Modeling and Performance Analysis of Wireless Networks With Ambient Backscatter Devices

Abstract:

Ambient backscatter is an intriguing wireless communication paradigm that allows small devices to compute and communicate by using only the power they harvest from far-field radio-frequency (RF) signals in the air. Ambient backscattering devices reflect RF signals emitted by existing or legacy communications systems, such as digital TV broadcasting, cellular, or Wi-Fi ones, which are designed for transporting information and are not intended for RF energy transfer. This paper deals with mathematical modeling and performance analysis of wireless broadband networks operating over fading channels with ambient backscatter devices. After introducing a detailed signal model of the relevant communication links, we study the influence of physical parameters on the capacity of both legacy and backscatter channels, by considering different receiver architectures. We analytically show that, under reasonable operative conditions, a legacy system-employing an orthogonal frequency-division multiplexing (OFDM) modulation scheme-can turn the RF interference arising from the backscatter process into a form of multipath diversity that can be exploited to increase its performance. Moreover, our analysis proves that a backscatter system-transmitting one symbol per OFDM symbol of the legacy system-can achieve satisfactory data rates over relatively short distances, especially when the intended recipient of the backscatter signal is co-located with the legacy transmitter, i.e., they are on the same device.