UCD Impact Case Study

Optimising the Last Mile of 5G Wireless Networks

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SUMMARY

Fifth-generation wireless networks, commonly known as 5G, seek to send data rapidly and reliably. To achieve this, a critical issue that needs to be resolved is the 'last hop' between users' devices and the serving base stations. Specifically the connections in the last hop of a wireless network can suffer from severe interference, and it is expensive and inefficient to overcome that by allocating dedicated time slots or frequency bands to each device.

Dr Le-Nam Tran at UCD School of Electrical & Electronic Engineering is developing new ways to optimise this important step in transmission for future wireless networks, and the impact will be a more reliable, affordable, sustainable communications system.

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Overcoming Interference

When a device talks to a wireless network, it first needs to communicate with a base station that can receive and transmit signals. This is a key link between the local device and the broader network.

What happens at this 'local hop' though can be complicated. Wireless signals are generally omnidirectional, and thus when multiple devices are looking to communicate at the same time, they interfere with each other. The signal strength is reduced and so is the speed of the whole network. In addition, wireless signals travel through an open space that offers hackers more entry points. Thus security may be compromised by eavesdroppers.

Dr Tran is working on new ways to overcome these issues, using a holistic approach and advanced mathematical tools. "I am mostly working on the last mile of wireless communications systems, to provide the methods to make the transmission from base stations to mobile phones or wireless devices fast and reliable," he explains.

"When you transmit a signal from your device, it will interfere with signals from other devices, and if you don't have a way to deal with that interference, then nobody can send messages."

Dr Tran leads a project supported by a Science Foundation

Ireland Career Development Award called 'Green and Secure Transmission Techniques for Future Wireless Networks' in which he looks to resolve the device-to-base-station communication.

"One of the most important things to control is the power of the signal," he explains. "If the signal from one user is too strong the signals from other users are lost. Current ways to get around that are to buy a dedicated channel, which is expensive, or allocate a distinct time slot for each user. But both can be wasteful if only a small amount of information is being transferred. My research is looking at how to design the signals so you avoid interference in a way that keeps the cost down and keep the security high."

Tackling Barriers to 5G

5G offers the possibility of rapid mobile connections, which will in turn **enable technologies such as the 'Internet of Things'**, which includes self-driving vehicles, smart-home appliances and environmental sensors. However, while 5G aims to provide fast data links, the challenges of providing an affordable, energy-efficient and secure service remain to be solved.

"My research is really motivated by the on-going development of this new wireless standard," explains Dr Tran. "5G will require that we can support many users at the same time and the speed of data will be around 10 times faster than the current 4G rates. Using sophisticated technologies to do this is very expensive, and this is a barrier for telecoms companies and also for consumers. That's why I want to **figure out how we can achieve fast, secure, reliable connections** using low-cost methods."

Reduced Energy and Better Security

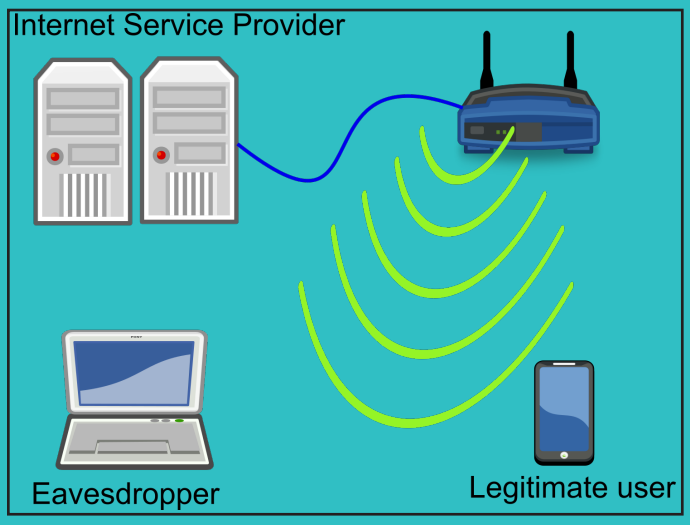
The mathematical algorithms, or solutions, that Dr Tran develops will allow base stations to form radio beams in a manner that supports several low-power devices at the same time. This will avoid the need for separate channels or time slots, and it will reduce the energy cost.

"Communications technologies account for about 10 per cent of the world's energy demands, and this is set to rise with 5G. So we need to come up with smarter ways to transmit signals between devices and base stations reliably with minimal amounts of energy," explains Dr Tran. "My research will enable this."

Security, too, will benefit from Dr Tran's optimised approaches to linking with base stations. "In our homes, as we get more and more smart appliances, we need to have better ways to handle both the interference and also the vulnerability to eavesdropping," he explains. "Better security will encourage more widespread adoption."

Bringing Down the Cost

The key to Dr Tran's approach is to use mathematical programming to optimise how signals are transmitted between base station and device. Using such low-cost and low-complexity methods should **reduce the cost of providing a fast and reliable service in 5G**, he explains. "When you use a lot of complex technics to meet the demand you spend a lot of money, so my research tries to reduce the complexity of achieving the same goal. When you don't need to spend as much in the equipment and operation of the network, that should make it more affordable and eventually benefit the end users."



Ultimately, the research on system design and performance analysis will enable the goals of 5G, according to Dr Tran, who has **authored or co-authored in some 80 papers** published in international journals and conference proceedings. "Without this kind of research, we are not likely to foresee the achievable performance and to use radio resources in the best way. This research is about making wireless communication systems better."

Research References

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