Low energy wireless relay networks using physical layer network coding

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There are increasingly many applications for networks of autonomous wireless devices communicating with some central server, including wireless sensor networks (WSNs) of various kinds, vehicular networks, 'smart grid' systems, and body area networks, to name a few. However in such systems energy is particularly at a premium, since these devices are often reliant on batteries, or on energy harvesting. The use of relays can in principle reduce the energy required for data transmission, by reducing the range over which the devices must transmit. However in conventional WSNs it is often found that energy savings due to relaying may be minimal, partly because of the energy consumed by the relays in processing the signals, and partly because the relayed transmissions tend to increase congestion in the network, resulting in more collisions.

In this paper we consider an approach based on physical layer network coding which can avoid this by allowing most collisions to be resolved. If two or more devices happen to transmit simultaneously, instead of both packets being lost, the relay decodes some function of the data of the two packets (the simplest such function being the XOR of the data). These functions are then combined at the final destination to recover the original source data. In this way collisions may be exploited and retransmission avoided. The paper will analyse the potential for energy saving using this paradigm compared to conventional contention-based protocols, considering a simple WSN topology.