MIT Auto-ID Center Advances the Standardization of RFID Tags

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Abstract

The Auto-ID Center is a not-for-profit global research organization headquartered at the Massachusetts Institute of Technology (MIT). Its mission is to standardize and build the infrastructure for an open, global network system that will enable efficient physical distribution. This article introduces the concept and the standardization efforts of the Auto-ID Center. NTT is one of its sponsors.

1. Introduction

Many companies and organizations are working to advance the widespread use of radio frequency identification (RFID) tags. They will be attached to various objects to make possible efficient physical distribution and new network-oriented applications. One such organization is the Auto-ID Center headquartered at MIT. In August 2002, NTT and NTT Comware became sponsors of the Center, which consists of 96 organizations (as of April 2003), including 11 organizations from Japan, mainly in the distribution, consumer product manufacturing, and electronics industries.

2. What is an RFID tag?

An RFID tag is a small IC chip with a radio circuit and an ID code integrated into it and an antenna attached to it. It has a broad range of possible applications. For example, RFID tags can be attached to a large variety of products to facilitate the location and distribution management and the identification of individual items. There are two types of RFID tags: active and passive. An active tag includes a battery, while a passive tag operates on the radio wave power provided by a tag reader. In particular, passive tags, which feature an almost unlimited lifetime, small size, and low manufacturing cost, are expected to be attached to almost everything in the future, like bar codes at present.

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3. Concept addressed by the Auto-ID Center

The Auto-ID Center was established at MIT in 1999. It is studying and standardizing the codes used in RFID tags, and the relevant network functions and management software, anticipating large-scale application of RFID tags.

For RFID tags to be used widely, their cost must be reduced. Since the cost of a mass-produced IC chip is ultimately proportional to the area it occupies on a silicon wafer, it is necessary to reduce the size of each IC chip. For this reason, the basic architecture adopted by the Auto-ID Center is to allocate only the ID and minimal radio functions to the IC chip and to leave everything else to the network. In other words, a wireless tag holds no information about product price, product name, or distribution history. It only holds an ID code assigned according to a defined rule. The user reads the tag's ID with a tag reader and sends a command to a center in the network to retrieve or edit the information related to the tag. This architecture can achieve a dramatic reduction in cost (down to 5 cents per tag). To develop this architecture, the Auto-ID Center is advancing standardization in the following areas (Fig. 1).

(a) Wireless access: the radio access interface between a tag and a reader

(b) Product code (ePC: Electronic Product Code): a 96-bit ID code consisting of the information contained in the existing bar codes (vendor

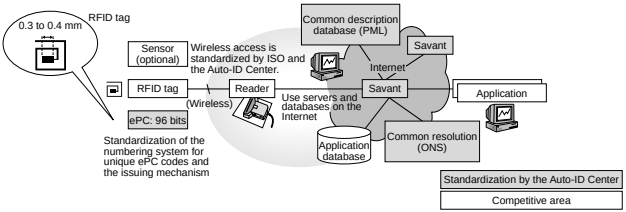

Fig. 1. Auto-ID Center's concept and standardization areas.

code + product code) and a serial number.

(c) ONS (Object Name Service): resolution of the location of the product information from an ID; a function equivalent to what a domain name system does for an IP address

(d) PML (Physical Markup Language): language used to describe each product item

(e) Management software (Savant): Application programming interface (API) for the software that controls ePC and ePC-related data read by a tag reader.

ePC is a 96-bit ID code written into an RFID tag. It consists of a version number, vendor code, product code, and serial number. It differs most significantly from existing bar codes in that it contains a serial number. Therefore, each item of a product type can be individually identified for detailed distribution and inventory management, which is not possible with a bar code. In addition, a tag can be used by various applications even after an item has been purchased by the end user.

The network obtains the product information related to the retrieved ePC in two stages. First, the location (URL) of the information related to the ePC is provided by the ONS server. Second, the actual information is found in the database (a PML server) specified by the URL. The description of a product item in the database is written in PML. The reason for this two-stage approach to obtaining production information is that centralized management of the location of production information is necessary whereas databases of vendor products can be distributed. A personal computer (PC) with a connected tag reader accesses the ONS and PML servers. Management software called Savant runs on a PC to support the overall operation related to the RFID tag.

4. Participating members

Auto-ID Center sponsors can be categorized into two groups: end-user companies and technology vendor companies (Table 1). Among the user companies are many leading distributors, such as Wal-Mart Stores, which is actively involved in field tests. They

Table 1. Major sponsors of the Auto-ID Center.

End-user companies and organizations	
Best Buy Corporation	Kraft Foods
Canon Inc.	**Mitsui & Co., Ltd.**
Coca-Cola	Pepsi
CVS	Pfizer
Dai Nippon Printing	Philip Morris Group
Department of Defense	Procter and Gamble Company
Ean International	Target Corp.
Eastman Kodak	The Gillette Company
Home Depot	**Toppan Printing**
International Paper	Uniform Code Council
Johnson & Johnson	Unilever
Kellogg's Corp.	United States Postal Service
Kimberly-Clark	UPS
	Wal-Mart Stores, Inc.

Technology vendor companies	
Accenture	Rafsec
ACNielsen	SAP
Alien Technology	Sensitech
British Telecom	Sensormatic Electronics Corp.
IBM Biz Consulting Services	Siemens Dematic
Intel	STMicro
Ishida Co., Ltd.	Sun Microsystems
Nihon Unisys Ltd.	Symbol Technologies
NTT	ThingMagic
NTT Comware	**Toppan Forms**
Omron Corp.	**Toray International, Inc.**
Philips Semiconductors	

* Japanese companies are shown in bold type.

also include big-name consumer product companies, such as P&G, the Gillette Company, and Coca-Cola, which are studying embedding tags in their products during production and are undertaking cycles of research and experimentation. Gillette is particularly committed and made news headlines in late 2002 for ordering 500 million tags from Alien Technology, a venture business specializing in the production of tags. In addition, UCC (Universal Code Council) and EAN (European Article Number) International, both bar code standards bodies, are contributing to the standardization and practical operations aspects, seeing RFID tags as next-generation bar codes.

Technical vendor sponsors include Sun Microsystems, Intel, Accenture, IBM, and some chip makers, such as Philips. In addition to NTT and NTT Comware, sponsors from Japan include Dai Nippon Printing, Toppan Printing, Canon, and Mitsui & Co. In January 2003, a research site was established within Keio University, and Professor Jun Murai of Keio University announced that the new organization will focus on research into network functions and on activities related to field tests.

5. Status of standardization activities

At present, the specification of the wireless access using UHF and HF frequencies is at the final stage of standardization. As the first stage of defining ePC, a 96-bit-based specification has been published. A study is underway on using a longer bit sequence to allow for future expansion. Field tests are being carried out on ONS, PML, and Savant, and their specifications will be published in September 2003. For the tag system to be widely used in society, it is extremely important to ensure security and protect user privacy. This is not simply a technical issue but requires careful consideration of social issues, including the legal systems of various countries in the world with regard to how the tags will be used and accepted. At the Auto-ID Center, a Public Policy Advisory Council has been established, independently of the technical studies, to study global consumer perceptions and legal systems. Based on this survey activity, a policy will be established for using the technology developed by the Auto-ID Center.

6. NTT's participation and activities

NTT is participating in the Auto-ID Center mainly to contribute to the standardization of the network functional aspects. In particular, NTT intends to provide technical support on security issues. However, since RFID tag technology is not limited to that specified by the Auto-ID Center, NTT will not limit itself to a specific standardized system but will undertake R&D aimed at developing and spreading the use of RFID tags from a broader perspective.

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He received the B.E. and M.E. degrees in precision machinery engineering from the University of Tokyo, Tokyo in 1988 and 1990, respectively. He received the M.S. degree in electrical engineering and computer science from the Massachusetts Institute of Technology in 1998, and the Ph.D. degree from the University of Tokyo, Tokyo in 2001. He was a manager in the R&D strategy department of NTT from 2001 to 2003. He is currently a senior research scientist at NTT Communication Science Laboratories, His research interests include computer vision, machine learning, and human-robot interaction.

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In 1992, he joined the equipment engineering department, NTT, Kobe, Japan, where he was engaged in access network engineering. After that, he joined the equipment planning department, NTT headquarter, where he was engaged in equipment planning and investment. Currently he is engaged in new business creation using the results of the NTT research institute.