platform for self-powered, battery-less devices in the "Internet of Things."

Once we started the company, in order to get it on its feet, we raised a seed round from angel investors, mostly in Charlottesville. We were introduced to NEA, a venture capital firm. They decided to invest in us in the Series A round and we have benefited tremendously from their expertise. The folks on our board, Greg -Papadopoulos and -Forest Baskett, are invaluable in their experience in this industry and they have been great advocates for the company and great advisers as well. The partnership is ongoing.

Q. How do you balance being a full-time faculty member and an entrepreneur?

A. I still actively run my research group at U.Va. I am also participating in the company and I think the way to make it work is to have great people around. I have a terrific team at the University; my graduate students are all top-notch and we work really well together. On the company side, I also have a terrific team, both management and engineers, many of whom have worked with me before in the graduate program. These teams get work done on each side and it's a privilege for me to work with both of them.

Q. What does this innovation award mean to you and your team?

A. This award is a really big honor. It is a real validation and recognition of the kind of work my team has been doing for the last eight or nine

years at the University of Virginia and more recently at PsiKick. Any researcher is very interested in having a large impact and we measure that impact in the number of publications and who else is using our work, but to get recognition like this just adds to the feeling that the work we are doing has really been seen and appreciated.

Provided by University of Virginia