Smart science to power the Internet of Things

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SUMMARY

In the 21st century we are used to connected technology reliably working in the background to monitor and fine-tune our environment. We have also come to expect that we can communicate easily and instantly with others around the world.

This level of instant connectedness requires not only clever engineering but also smart science, so that devices can function as needed in their environments.

Professor R. Bogdan Staszewski at UCD School of Electronic & Electrical Engineering is solving fundamental issues to enable devices to monitor and communicate at scale as the Internet of Things. He is also developing technology to allow human communication in even the most challenging of environments, such as sites of natural disasters.

Professor Staszewski works closely with industry leaders such as Intel, Xilinx and Analog Devices, and his research has resulted in hundreds of patents and two start-up companies based in Europe.

Enabling the Internet of Things to enable us

How many times in recent days, or even recent hours, has the Internet made your life easier? Being connected to information allows us to plan, to keep up to date and to keep in touch with colleagues and friends.

That is the Internet of People. But what’s coming next is the Internet of Things: billions of connected devices that collect and share information and, if needed, prompt action.

“By the year 2020, there are expected to be 30 billion devices in wireless sensor networks, and in the next decade there will be more than a trillion, so perhaps 100 devices for every person on Earth,” says Professor Bogdan Staszewski.

“You can imagine that in your house, these devices could be embedded in walls monitoring pressure and structural defects, tracking the temperature and presence of people in different rooms so the temperature can increase just in the areas where it is needed and so you save energy. Then you can think about the possibilities in industry and the environment, where devices monitor processes and conditions automatically and report back with information to improve efficiency and spot issues early or even before they arise.”

While the concept of the Internet of Things opens up countless opportunities to solve commercial, environmental and societal problems, it won’t happen without clever engineering and scientific research to ensure that the devices are cost- and energy efficient and that they can carry out their functions reliably in the environments where they are deployed.

Powering impact to build connections

This is where Professor Staszewski is making a difference. “These **devices need to be cheap so they can be made at scale and remain affordable, and they need to harvest energy**, maybe from sunlight or through movement. Where we come in is to design the circuits and electronics in devices so they can use energy efficiently and they can measure what is required,” he says. “We are working on all kinds of electronic circuits to interface with energy harvesters and make smart use of those resources, and we design the ‘brain’ and build communication circuits to send information to other nodes or devices.”

Professor Staszewski’s expertise has led to **collaborations with various companies, including Analog Devices, Xilinx**

and Intel. “We are a research group, we are solving research issues,” he explains. “We work with our partners and enable the partners to build productive technologies. The Internet of Things is a huge and diverse area and it is not a case of one-chip-fits-all, so we work with different groups on the challenges they face.”

That challenge might be to develop a sensor that can reliably detect small changes in the environment reliably, but that does not need extensive factory calibrations, because this would make its manufacture too expensive. “These are the kinds of scientific challenges that need to be solved before the engineering can be done at scale in a way that will be useful to consumers and industry,” says Professor Staszewski.

The impact of his electronics research, which is funded by Science Foundation Ireland and European Research Council, will be to **enable the Internet of Things through low-power and smart circuits**, and the applications of those technologies stand to **revolutionise how human societies monitor the environment, use natural resources such as water and energy, drive economies and facilitate human health and wellbeing.**

“As examples of how this approach could be of environmental benefit, you can monitor chemicals in the environment in real time to detect pollution,” he says. “And you can put sensors on crops in areas prone to drought to monitor moisture and ensure you are using enough water to support growth but not too much water that it is wasted. There are so many possibilities.”

As well as enabling devices that talk to each other, Professor Staszewski is also **developing more robust technology to help people communicate in a crisis**, such as a natural disaster. He is in a process of securing funding to work on inexpensive base stations that can be deployed in emergency situations where the local infrastructure for communication has collapsed.

“This kind of technology would mean that, suppose after an earthquake, people can communicate using their mobile devices, perhaps even signaling where they are trapped,” he explains.

Professor Staszewski has made **major contributions to the academic research in electronics**: he has co-authored three books, five book chapters and more than 200 journal and conference publications. He is an **IEEE Fellow and a recipient of 2012 IEEE Circuits and Systems Industrial Pioneer Award.**

Professor Staszewski has achieved considerable **success in bringing research findings towards commercial application**. While at Delft University of Technology in the Netherlands (where he remains a part-time Full Professor) he co-founded two companies: Fastree3D for 3D sensors on autonomous cars, and DITIQ to enable fully digital transmission of information.

He also currently **holds more than 200 patents arising from his research**, and has built up a considerable cohort of experts. “Right now, in 2017, we have 5 postdocs, 21 PhD students in UCD and four in Delft, four thesis Masters students and four additional Masters students doing summer internships,” he says. “And in my group on average every PhD student gets granted a patent per two years.”

Research References

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