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— Invited Paper — Backscatter Communication and RFID: Coding, Energy, and MIMO Analysis

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Abstract:

Radio Frequency IDentification (RFID) is intended to supplant legacy (optical) bar code scanning technology found in many logistic and retail applications. RFID is distinguished by inexpensive, low power and compact form factor tags, whose longevity and efficacy are predicated on using passive communication techniques and on-tag power harvesting. Such tags employ backscatter modulation, which does not require any active RF components. As a result, backscatter has become an attractive design choice for short-range communications in power constrained wireless sensor networking scenarios. The purpose of this work is two-fold. First, it aims to expose backscatter communication as an emerging topic to a communication systems-theoretic audience. Since backscatter modulation and on-tag power harvesting efficiency are coupled, it is necessary to re-examine notions of power and spectral efficiency from an energy-constraint perspective; this leads to novel coded modulation schemes for future RFID systems. Further, we investigate RFID MIMO systems where the channel fading encountered has different statistics than the classical Rayleigh fading model. In turn,the trade off between diversity order and spatial multiplexing gains are distinct from wide-area MIMO.

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I. Introduction

Radio Frequency IDentification (RFID) technology is a short-range wireless communication technique for reading data such as an electronic product code (EPC) (and increasingly, other relevant information) stored on a tag affixed to objects [1]. The information on EPC-tagged objects are communicated to a nearby RFID reader via backscatter modulation, which is the focus of this work. Seen as a way to improve on the limitations of the present-day optical bar code reader systems, commercial adoption of RFID has been critically enabled on (ultra) low-cost tags. This has lead to an emphasis on passive tags that operate without any on-tag power source and rely entirely on backscatter, as a passive communication method, for the tag-to-reader uplink. Consequently, the maturation of passive low-cost RFID tag technology has made it a viable candidate for more general wireless sensor networking scenarios [2] [3] where short-range, low rate links suffice.

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