Frontiers of 5G: Sparse Adaptive Battery-less Ambient Backscatter Communication Networks

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This research project explores the interconnected schemes of ultra-low power ambient backscatter to function as the basis of the next generation of telecommunications technology integration. However, current telecommunication schemes suffer from connectivity and complexity issues as a result of implementing ultra-low power backscatter devices on highly-overloaded networks. Consequently, a novel network structure was developed to facilitate communication of high-user, battery-less ambient backscatter devices. In the physical network layer, a differential encoder and optimized signal modulation mechanism were implemented. Modulation order was optimized using Additive White Gaussian Noise (AWGN) Constellation Plot simulations. Clustering analysis of these simulations demonstrated the effectiveness of Quadrature Phase Shift Keying (QPSK) in maximizing data throughput while maintaining backscatter tag connectivity. In the link-layer level, a Sparse Code Multiple Access (SCMA) scheme was reworked considering channel estimation mechanisms to identify ambient backscatter tags. A novel compressive scheme was derived and implemented to minimize Bit Error Rate (BER) while efficiently identifying devices and leveraging orthogonality. This architecture was evaluated using open-form theoretical and Monte Carlo simulation of Conditional BER while optimizing data-transmission parameters. With many applications, ambient backscatter tags were theoretically investigated as sensor interfaces for battery-less implant devices through an exploration of signal propagation limitations in biomaterials. A backscatter tag was designed for implant environments with a proof-of-concept backscatter tag, receiver, and client implementation sending User Defined Protocol (UDP) packet data over WiFi.

Awards Won: