
Popular Science Summary

Recent developments in wireless communications, and the road towards 6G means that, billions of small communication devices will be used, in a broad range of applications, in the near future. Existing technology for these devices uses complex components, making them costly and consume considerable amounts of energy, as they have to generate their own radio signals. Therefore, it is interesting to explore an alternative technology, in which these small devices can be designed with simple components, and require little to no power to operate. Ambient backscatter technology is one such alternative, in which the devices can communicate using the ambient radio signals, generated from already existing sources like Wi-Fi routers and cellphone towers. This technology can also allow devices to harvest energy from the ambient signals, thereby making them self-sustainable. These features mean that the ambient backscatter devices can operate with a net-zero/ultra-low power consumption.

That said, the ambient backscatter technology is at its infancy, and it needs to overcome many challenges, before it is adopted widely. For instance, the backscatter signals are typically very weak, and they face strong interference from the existing signals in the environment. In addition, backscatter signals are also severely affected by the fading in the channels. It becomes a challenge for the backscatter devices to solve these problems, using simple designs, and very low power consumption. Furthermore, a wide range of future applications mean that the performance of ambient backscatter systems needs to be studied across various environments.

Therefore, in this thesis, we provide simple structures for the backscatter device and the receiver, and we address the above problems using well-known transmission and detection techniques. We also study the performance of ambient backscatter systems across different channels, environments, and frequencies. In addition, we provide an analysis on how the error rates, data rates, and signal coverage of ambient backscatter systems are related to one another in a variety of scenarios.