Wireless Powering/Harvesting for RFID Sensors

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With the explosion of mobile phones and wireless internets, we are now living in a sea of radio waves. Unfortunately, most of the radio frequency (RF) energy just goes wasted unless it's intercepted by its intended RF devices. We are also living in the world of sensors which play important roles in safeguarding our modern technologies and infrastructures. Most sensors require electrical power for either sensing operations or for sending sensed data to data collection and processing devices. Such power is commonly provided from batteries that need to be recharged or replaced periodically, which undesirably increases operation cost and decreases sensor's life cycle. There are many applications where embedded sensors would be very useful but have not been taken advantage of due to the inability to service the batteries. Therefore, it makes sense to harvest the ubiquitous RF energy for sensors or to wirelessly deliver power to sensors.

Harvesting RF energy requires first intercepting and capturing the RF signals, and then converting them to DC power for operating sensors. The two key technology bottlenecks here are the antenna and RF-to-DC rectifier. The former is related to the dimension of the RF harvesting or reception device. A small (w.r.t. wavelengths) antenna area intercepts less RF power to be rectified. A large antenna area, however, may not be acceptable in practice.

The bottleneck associated with the rectifier is related to its RF-to-DC conversion efficiency which is currently limited to approximately 70% and is often a non-linear function of received RF power and frequency. Therefore, the rectifier often needs to be tuned for specific input power level and frequency to maximize its efficiency. We introduced three novel rectifying circuit design that features (1) better efficiency at lower power (-20 ~ -10 dBm), (2) harvesting RF harmonics at output of rectifying diode, and (3) harvesting entire spectrum from 900 to 2500 MHz. These rectifier design and results will be presented.

In the case of wireless power delivery, a narrow RF beamwidth is used for maximal and targeted power delivery. The input power to the rectifier can be much higher than previous ambient RF energy case, and therefore the efficiency needs to be optimized for such condition. This efficiency optimization involves input impedance matching network, output load optimization, and most importantly, choosing the right rectifying diode. We will discuss about the diode selection guidelines and present some rectifier circuit design examples for input power in a few Watts range.