Towards Energy Efficient Protocols for Active RFID

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Abstract

The absence of a global standard is a bottleneck when using Radio Frequency Identification (RFID) technology. This thesis explores data communication protocols for Active-RFID regarding their energy efficiency and how they can be suited to fit a large variety of applications.

The use of Radio Frequency Identification systems (RFID) is growing rapidly. Today, mostly “passive” RFID systems are used because no onboard energy source is needed on the transponders. However, “active” RFID technology, with onboard power sources in the transponders, gives a range of opportunities not possible with passive systems. Besides that Active RFID offers longer working distance between RFID-reader and tag than passive RFID, this also enables the tags to do sensor measurements, calculations and storage even when no RFID-reader is in the vicinity of the tags.

To obtain energy efficiency in an Active RFID system the data communication protocol to be used should be carefully designed with energy optimization in mind. This thesis describes how energy consumption can be calculated, to be used in protocol definition, and how evaluation of protocols in this respect can be made. The performance of such a new protocol, in terms of energy efficiency, aggregated throughput, delay, and number of air collisions is evaluated and compared to an existing, commercially available protocol for Active RFID, as well as to the IEEE standard 802.15.4 (used e.g. in the Zigbee medium-access layer). Simulations show that, by acknowledging the payload and using deep sleep mode on the tag, the lifetime of a tag is increased.

For all types of protocols using an air channel for transmitting and receiving information it is obvious that the utilization of that channel is maximized when no collisions occur. To avoid and minimize collisions in the air interface it is possible to listen to the channel (carrier sense) and know its status. Knowing that the channel is occupied should result in a back-off and a later retry, instead of persistently listening to the channel which would require constant energy consumption. We further study the effect on tag energy cost and packet delay incurred by some typical back-off algorithms (constant, linear, and exponential) used in a contention based CSMA/CA (Carrier Sense Multiple Access/ Collision Avoidance) protocols for Active RFID communication. The study shows that by selecting the proper back-off algorithm coefficients (based on the number of tags), i.e. the initial contention window size and back-off interval coefficient, the tag energy consumption and read-out delays can be significantly lowered.