

RFIDays 2008: Workshop on Emerging Technologies for Radio-Frequency Identification

May 12-13, 2008, University of Roma "Tor Vergata," Rome, Italy

Identification of things and processes by radio frequency (RFID) is quickly growing up as the emergent technology in logistics, security, and bioengineering. Different kinds of data may be wirelessly transmitted from the local query unit (the reader) to the remote transponder (the tag), which includes the antenna and the microchip transmitter. The best-established standards are related to low frequencies (HF, 13.56 MHz or less), but the ultrahigh frequencies, UHF, and microwaves (870-960 MHz, 2450 MHz) are the most promising technologies. Great interest is building in ultra-wideband (UWB, 2.4-4.8 GHz, 6-8.5 GHz) platforms for detailed localization and high immunity to multipath.

In addition to commercial applications, where tags replace or complement barcodes, new interesting convergences among RFID technologies, personal telecommunication networks, and distributed sensors are currently envisaged in localization and ubiquitous processing platforms. The most innovative research is related to affordable interrogation within a complex environment, to the identification of metal objects, to the efficient scavenging of environmental energy, to the development of miniaturized active systems with high autonomy, to low-cost sensor tags, and to biomedical telemetry.

In the Italian context there, are both academic and industrial organizations performing research and development activities in the field of radio-frequency identification. The fast diffusion of this technology, and the related heavy scientific and commercial competition, make it really important to encourage meeting opportunities among different skills, with the purpose of sharing experiences and to finalize the most advanced research into applications and products.

On May 12-13, 2008, the University of Roma Tor Vergata, Italy, in close collaboration with CNIPA, the Italian Agency for Digital Government, organized the Workshop RFIDays-2008 on the Emerging Technologies for Radio-Frequency Identification. By emphasizing the natural multidisciplinary nature of the RFID context, this two-day event offered a unique review of ideas, algorithms, technology, and experiments, coming from electronics, electromagnetics, telecommunications, computer science and logistics. It proposed extraordinary interactions among universities, research laboratories, and companies, stimulating new interests and synergies.

The workshop had an Italian connotation, with about 25 technical presentations and an audience of more than 150 participants. Moreover, some foreign speakers illustrated the new development trends, the funding, and the patent opportunities of RFID technology in an international perspective.

The proceedings collected many of the most valuable contributions. Here, they are organized into two parts concerning new technologies for reader and tag design, and the development and implementation of algorithms for system-level applications

with attention to security issues. The complete collection of the speech slides may be freely downloaded at

<http://www.disp.uniroma2.it/alab>.

After the opening ceremony (Figure 1), a detailed tutorial on RFID was given by P. Talone (U. Bordoni Foundation, Italy, Figure 2). F. Frederix (DG INFSO, European Commission, Figure 3) reviewed the concerted European efforts on RFID, the running projects, the RFID thematic networks, and the funding policy for 2009-2010. M Ricciardi (European Patent Office, Figure 4) gave a patent view of RFID technology, with attention to still-open opportunities for university and industry.

Reader and Tag Technology

The most advanced tag-design technology brings together low-cost electronics, multi-standard identification with sensing capabilities, and ultra-wideband operations. G. Iannaccone (University of Pisa, Figure 5) showed how the reading range of passive UHF RFID tags may be sensibly improved by a proper optimization of the chip's analog front end, with a real possibility of keeping the chip's power consumption below a fraction of a microwatt. Compact transponders, embedding integrated radiating elements for both HF and UHF services, particularly suited for e-cards, were proposed by A. Toccafondi (University of Siena). E. Verona (CNR, Italy, Figure 6) showed how electro-acoustic devices (SAW) may be integrated with HF and UHF antennas to achieve passive RFID systems able to send back physical information about temperature, pressure, and chemical events. G. Marrocco (University of Roma "Tor Vergata," Figure 7) addressed the topic of UHF tags for human-body sensing. Ad hoc antennas,



Figure 1. The opening ceremony (l-r): F. Vatalaro, IEEE Italy Section; E. Manganeli, Council of CNIPA, A. La Bella, Dean of the University of Roma "Tor Vergata," G. Marrocco, University of Roma "Tor Vergata," workshop organizer.



Figure 2. P. Talone, Fondazione Ugo Bordonì, introducing RFID technology.



Figure 4. M. Ricciardi, European Patent Office, speaking about the patent opportunities of RFID technology.

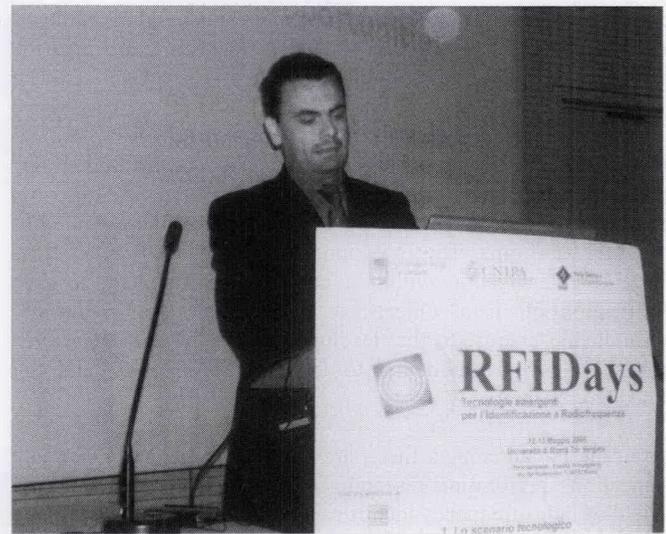


Figure 5. G. Iannaccone, University of Pisa, talking about low-power RFID transponders.



Figure 3. F. Frederix, European Commission, reporting on the running European research programs on RFID.

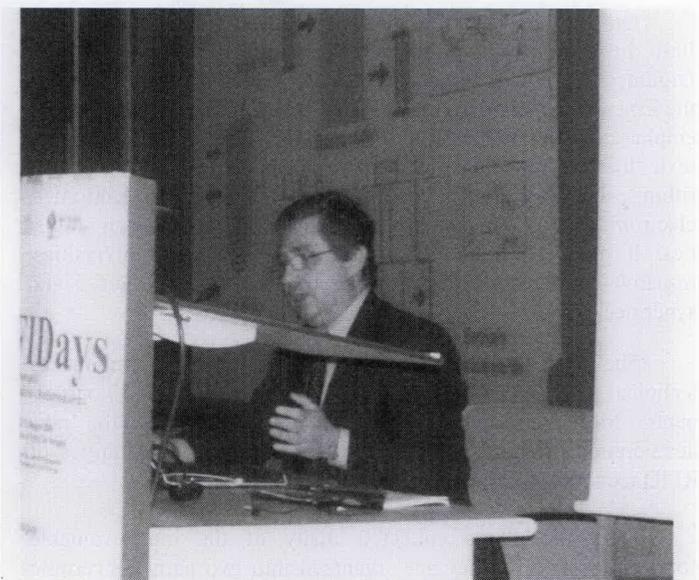


Figure 6. E. Verona, CNR, introducing a SAW transponder.



Figure 7. G. Marrocco, University of Roma "Tor Vergata," addressing human-body-matched RFID antennas.

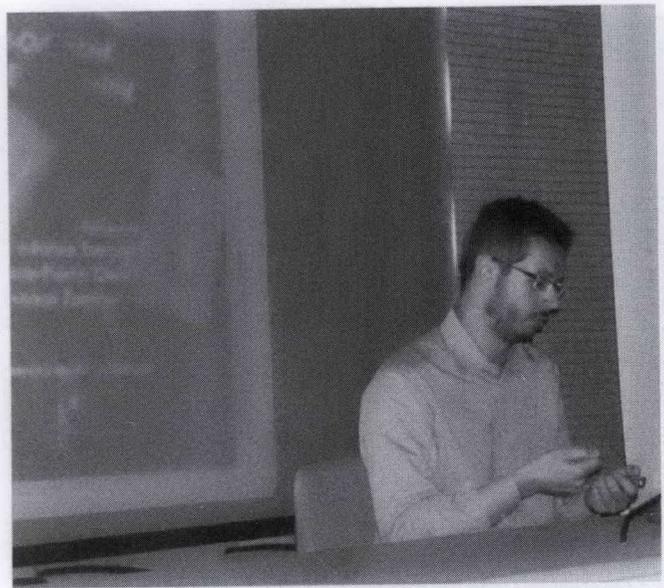


Figure 10. M. Mamei, University of Modena Reggio Emilia, talking about RFID networks implementing collective intelligence.

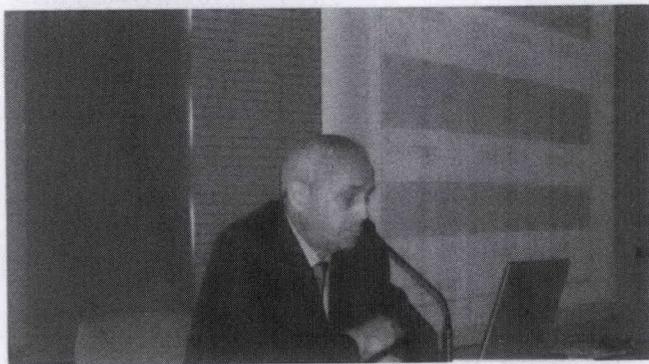


Figure 8. G. Biffi Gentili, University of Florence, talking about active and ultra-wideband RFID systems.

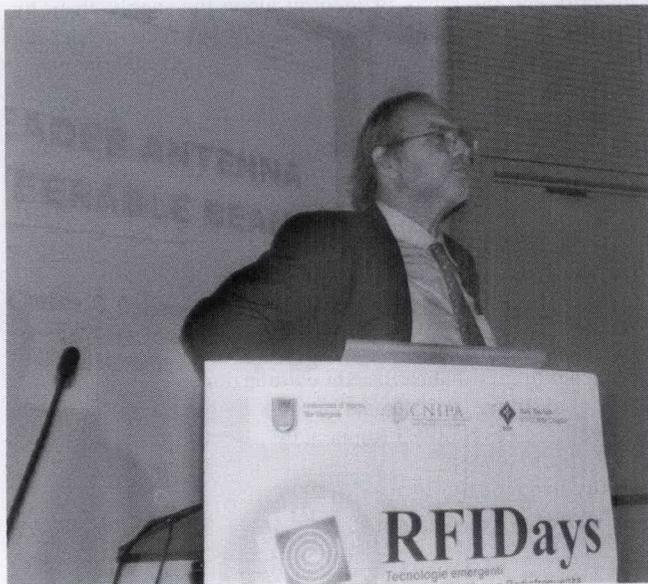


Figure 9. M. Orefice, Turin Polytechnic, speaking about beam-scanning readers.

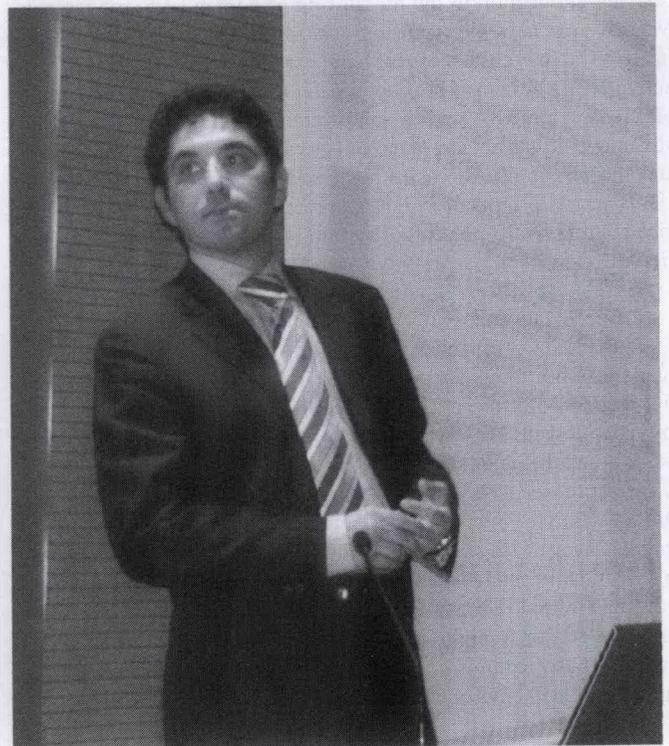


Figure 11. G. Me, University of Roma "Tor Vergata," discussing RFID security issues.



Figure 12. M. Rebaudengo, Turin Polytechnic, who proposed the application of cryptography to improve the security of food.

able to host sensors, permit maximizing the reading range when placed onto the body. Multi-band operations can be achieved, with relevant application to the monitoring of human-body movements. Moreover, a new physical approach promises to use the antenna itself as a low-cost sensor of the target's changes. A complete active RFID system was proposed by G. Biffi Gentili (University of Siena, Figure 8), with a dual-frequency protocol. As its main advantage, it has a wide range of activation and very compact size, and the possibility to easily host sensors. Preliminary studies on UWB tags, promising high-data-rate capabilities, and precise localizations were presented by both A. Toccafondi and G. Biffi Gentili.

Recent advances in reader technology were reviewed by I. Kipnis (Intel Corp.). New all-on-chip reader electronics are now available from Intel. These are already implemented into commercial readers, offering a high degree of integration within portable low-cost devices (G. Grieco, Caen, Italy). This technology promises a broad diffusion of the reader-tag paradigm into everyday life. A versatile reader-scanning technology was introduced by M. Orefice (Polytechnic of Turin, Figure 9), concerning the use of antenna arrays with steerable beams. This system has the capability to dynamically change the radiation patterns in the UHF and microwave bands, and to selectively interrogate particular portions of the environment, or to cover a large area without moving the reading station. These features could greatly improve the radio interrogation of crowded environments.

The true performance, in term of the bit-error rate of a reader-tag system, within a real scenario including scattering objects, was discussed by C. Piersanti (University of Bologna). Some relevant effects and tradeoffs in transponder and reader design were shown. In particular, it was demonstrated that the true interrogation region is nonuniform. The communication between the tag and reader could fail, even at distances lower than the maximum interrogation range, due to multipath propagation.

Distributed Systems

The application of pervasive computing to the RFID paradigm, and its integration with existing communication networks, was the subject of four contributions. RFID-based indoor localization systems were introduced by F. Mazzenga (University of Roma "Tor Vergata"), who discussed simple localization algorithms combining both active and passive devices, with particular emphasis on multi-frequency configurations. M. Mamei (University of Modena and Reggio Emilia, Figure 10) described how some animal collective intelligence, based on the pheromone multi-agent interactions, may be implemented by an RFID network. Humans and robots could spread/sense pheromones by properly writing/reading RFID tags, which are likely to populate our everyday environments. Such pheromones can encode and describe application-specific information useful in achieving object tracking, and to provide context-aware information. A. Sciarappa (Istituto Superiore Mario Boella, Italy) presented several middleware solutions to implement the "Internet of Things" for dynamic contexts in applications of ubiquitous communications, pervasive computing, and ambient intelligence. Finally, A. Moroni (University of Roma "Sapienza") provided an introduction to near-field communication, and its integration with the GSM/UMTS mobile networks and Wi-Fi, towards intuitive, safe, and contact-less transactions.

The issue of RFID security is a key concern for a safe and reliable diffusion of this technology. G. Me (University of Roma "Tor Vergata," Figure 11) reviewed possible computer attacks and spamming relevant to RFID, and discussed the opportunity of tags with cryptographic codes. Concerning the same issues, M. Rebaudengo (Polytechnic of Turin, Figure 12) told how to improve the integrity and the safety of food all along the supply chain by introducing cryptographic procedures within the reader-tag communication protocols, taking advantage of the read/write memory of the tag.

The workshop concluded with the contributions of industry (G. Violante, EltagDatamat; L. Di. Pace, IBM; M. Caprino, Reply; G. Zanelotto, Microsoft) regarding system integration with final users.

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