Tutorial: Advanced UHF RFID Tag Antenna Design (April 3: 8:30 am – 12:00 pm)

Organizer: Gaetano Marrocco (University of Roma Tor Vergata)

Things equipped with electronic labels having both identification and sensing capabilities could naturally be turned into digital entities in the framework of the Internet of Things. Radio frequency identification (RFID) technology offers the natural background to achieve pervasive sensing, provided that the basic physics governing the electromagnetic interaction phenomena are fully exploited and engineered. This tutorial reviews the design of tags for labeling and sensing with the purpose of showing how advanced and non-conventional performance may be achieved by means of low-cost battery-less devices. The most appropriate methodologies to design and evaluate tags are described with great attention to miniaturization, to the compatibility with metals, high dielectrics and the human body, as well to exploit new multi-chip systems and the integration with sensors.

Topics Included

- Introduction to UHF systems: direct and inverse links, performance parameters (gain, rcs, tau, sensitivity, effective sensitivity, bandwidth, analog identifier)
- Classification: tag for low-permittivity objects, for metal and lossy objects, wearable tags, implanted tags
- Methods for Conjugate Matching: T-match, coupled-loop, Nested slot; matching charts
- Methods for size reduction: meandering, planar folding, embedded resonators, high dielectrics
- Measurements and Testing. Method of the image plane, turn-on method, Analog identifier
- Multi-chip tags: The RFID grid, maximization of power scavenging by engineered electromagnetic coupling
- Design tags as sensors. Sensing modalities (self sensing, sensor-powered). Communication and Sensing charts. Deformation sensor, gas sensors, motion sensors, temperature sensors, implantable sensors.

Tutorial: RFID Technical Tutorial (April 3: 8:30 am – 12:00 pm)

Organizer: Dale R. Thompson (University of Arkansas)

Radio frequency identification (RFID) information systems provide information to users about objects with RFID tags. Typically, students experience only narrowly focused layers of an RFID system such as the tag, air interface, reader, network, middleware, or applications in separate courses instead of a system-wide approach. This tutorial provides an overview of RFID systems with enough technical detail to understand the details of RFID with a focus on the EPCglobal UHF Class-1 Generation-2 (Gen-2) passive tags.

Topics Included

- RFID Background: History, Applications, RFID Reference Model, Types of Tags, Shareholders, Hacking, Social Implications, and Privacy
- Tag Layer: Architecture and EPCglobal Gen2 Tag Finite State Machine
- Media Interface Layer: Frequency Bands, Electromagnetics, Antennas, Nominal Read Range, Modulation, Encoding, Data Rates, Fast Fourier Transform, and Singulation
- Reader Layer: Architecture, Antenna Configurations, Gen2 Sessions, Gen2 Single-, Multiple-,and Dense-Interrogator Operation, Low Level Reader Protocol (LLRP), and Middleware
- RFID Standards, Laws, Regulations, Policies, and Guidelines: EPCglobal, ISO/IEC Item Management, Contactless Smart Cards, Animal Identification, FCC Rules for ISM Band, Identity Standards, and Guidelines for Securing RFID Systems

Workshop: RFID and Sensing (April 3: 1:30 – 4:30 pm)

Organizers: Rahul Bhattacharyya (MIT), Radislav A. Potyrailo (GE Global Research), Pavel Nikitin (Intermec), Rich Fletcher (TagSense)

RFID has matured into a low-cost, reliable wireless communication technology. Originally intended for object identification, the opportunity to look beyond the "ID" in RFID presents itself – and the domain of wireless sensing is one exciting avenue of research gaining traction in the community. Researchers have adopted several diverse approaches to RFID based sensing: some approaches focus on RFID as a passive front end to solid state electronics, others attempt to exploit the RFID tag antenna as a sensing mechanism while others focus on printed electronics. The RFID and Sensing Workshop presents a forum to facilitate an interactive dialogue between researchers and industry professionals in the area of RFID based sensing. The half-day workshop includes academic presentations, industry presentations, and question-and-answer sessions.

Topics Included

- Overview of LF, HF, UHF and Chipless RFID Sensing Approaches
- Overview of UHF RFID and Position Sensing Methods
- Key milestones in RFID-based sensing over the past 20 years
- RFID Tag Antenna Based Sensing
- HF RFID Tag-Sensors for Medical Applications
- The Intel WISP
- Wearable and Implanted Tags in Biomedical Engineering

Workshop: RFID Emulators and Simulators (April 3: 1:30 – 4:30 pm)

Organizers: Jin Mitsugi (Keio University), Alanson Sample (University of Washington), Christian Floerkemeier (MIT)

The industrial advantage of RFID is the enhanced visibility in business information systems. Therefore, it is essential to evaluate and show the contributions of advance RFID hardware and software technology onto business process. Most of RFID hardware and software platforms have been independently developed and used within limited research communities. Exchanging information among such local initiatives would motivate collaborations and speed up the developments and, consequently, enhance the adoption of RFID technology. This workshop collects recent developments on RFID hardware and software platforms, which include RF tag emulators, software defined interrogators, RFID protocol simulators and open source information systems.

Topics Included

- RF Tag Emulators
- Software Defined Interrogators
- RFID Protocol Simulators
- Open Source Information Systems

Workshop: 5.8 GHz for RFID and Sensors (April 3: 1:30 – 4:30 pm)

Organizer: Gregory D. Durgin (Georgia Tech)

Workshop presentations will explore technical issues relevant to 5.8 GHz passive and backscatter communications. This band, with its smaller overall wavelength and higher total bandwidth, is very promising for future operations of sensors and RFID -- but only after significant technical challenges are addressed. For example, the higher frequency allows for very small, compact antennas and enables multiple-antenna tags in a small tag footprint. This truly international ISM band has at least 125 MHz of contiguous bandwidth to exploit for new tag-reader signaling schemes and passive tag excitation methods. However, there are significant hurdles in terms of reader design, energy-harvesting circuitry, integrated circuit fabrication at 5.8 GHz, and multiple access. This workshop will highlight both the current state-of-the-art as well as the challenges of this exciting new band of operation for RFID.

Topics Included

- Antenna Design at 5.8 GHz
- Microwave Backscatter Modulation
- Multi-Antenna Techniques for Tags & Readers Semiconductor
- Issues for 5.8 GHz ASIC Design
- Microwave Energy Harvesting
- Multiple Access Techniques Reader Design at 5.8 GHz
- Examples of Sensing Applications at 5.8 GHz