Recent Activities for RFID Standardization

Mitsuo Tsukada†

Abstract

This article introduces recent activities concerning RFID (radio frequency identification) standardization, especially those in EPCglobal, which is the most influential standardization organization for RFID-related technology.

1. Background

RFID (radio frequency identification) is an automatic identification technology using wireless communication. Although it has been around since the World War II, it has recently attracted renewed attention as "networked" RFID, in which different users exchange IDs and ID-related information over a network. The idea is to identify every individual object by attaching a very cheap tag to it. Only the minimum functions should be embedded in the tag itself and other necessary functions should be provided via the network. A typical example of a "networked" RFID system is "Auto-ID" proposed by the Auto-ID Center, which was established by the Massachusetts Institute of Technology (MIT) in 1999 [1]. The basic concept of Auto-ID is shown in **Fig. 1**. An Electronic Product Code (EPC), which is a unique ID, is stored in a tag and assigned to each item. The Auto-ID Center had been engaged in the development of the following components of the Auto-ID system in order to achieve a smooth migration from bar codes, which are currently used extensively for automatic identification.

- Middleware: handles the raw data read by a reader from the tag by wireless communication and passes it to an application
- ONS (object name service): resolves the location of the database containing information about a specific EPC

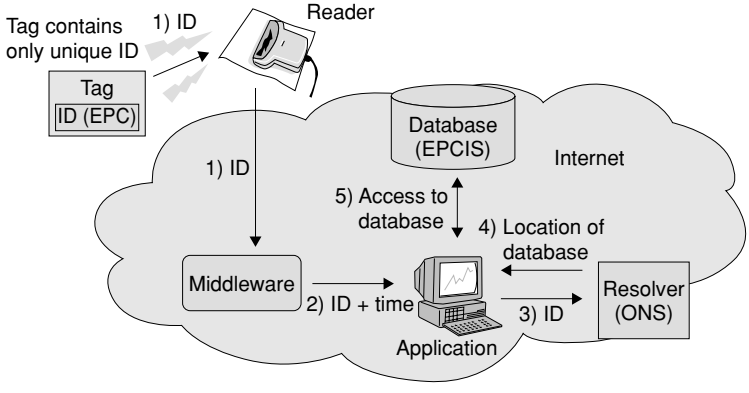

Fig. 1. Basic concept of Auto-ID.

† NTT Service Integration Laboratories
Musashino-shi, 180-8585 Japan
E-mail: tsukada.mitsuo@lab.ntt.co.jp

- EPCIS (EPC information service): provides a database for storing and managing information about a specific EPC (event history and attributes of each item assigned to a specific EPC)

To enable tags, readers, and the ID-related information to be used by different users, we must standardize the interface between components, the data format, and the communication protocols.

2. EPCglobal

NTT joined the Auto-ID Center in August 2002. More than 100 organizations around the world (including 11 Japanese companies) joined this activity as well. In addition, six laboratories were established (including MIT) and one of them was in Japan (at Keio University).

The Auto-ID Center concluded its research and development achievements in October 2003 and established EPCglobal [2] as the successor to this activity in November 2003. EPCglobal is a non-profit organization formed as a joint venture supported by both EAN International (an international organization managing bar codes for the retail industry) and UCC (Uniform Code Council, a bar-code-managing organization in the United States). The mission of EPCglobal is to assign EPCs to each subscribing organization, manage the master database, facilitate the standardization of related technology, and promote the use of EPC technology all over the world.

The most prominent feature of EPCglobal is its user-driven standardization. In June 2005, the number of the subscribing organizations reached 549. Almost half of them are user companies. Organizations based in North America form the biggest faction (more than 350). There are about 80 European organizations and about 100 Asian organizations, including 22 Japanese companies.

2.1 Organization and standardization activities of EPCglobal

The organization of EPCglobal is shown in **Fig. 2**. Business action groups (BAGs) prepare EPC use cases and the technical requirements derived from them for each industrial sector. At present, there are two BAGs: one for the consumer packaged goods industry called FMCG (fast moving consumer goods) BAG and the other for the healthcare industry called HLS (healthcare & life science) BAG. A new BAG for the logistics industry was established at the end of 2005 as TLS (transport and logistics service) BAG. Each BAG has clear goals for using EPCs. The FMCG BAG will use relatively long-range passive tags (which do not contain batteries) operating in the UHF band on cases/pallets of retail items for efficient supply chain management. The HLS BAG is discussing the use of RFID for anti-counterfeit measures for medicines by tagging each item with a relatively short-range HF-band passive tag. Therefore, a security mechanism is required to prevent any tampering with the related information. The TLS BAG intends to discuss the use of active tags (which contain a battery and oscillator) for the management of containers in marine transportation.

Once the use cases and technical requirements have been finalized, the technical action group (TAG), which is composed of a hardware action group (HAG) and software action group (SAG), will prepare technical standards according to the technical requirements produced by the BAGs. The Auto-ID

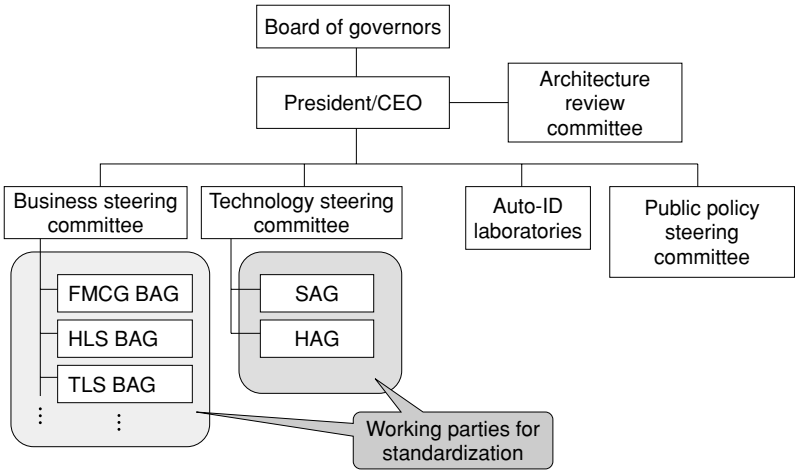

Fig. 2. Organization of EPCglobal.

Center had already worked out the basic specifications of both hardware and software by October 2003, but EPCglobal must still settle the details of the specifications for each component and expand the required but unresolved subjects to facilitate the smooth adoption of EPC-related technology by user companies. The main feature of EPCglobal's standardization activities is its user-driven approach to standardization. This is reflected strongly in the activities of the TAGs, where priority is given to subjects requested by the user companies. Examples of this are clearly seen in the development of the tag-reader air interface protocol standard for UHF-band passive tags (UHF Class 1 Generation 2 Standard, which is usually called "Gen 2"). This standard was strongly requested by big retail companies in the USA and Europe, as well as by the U.S. Department of Defense. While efforts were focused on establishing the "Gen 2" standard, many EPCglobal activities concerning other issues were put aside during 2004. This case illustrates that even when something is technically excellent, it is difficult to start discussions of it in EPCglobal before specific user requirements have been identified.

EPCglobal has the following steering functions besides BAGs and TAGs. (1) The Business Steering Committee and Technology Steering Committee govern the activities of each BAG and TAG and guide their activities toward the goals of EPCglobal. (2) The Architecture Review Committee monitors the effects of newly established standards on the existing architecture of the EPCglobal network and audits the activities of BAGs and TAGs. (3) The Public Policy Steering Committee monitors the effects on society of the use of EPC technology (e.g., consumer privacy, environmental burden, and labor) and lobbies the appropriate government organization and congress. (4) Auto-ID Laboratories engage in research and development of new EPC-related technologies and take part in standardization activities in BAGs and TAGs.

2.2 EPCglobal network architecture

The architecture of the EPCglobal network is illustrated in **Fig. 3**. Here, two enterprises (A and B) want to exchange tagged goods and related information (event history and attributes). For this exchange, the following three points should be standardized:

- IDs stored in tags
- air interface protocol of wireless communication between tags and readers
- data format and communication protocol between EPCIS for storing and exchanging the ID-related information.

On the other hand, the internal management of goods in each enterprise is achieved by the standardization of the following four subjects:

- communication protocol between readers and middleware
- mechanism to manage multiple readers efficiently
- ID translation function for converting between the binary encoding stored in tags and a format that can be easily handled by application software

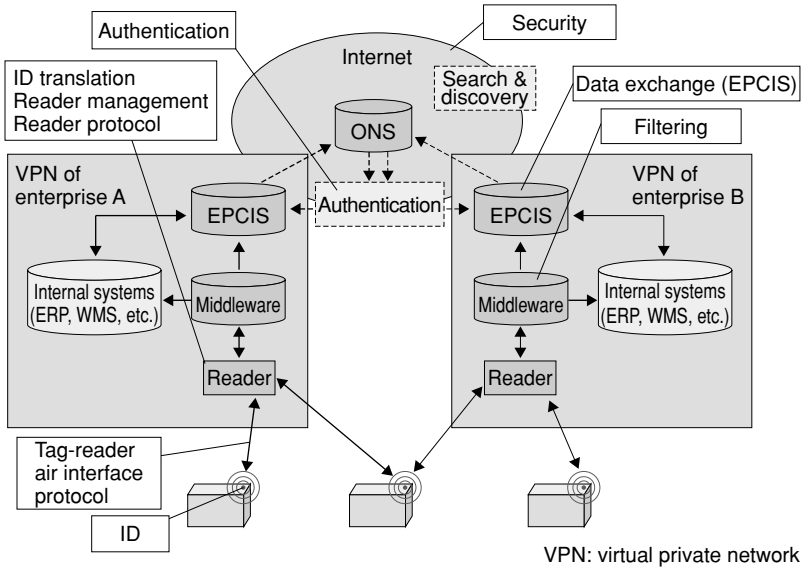

Fig. 3. Architecture of EPCglobal network.

- function for filtering and collecting raw data to extract business meaning.

EPCglobal creates specifications for some of these functions. Security measures such as authentication, access control, and encryption are required to ensure the smooth exchange of information between enterprises. In addition, the EPCglobal network needs to be integrated into existing internal systems in companies such as ERP (enterprise resource planning) and WMS (warehouse management system).

The relationship between the network architecture and standardized subjects of EPCglobal is shown in **Fig. 4**. With a few exceptions, the standardization in EPCglobal is mainly focused on the interface between the functions making up the whole EPCglobal network, rather than on the functions themselves. Functions themselves are left as areas of competition among vendor companies. The most important thing is to ensure interoperability between the products produced by different vendors.

EPCglobal has already finished establishing the final draft of the technical standard specifications of basic components other than EPCIS. These specifications should become the official EPCglobal standard once they have been ratified by the Board of Governors. EPCIS specifications are close to being finalized. To facilitate global adoption of its standards, EPCglobal is asking for the intellectual property included in its standards to be royalty free. However, in response to strong requests from many vendor companies, it created a mechanism for receiving reasonable and non-discriminatory (RAND) claims of intellectual property by establishing a 30-day intellectual property declaration period between the establishment of the final draft of a specification and its ratification by the Board. Many Japanese companies are reluctant to accept this position on intellectual property by EPCglobal and only a few Japanese companies are actively involved in EPCglobal standardization at present.

EPCglobal is also developing a verification mechanism for various software and hardware products from vendor companies. It will test (1) conformance to EPCglobal standards, (2) interoperability between products developed by different vendors, and (3) performance in the real world. EPCglobal aims to establish a verification mechanism for hardware (tags and readers) soon. Based on the results of these tests, EPCglobal prepares guidelines for user companies in order to choose among the many products on the market.

2.3 Future developments of EPCglobal

As most of the minimum requirements for EPCglobal standards have already been almost met, future developments will focus on the following issues.

Most of the hardware-related work is devoted to the tag-reader air interface protocol of passive tags, especially UHF-band tags which can be used over relatively long distances and are suitable for efficient supply chain management. Many user companies in the HLS BAG are now asking for item-level tagging, so discussion on enlarging and strengthening the functions of HF-band passive tags for relatively

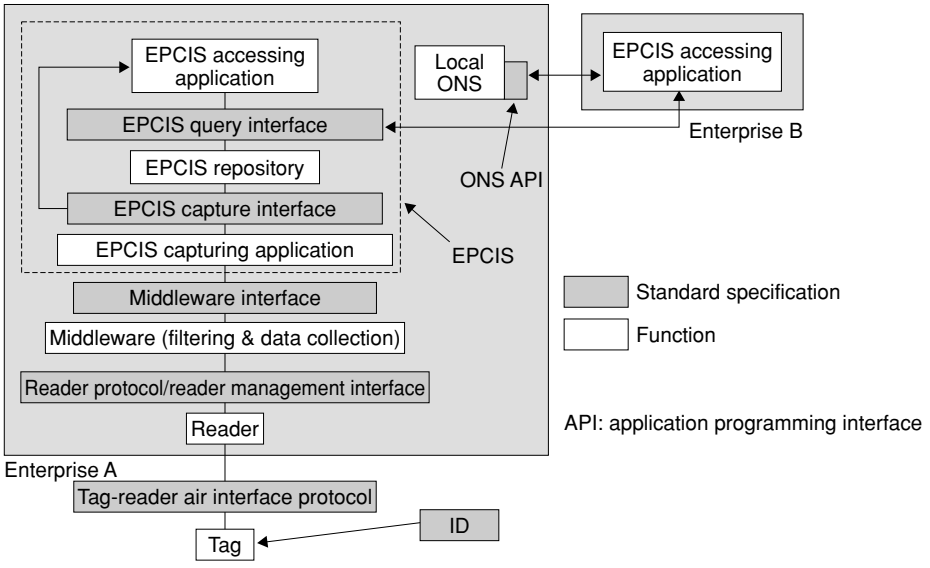

Fig. 4. Functions and standard specifications of EPCglobal network.

short-range use, which are more suitable for this purpose, will start soon. Moreover, the TLS BAG is examining use cases of active tags and sensors, so standardization of such hardware is likely to begin before long.

Most of the software-related requirements have already been met. However, unresolved subjects need to be worked out from now on. One unresolved subject is security measures such as authentication, access control, and encryption. They are listed as subjects of future discussion. Another subject is a search and discovery mechanism for finding all the databases located around the world storing event history and attributes related to a specific ID. This is expected to be conceptually like an Internet search engine, but practical design of this component has not begun yet.

Aside from these technical developments, EPCglobal is now trying to expand its adoption by many different industry sectors. Having already established BAGs for three industries, EPCglobal is now approaching the industry segments of aerospace and defense, automotive, apparel, and consumer electronics. For the automotive and consumer electronics segments, EPCglobal is very interested in active participation by Japanese manufacturers.

3. Other standardization activities

Among user companies in the U.S.A. and Europe, EPCglobal standards are regarded not as merely one of several candidates, but as the one and only set of standards without any other alternatives. For most Japanese companies, however, it is difficult to apply the use cases of companies in the United States and Europe and to determine the return on investment for using RFID, so only a few of them are trying to implement the EPCglobal standards.

One of the standardization activities centered in Japan is led by the Ubiquitous ID Center [3], which was established in the T-Engine Forum [4] in March 2003. More than 480 companies and research institutes participate in the T-Engine Forum, and most of them are Japanese. While EPCglobal has a clear vision of "user-driven standardization", the Ubiquitous ID Center is mainly managed by vendor companies developing the technology. From a global perspective, many organizations in Asian countries, such as South Korea, China, India, and Singapore, are involved in the Ubiquitous ID Center.

The basic concept of Ubiquitous ID is similar to that of Auto-ID (shown in Fig. 1). In addition, security mechanisms using encryption and authentication have already been prepared. The Ubiquitous ID Center is focusing on pilot projects for verifying Ubiquitous ID technology.

China is also conducting its own standardization activities and is expected to establish a Chinese Standard that is consistent with the EPCglobal standards. EPCglobal is eager to incorporate these Chinese activities into its standardization activities and is proactively engaged in Chinese standardization activities.

ISO (international organization for standardization), which is an international organization for establishing industrial standards, is also preparing RFID-related standards. It began discussions on RFID for managing general items in 1997 and it has already made standards for the air interface protocol between tags and readers (ISO/IEC 18000-1 to -7 for each radio frequency), data format (ISO/IEC 15961 and 15962), unique ID (ISO/IEC 15963), application requirements (TR 18001), and so on. Becoming an ISO standard is important for any technology that is intended for global use, and EPCglobal has already submitted the "Gen 2" standard for the tag-reader air interface protocol for UHF-band passive tags as ISO/IEC 18000-6 type C. It is expected to be adopted as the ISO standard in March 2006. EPCglobal will try to submit its other standards to ISO as appropriate.

References

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[2] http://www.epcglobalinc.org/
[3] http://www.uidcenter.org/
[4] http://www.t-engine.org/

Mitsuo Tsukada
Senior Research Engineer, Service Innovation Project, NTT Service Integration Laboratories.
He received the B.S. and M.E. degrees in physical chemistry from Waseda University, Tokyo in 1986 and 1988, respectively. He joined NTT in 1988 and engaged in R&D for improving the reliability of interconnections in silicon-based LSIs and ferroelectric oxide thin films for LSIs. From 1998 to 2002, he worked to establish an R&D department at NTT MSC in Malaysia and on projects to transfer technology to Malaysian and Southeast Asian companies. Since 2002, he has been participating in RFID standardization activities. He is a member of the Japan Society of Applied Physics.