UCD Impact Case Study

A Boost for Wireless and Energy-Harvesting Technologies

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SCIENTIFIC · TECHNO-LOGICAL · ACADEMIC · ECONOMIC

SUMMARY

One of the driving trends of the 21st century is technology's ability to connect. Dr Elena Blokhina at UCD School of Electrical & Electronic Engineering is working on fundamental approaches to enabling even more efficient connection into the future.

She is developing new architecture for signal generation to facilitate 5G, the latest standard in wireless infrastructure, and she is designing energy-harvesting technology to enable small devices such as sensors to use nearby movement as a power source. The impact will be a more connected and sustainable web of devices.

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Complex, Sustainable Systems

Wireless architectures and infrastructures allow devices to establish connections and transfer information, whether it's a conversation between humans, a data transfer for business or a remote sensor relaying information about its environment.

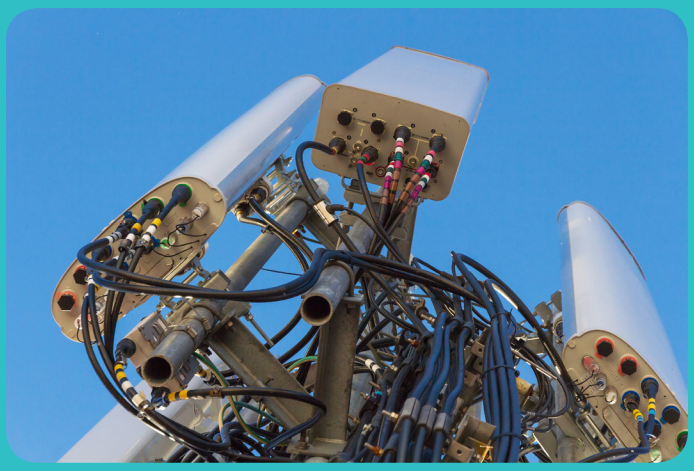
Dr Blokhina's research seeks to improve the fundamental functioning of wireless communication between devices, both by improving the underlying architecture for generating signals and by enabling sensors to harvest energy from their surroundings.

"In electronics, you can take a system and improve circuit by circuit, but we want to come up with a new vision for systems and architectures," explains Dr Blokhina, who is currently working on 5G, the most efficient and ambitious global wireless network standard yet. "We want to see if it is feasible to achieve the standards required for 5G."

One aspect of this work, funded through the Science Foundation Ireland CONNECT Research Centre and Enterprise Ireland, involves designing interactions between signals and antennae. "A physical device sends electromagnetic waves, and to transmit and receive a signal you need an antenna," says Dr Blokhina. "We are looking at smart ways to manage this, how we can interconnect numerous antennae and synchronise them so they can receive the transmission efficiently and quickly. It's a very complex, non-linear system."

Another strand of Dr Blokhina's work, which receives funding from SFI, looks at how small, remote devices, such as sensors, can make use of the energy available in the environment.

"If you have a network of sensors and devices out in the environment, they need an ongoing source of power, because it is not practical or sustainable to go out and replace batteries in these distributed devices," she explains. "So, we are designing a system that can take vibrations from the environment – maybe from traffic passing over a bridge, for instance, or from people walking up and down a staircase – and the system can convert that into power for the device."



A More Sustainably Connected World

The overall impact of Dr Blokhina's research will be **a move towards more sustainable and smart connectivity around the globe.** "5G is an ambitious standard of connectivity, so we need to design the architecture to enable that," she says.

The success of 5G will in turn **enable faster and more responsive connections for the billions of devices that require a mobile Internet connection**, from smartphones to connected home appliances to autonomous vehicles and even devices that sit in the environment and track important factors such as environmental changes or traffic flow.

Many of these remote devices need a power source, and again Dr Blokhina's research will **help to ensure that they can continue working, drawing power from freely available energy** in the environment.

"We all want a more sustainable world, so we need to tackle the issue of wasting energy powering small sensors," she says. "Think about tens of billions of devices, all needing power. When you add those together, it's a huge energy demand, but if we can design systems that can harvest that energy directly from movement nearby, then you save on using other, less sustainable forms of energy. It is a distant vision, but you need this vision to progress."

Dr Blokhina describes the electrostatic energy harvesting as a particular niche where her research shows strength at a global level. "As a group between UCD and Sorbonne University, with whom we collaborate, we have published several papers and books on these non-linear systems, which are hard to design. We are among the most advanced in the design of such complex systems."

Supporting Other Engineers

As well as carrying out her research in UCD and as a Visiting Professor in Sorbonne University in Paris, Dr Blokhina plays an active role in the professional development of engineering. She is a senior member of the Institute of Electrical and Electronics Engineers (IEEE) and the Chair Elect of the IEEE Technical Committee on Nonlinear Circuits and Systems, and she has presented special sessions and tutorials on nonlinear energy harvesters, the complexity of systems-on-a-chip and the nonlinear dynamics of micro-scale systems. IEEE is the world's largest technical professional organization dedicated to advancing technology.

Dr Blokhina also helps to enable women in engineering - from 2014 to 2017 she chaired the IEEE CAS Young Professionals and Women in Circuits and Systems committee. "We do a lot of work for women who are early-career stage researchers," she explains. "This is important as women are in the minority in engineering, and we want to ensure they have technical and professional support."

Research References

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