Sr. No	Paper Title	Abstract
1	RFID-Grids for Deformation Sensing	This paper explores the possibility to monitor structural deformations by means of grids of antennas. Deformations, occurring in engineering structures due to unexpected loading conditions and to obsolescence, may lead to potentially dangerous events, especially in critical environments such as aerospace platforms or civil infrastructures. By engineering the electromagnetic interaction among the elements of a grid of UHF Radiofrequency Identification (RFID) tags, it is possible to extract various measurable indicators useful to track the local as well the overall deformation of the body on which the antennas are attached on, and hence to monitor the "health" of sensitive structures.
2	Channel Estimation in Tag Collision Scenarios	Multiple tags in Radio Frequency Identification (RFID) systems are scheduled by a medium access control layer using the Framed Slotted Aloha (FSA) or binary tree protocol. The focus of our research is on FSA and passive Ultra High Frequency (UHF) RFID. In current standards, only one tag can be acknowledged per slot. In this work we propose the increase of the theoretical throughput of FSA RFID systems with multiple antennas for physical layer collision recovery by acknowledging two tags per slot. The expected throughput increase is approximately 5.03 times the throughput of a conventional reader. In order to profit of such increase we propose a method for channel estimation with a modified tag response, a so-called "postpreamble". The influence of the channel estimation on the performance is investigated through simulations.
3	An Active MOS Diode with Vth-Cancellation for RFID Rectifiers	An active MOS diode for low voltage and low power RFID rectifiers is presented. The diode is based on the technique with internal threshold cancellation (ITC) for MOS diodes and uses a simple control scheme to minimize the diode reverse leakage so that full threshold cancellation is achieved. A theoretical background that illustrates the limitations with the ITC diode and a detailed presentation of the proposed diode with a short design procedure is included. The proposed diode is implemented in AMS 0.35 Î¼m CMOS and simulated in Cadense Spectre in a single diode rectifier. With a diode voltage ranging from 50 to 100 mV, the proposed diode simultaneously demonstrates improved voltage and power conversion efficiency of more than 20 % each for frequencies up to 1 MHz, as compared to the MOS diode with internal threshold cancellation.
4	A Multistandard HF/ UHF-RFID-Tag With Integrated Sensor Interface and Localization Capability	This paper presents a passive multistandard HF/ UHF-RFID tag implemented in a 0.13um bulk CMOS process. The RFID-tag consists of a multi-standard HF/ UHF frontend for both frequency bands at 13.56MHz and around 900MHz. The tag is enhanced with additional functionality for sensing and localization. The integrated sensor interface consists of a multiplexer, a temperature sensor and an ultra-low power SAR analog-to-digital converter, which features a sampling rate of 100kHz at a power consumption of less than 700nW. Additionally the tag supports its localization through an FMCW-radar working at 2.45GHz

5	A Compact Chipless RFID Tag Using Polarization Diversity for Encoding and Sensing	The chipless RFID tag presented exploits the advantage offered by polarization diversity to encode more information within a given surface size. It is based on 3 split ring resonators with variable gap configuration. Depending on the used linear polarization, different resonant modes can be measured for the same resonator so that the coding capacity is increased. Since the used structure is very sensitive to polarization angle, this interesting behavior can be used to detect a rotation angle of an item with 20Â° of accuracy. On the other hand, contrary to most of chipless tags that need UWB operating frequencies, the proposed tag is based on diversity polarization and only narrow frequency bands are needed. Using only 3 resonant frequencies in the 3.4 GHz to 7.1 GHz band, a capacity of coding of 6 bits is reached within a tag of size 3x3 cmÂ². Measurements done using a bi-static radar configuration in the frequency domain validate this new concept.
6	UHF RFID Shelf Solution with Cascaded Reader Antenna and Positioning Capability	Automatic goods inventory on the shelf is an important Ultra High Frequency (UHF) Radio Frequency Identification (RFID) application. Compared to other applications, it has some unique requirements: 1) Confined read region to avoid the cross reads to other layers and shelves; 2) Positioning capability to identify the placed layer for each goods; 3) Low total system cost to support shelves with different variants. In this paper, an innovative low cost solution is proposed for the RFID shelf. It mainly contains two key technologies. First, a special shelf antenna is designed. It can provide the confined read region on each layer. Also it provides the possibility to connect 5 cascaded antennae to one antenna port of the reader. Second, a phase difference measurement based tag filtering method is proposed to determine the placed layer for each goods covered by the cascaded antennae. This solution can significantly reduce the system cost due to the following reasons. 1) Much less readers are needed; 2) The RF cable connections are much simpler; 3) By cascading the basic antennae, the new antenna with different length can be constructed to support different shelves. A prototype was developed to prove the proposed solution. According to the measurement results, the shelf antenna can provide the confined reading for each layer. 100% layer level positioning accuracy was obtained by the tag filtering method.
7	Polymer-Doped UHF RFID Tag for Wireless-Sensing of Humidity	Passive UHF RFID tags, beside item labelling, are also able to exploit capability of sensing the physical state of the tagged object as well as of the surrounding environment. Here a family of polymer-doped tags are proposed and fully characterized for the detection of ambient humidity. A sensitive chemical species based on PEDOT:PSS is used to dope a properly shaped slot carved into a folded-like patch tag. The communication and sensing capabilities of the radio-sensor are investigated by means of simulation and measurements showing how to control and balance above opposite requirements by dosing the quantity of sensitive material. The device could have interesting application in the assessment of the air quality in living and controlled rooms, in the monitoring of the conservation state of foods, in the

		preservation of walls, and even to monitor the healing degree of wounds.
8	Enabling Standardized Cryptography on Ultra-Constrained 4-bit Microcontrollers	4-bit microcontrollers (MCUs) are among the simplest, cheapest and most abundant computing devices that, thanks to their low power consumption, may be deployed even in passive RFID tags. Besides, 4-bit MCUs are embedded in a wide variety of daily-life objects that, when connected to a network, could become a substantial part of the Internet of Things. Despite the fact that quite a number of applications are security sensitive, no implementation of standardized cryptography has been available yet. In this work we present the first implementation of the Advanced Encryption Standard (AES) on a 4-bit MCU and thus, by closing this gap, enable security functionalities on myriads of legacy devices. Besides, we describe the first software implementation of PRINTcipher, a recently proposed block cipher optimized for printed electronics. We describe and apply various optimization techniques to develop time and code-size efficient implementations on the MARC4. As a result we gain the most energy efficient implementations of a cryptographic algorithm on a 4-bit MCU.
9	Range Estimation for Passive RFID Systems That Use Power-Optimized Waveforms	A maximum-likelihood range estimator is analyzed for use in a passive RFID system that already uses power-optimized waveforms (POWs) for an increase in energy-harvesting efficiency. Such a range estimator assumes that POWs are transmitted to the tag, which experiences a range and reliability improvement. The backscattered signal from the tag includes the POW as a carrier of tag data. The interferers in the system are multipath components and noise. The charge pump of the tag may also induce nonlinear distortion of the impinging POW. It is shown in this paper that each of these sources of interference may be accounted for in theoretical models of the uncertainty and bias of the estimator.

10	A Novel Method for UHF RFID Tag Tracking Based on Acceleration Data	Options for RFID tag tracking and localization are an essential asset for future high performance RFID reader systems. A reader with long reading range, high reading rate and multi-tag capability should be able to assist the user to find / retrieve tags, to create spatial object maps and to restrict the reading range to specific regions of interest. In this paper we introduce a novel method for RFID tag tracking with a moving - for example handheld - reader. An inertial measurement unit (IMU) is used to characterize the handheld trajectory. Contrary to approaches where IMU locations are reconstructed via double integration of the acceleration data, our novel technique only uses acceleration data without knowledge of the actual antenna locations. Inexpensive, standard inertial sensors can be used in this approach, and the usual drift and offset issues associated with IMU-based positioning are avoided. Parallel to the IMU acceleration data, the phase of the backscattered RFID signal is input. Double differentiation of the signal phase yields a second acceleration data set. By comparing the IMU and the RFID signal phase acceleration data, the direction of arrival of the RFID signal is estimated using a quasi-spatial optimal filter. This paper introduces the novel RFID tracking approach and illustrates its capability with numerical simulations and experimental results. This novel approach is a simple, yet promising, solution which can be implemented in any handheld reader and will improve its functionality considerably.
11	An Adaptive Data Cleaning Scheme for Reducing False Negative reads in RFID Data Streams	Due to the high sensitivity of RFID tag-reader performance to the operating environment, RFID data streams generated are unreliable and contain a significant amount of missed readings. RFID data cleaning is therefore an essential task for successful deployment of RFID systems. One of the common techniques used by RFID middleware systems to compensate for the missed readings is the use of sliding-window filters. However, setting an optimum window size is non-trivial task especially in mobile tag environments. In this paper we present a new adaptive data cleaning scheme called WSTD based on some of the concepts proposed in SMURF but with an improved transition detection mechanism. WSTD uses the comparison of the two window sub-range observations or estimated tag counts to detect when transitions occur within a window. In the mobile environment, our experimental results show that the WSTD scheme performs better than SMURF producing an improvement of about 30% less overall errors than that produced by SMURF.
12	Two-Level Path Authentication in EPCglobal Network	In this paper, we propose a two-level path authentication protocol for object genuineness verification in RFID-based supply chain and EPCglobal Network. In our solution, a tag's path in a supply chain can be generated dynamically, where each reader in the path can verify the validation of the path using its own private key. Our solution has a few promising properties, including dynamic path generation, distributed authentication, and scalability. In comparison, the previous path authentication solution for RFID tags is focused on static path generation and centralized control. The efficiency of our path

		authentication protocol is enhanced significantly by dividing a whole path into multiple segments according to organization structures. The security and privacy of our protocol are established based on two cryptographic primitives, hierarchical identity-based encryption and batch verification signature.
13	Modulation Silencing: Novel RFID Anti-Collision Resolution for Passive Tags	RFID technology has been gaining popularity in several automated inventory management applications. In such applications, thousands of RFID tags are attached to different products and the reader(s) will be collecting tags IDs using an arbitration protocols. In the existing tag arbitration protocols, significant time and power are consumed on inevitable tag collisions. In this paper, collision time reduction mechanism, called Modulation Silencing Mechanism (MSM) is proposed. MSM accelerates ending of collision slots by allowing the collided tags to interpret the silencing feedback from the reader and stop their backscattering. The proposed mechanism achieves a considerable reduction in collision time; hence, we proposed a new generalized performance metric to consider the shorter duration of collision slots by MSM. In addition, we evaluate the main RFID arbitration protocols after applying MSM and the time efficiency of these protocols was significantly increased.
14	Passive Tag-to-Tag Communication	In this paper, we describe a novel passive RFID system capable of direct tag-to-tag communication in the presence of external radio frequency field. Tags talk by modulating the external field and thus backscattering the commands to each other. We present the system concept and show its hardware implementation based on TI MSP430 microcontroller. We also provide the theoretical model for modulation depth vs. distance which agrees with experimental results (maximum tag-to-tag communication distance). Finally, we discuss possible applications and outline future work.
15	Multi-Antenna Techniques for Enabling Passive RFID Tags and Sensors at Microwave Frequencies	Multi-antenna techniques are typically avoided in passive RFID because of the large footprints required. However, the smaller footprints required at microwave frequencies such as the 5.8~GHz industrial, scientific, and medical (ISM) band allow the use of multiple antennas. Two new multi-antenna technologies are featured in this paper to provide power and communications to a passive wireless tag in the 5.8~GHz ISM band. A four-layer FR-4 PCB is presented, which uses a staggered-pattern charge collector (SPCC) and a retrodirective array phase modulator (RAPM). An SPCC is an energy harvester that has with two independent antenna arrays that provide increased gain and beamwidth over a single-antenna source. A RAPM backscatters the reader-transmitted signal directly back to the reader and provides quadrature phase-shift keyed (QPSK) signaling.

16	A Real-time RFID Localization Experiment Using Propagation Models	This paper introduces a real-time localization system (RTLS) using efficient multiple propagation models to compensate for the drawback of the received signal strength technique. The RTLS is implemented on an active RFID system and uses received signal strength measurements and reference tags for ranging. The RTLS is implemented purely in software that post processes the received signal strength data from the reader and does not require any additional hardware or any modifications to the RFID reader or tags. The proposed algorithm using multiple propagation models improves the performance of the RTLS. Two-dimensional localization results are given for a four-reader system covering a 4.5 by 5.5 meter room. The scenarios of both single tag and two tags for the tag object are developed. It has been proven that tag multiplicity, two tags for the target object, improves the performance of the system by reducing inaccurate received signal strength measurements due to poor tag orientation. Experimental results show that the proposed system achieves a localization accuracy within 1 meter in over 50 percent of the experiments and outperforms other comparable systems. Currently developed three-dimensional space extension research is discussed and results are presented.
17	Identifying Passive UHF RFID Tags Using Signal Features at Different Tari Durations	Identifying and authenticating RFID tags based on their inherent signal features can be another level of security on top of the traditional way of demonstrating knowledge of a secret key. Authenticating tags based on their knowledge of a key has its drawbacks. First, the tag is assumed to be secure enough that it can hold the secret key without disclosing it to any other party. However, side-channel attacks on such devices have been successful. In addition, the tag is assumed to have the memory and processing capabilities to implement cryptographic operations. However, this increases the cost of the tag. In this work, passive UHF RFID tags are identified by their signal features. The backscattered signal is recorded and a set of features based on timing and power are extracted. Timing features at different Tari durations that correspond to different data rates were found to be effective features. In the population of measured tags, the tag manufacturer was identified with an accuracy of 100% when using timing. An individual tag was identified with an accuracy of 97.22% when using timing.

18	Linearized Combinatorial Model for Optimal Frame Selection in Gen2 RFID System	Radio Frequency Identification (RFID) technology become an important tool for items identification and tracking. In this paper we observe RFID Gen2 communication protocol [1] between the RFID reader and the low-cost battery free passive RFID tags. To establish communication between reader and tags, Gen2 uses Dynamic Frame Slotted ALOHA (DFSA) Medium Access Control (MAC) layer protocol with Q-Selection algorithm for frame length adaptation. DFSA constraints of Gen2 RFID Reader-Tag communication may become an issue in the fast identification of all tags in the interrogation area. To identify all tags as soon as possible, DFSA frame length should be selected properly so its throughput is maximized, and that can be achieved only if one can estimate number of interrogated tags correctly. In this paper we present Linearized Combinatorial Model (LCM) algorithm for the optimal frame length adaptation. Developed scheme is implemented and tested on Universal Radio Serial Peripheral 1 (USRP1) Gen2 reader application [2]. Results analysis shows that our scheme outperforms Q-Selection algorithm.
19	Identification of missing objects with group coding of RF tags	Physical objects often form a group such as objects in a shipping container. RFID enables us to identify each object and even the container itself. However, current RFID does not provide information on IDs missing from a group. This paper proposes a method to determine the unique IDs of objects missing from a group without any external database or verifier. The proposed method logically splits a group into mutually overlapped sub-groups and writes group-related information, which is generated from the unique IDs of objects in the sub- group, to RF tags' memory. When we check the integrity of a group of objects, unique IDs and group-related information of RF tags are extracted from RF tags' memory. With an iterative decoding over group-related information with the unique IDs of identified objects, missing IDs are determined. A numerical simulation reveals that the proposed method can identify 96-bit unique IDs of up to 64 objects missing from a group composed of 100 objects by writing 840-bit group-related information to each RF tag. We also examined the performance with an experiment and confirmed that we can successfully determine 16-bit IDs of up to 12 missing RF tags from a group of 20 RF tags by writing 280-bit group-related information to each RF tag. The experiment results agree well with the numerical simulation.
20	Optimized CMOS RF-DC converters for remote wireless powering of RFID applications	In this paper, we present for the first time a novel optimization procedure which allows to maximize the efficiency of RF-DC energy harvester converters, taking into account the contributions of the matching network. Thanks to this procedure, we have designed and realized a CMOS RF-DC converter operating in a very wide range of input power -14Ã·+1dBm with a peak efficiency of 45%. The RF-DC converter provides a constant output voltage ~2V in the whole input power range thanks to a smart voltage regulator integrated with the converter.

21	An Error Free Passive UHF RFID System using a New Form of Wireless Signal Distribution	A wide area and error free ultra high frequency (UHF) radio frequency identification (RFID) interrogation system based on the use of multiple antennas used in cooperation to provide high quality ubiquitous coverage, is presented. The system uses an intelligent distributed antenna system (DAS) whereby two or more spatially separated transmit and receive antenna pairs are used to allow greatly improved multiple tag identification performance over wide areas. The system is shown to increase the read accuracy of 115 passive UHF RFID tags to 100% from <60% over a 10 m x 8 m open plan office area. The returned signal strength of the tag backscatter signals is also increased by an average of 10dB and 17dB over an area of 10m x 8m and 10m x 4m respectively. Furthermore, it is shown that the DAS RFID system has improved immunity to tag orientation. Finally, the new system is also shown to increase the tag read speed/rate of a population of tags compared with a conventional RFID system.
22	Assessment of Visibility Restriction Mechanisms for RFID Data Discovery Services	RFID is a technology that enables the automated capture of observations of uniquely identified physical objects as they move through supply chains. Discovery Services provide links to repositories that have traceability information about specific physical objects. Each supply chain party publishes records to a Discovery Service to create such links and also specifies access control policies to restrict who has visibility of link information, since it is commercially sensitive and could reveal inventory levels, flow patterns, trading relationships, etc. The requirement of being able to share information on a need-to-know basis, e.g. within the specific chain of custody of an individual object, poses a particular challenge for authorization and access control, because in many supply chain situations the information owner might not have sufficient knowledge about all the companies who should be authorized to view the information, because the path taken by an individual physical object only emerges over time, rather than being fully pre-determined at the time of manufacture. This led us to consider novel approaches to delegate trust and to control access to information. This paper presents an assessment of visibility restriction mechanisms for Discovery Services capable of handling emergent object paths. We compare three approaches: enumerated access control (EAC), chain-of-communication tokens (CCT), and chain-of-trust assertions (CTA). A cost model was developed to estimate the additional cost of restricting visibility in a baseline traceability system and the estimates were used to compare the approaches and to discuss the trade-offs.

23	Optical Localization of Passive UHF RFID Tags with Integrated LEDs	The ability to accurately localize passive UHF RFID tags in uncontrolled and unstructured environments is limited by multi-path propagation. Therefore, in order to increase the spatial resolution of RF based localization methods it is necessary to combine them with addition sensing capabilities. In this work we enhance passive UHF RFID tags with LEDs, using the wireless identification and sensing platform (WISP). This allows both humans and computer systems (with cameras) to optically locate tagged items with millimeter accuracy. In order to show the effectiveness of this approach, a PR2 robot is equipped with an EPC Gen2 RFID reader and camera. Using the reader only the PR2 is able to identify and coarsely locate tagged items in an unstructured environment. Once the robot has navigated to the vicinity of the LED enhanced passive RFID tags, it uses the optical location method to autonomously grasp tagged items from a table.
24	Near Field Modulated Backscatter For In Vivo Biotelemetry	Fully implantable wireless biotelemetry devices have traditionally used active VHF/UHF transmitters or load modulation at HF frequencies. HF systems tend to be bandwidth- limited due to low frequency magnetic coupling, while active VHF/UHF transmitters generally consume a significant amount of power in DC bias current. We show in this paper that UHF near-field backscatter can be used to achieve higher data rates at lower implant power budgets. We present experimental path loss measurements in a saline proxy system using a segmented loop antenna designed for UHF near-field operation. We present experimental results from a modulated backscatter test circuit at bit rates of up to 30 Mbps and penetration depths of up to 6 cm. The main communication element, an RF switch, consumes about 164 Î¼A at 3 V while operating at a data rate of 30 Mbps, which is equivalent to approximately 16.4 pJ/bit.
25	Evaluation of Parasitic Capacitance Introduced during Tag Assembly Process	Power transfer between tag chip and tag antenna plays a critical role in determining the performance of passive UHF RFID systems. However, optimum power transfer is difficult to achieve due to parasitic capacitance introduced during the tag assembly process. Moreover, the parasitic capacitance leads to performance deviation and tag detuning. Thus it is highly desired to determine the parasitic capacitance before initializing tag antenna design. This paper presents a fast and quantitative method to evaluate the parasitic capacitance. The method is established based on a lumped-element model of double-tuned tags and the corresponding expression of the power transfer coefficient. Simulation and measurement results are provided to verify the purposed method. For strap-packaged Alien Higgs-3 chip and embedded T-match antenna assembled with an anisotropic conductive adhesive, the parasitic capacitance is demonstrated to be about 0.265~0.321 pF.

26	A 96 Mbit/sec, 15.5pJ/bit 16-QAM Modulator for UHF Backscatter Communication	We describe a low power vector backscatter modulator capable of transmitting 16-QAM at a rate of 96 Mbps while consuming only 1.49 mW (15.5 pJ/bit). While designed around a center frequency of 915 MHz, the modulator is capable of operation over the worldwide 868 - 950 MHz UHF band. We present experimental results from the modulator operating in 4-QAM/4-PSK, 4-PAM, and 16-QAM modes. Achieved data rates are comparable to WiFi (IEEE 802.11) with a measured tag-side power consumption over 50 times lower than a WiFi chipset. Potential applications for low power, high bit rate modulators include biotelemetry, high-bandwidth data transfer from camera tags or audio tags, uplink from mass storage tags, and exchange of large amounts of encryption or authentication data. Given a +36 dBm EIRP transmitter operating at 915 MHz, the semi-passive (battery-assisted) prototype tag is return link limited and has a theoretical maximum operating range of 17.01 m at 96 Mbps or 21.25 m at 40 Mbps.
27	A Fully Integrated Chip-ID Tag Used in Chip Information Identification	A fresh and creative passive UHF RFID tag, which can be referred to as "Chip-ID tag", has been proposed in this paper. The fully integrated Chip-ID tag, fabricated on the same substrate of the identified SOC, can be used for the SOC chip information identification, such as the chip manufacturer, function and series number identification, etc. The Chip-ID tag without OCA can be implemented as small as a PAD. OCA can be embedded in the periphery of the identified SOC chip or outside the ring of bonding pad. In order to guarantee the maximum power transmission between the reader antenna and the OCA tag, theoretical and experimental analysis between reader antenna and Chip-ID tag have been presented for verifying the feasibility of the proposed Chip-ID tag in this work. Finally, a Chip-ID tag with 4 mm x 4 mm single-turn square loop OCA, including the identified SOC chip, is successfully designed and taped out in 0.18-um CMOS technology. Measurement results demonstrate that the Chip-ID tag can be powered up and then transmit a unique Chip-ID data to the single-turn loop reader antenna with diameter of 1 cm by 110 KHz full-ASK clock signals modulation in complete contact circumstances, when the reader transmit a minimum RF input power of -9 dBm at 915-MHz band. The maximum reading range of 1.3 cm can be achieved with 20 dBm RF input power by the reader generated. It is worth emphasizing that, within all published papers, this paper is the first time to put forward a self-contained, CMOS-only Chip-ID tag for the SOC chip information identification.
28	Effects of Periodic Reinforced-Concrete Structures on Power Transmission	The optimization of wireless power transmission for sensors embedded in reinforced concrete structures are studied here. Computational methods are applied to investigate the transmission and reflection coefficients for reinforced concrete slabs as a function of concrete slab thickness and rebar configurations at different frequencies. Electric field induced inside reinforced concrete is also examined. Specifically, these analysis lead to the identification of optimum conditions for wireless powering of sensors embedded in

		reinforced concrete for structural health monitoring.