A Summary of RFID Standards

It's commonly said that there are no standards in RFID. In fact, there are many well-established standards and a few emerging standards. Here's a guide to the most important ones.

Standards are critical for many RFID applications, such as payment systems and tracking goods or reusable containers in open supply chains. A great deal of work has been going on over the past decade to develop standards for different RFID frequencies and applications.

There are existing and proposed RFID standards that deal with the air interface protocol (the way tags and readers communicate), data content (the way data is organized or formatted), conformance (ways to test that products meet the standard) and applications (how standards are used on shipping labels, for example).

The International Organization for Standardization (ISO) has created standards for tracking cattle with RFID. ISO 11784 defines how data is structured on the tag. ISO 11785 defines the air interface protocol. ISO has created a standard for the air interface protocol for RFID tags used in payment systems and contactless smart cards (ISO 14443) and in vicinity cards (ISO 15693). It also has established standards for testing the conformance of RFID tags and readers to a standard (ISO 18047), and for testing the performance of RFID tags and readers (ISO 18046).

Using RFID to track goods in open supply chains is relatively new and fewer standards have been finalized. ISO has proposed standards for tracking 40-foot shipping containers, pallets, transport units, cases and unique items. These are at various stages in the approval process.

The standard situation was complicated by the fact that the Auto-ID Center, which developed Electronic Product Code technologies, chose to create its own air interface protocol for tracking goods through the international supply chain. This article explains the evolution of the Electronic Product Code and the importance of various ISO standards.

The Auto-ID Center was set up in 1999 to develop the Electronic Product Code and related technologies that could be used to identify products and track them through the global supply chain. Its mission was to develop a low-cost RFID system, because the tags needed to be disposable (a manufacturer putting tags on products shipped to a retailer was never going to get those tags back to reuse them). It had to operate in the ultra-high frequency band, because only UHF delivered the read range needed for supply chain applications, such as reading pallets coming through a dock door.

The Auto-ID Center also wanted its RFID system to be global and to be based on open standards. It needed to be global because the aim was to use it to track goods as they flowed from a manufacturer in one country or region to companies in other regions and eventually to store shelves. For Company A to read a tag put on a product by Company B, the tag had to use a standardized air interface protocol. The Auto-ID Center developed its own protocol and licensed it to EPCglobal on the condition that it would be made available royalty-free to manufacturers and end users.

The center also was charged with developing a network architecture—a layer integrated with the

Internet—that would enable anyone to look up information associated with a serial number stored on a tag. The network, too, needed to be based on open standards used on the Internet, so companies could share information easily and at low cost.

One option the Auto-ID Center had was to develop the numbering system and network infrastructure and use ISO protocols as the standard for the air interface. Earlier, EAN International and the Uniform Code Council had merged their efforts to create the Global Tag (GTAG), with ISO's UHF protocol. But the Auto-ID Center rejected this, because the ISO UHF protocol was too complex and would increase the cost of the tag unnecessarily.

The Auto-ID Center developed its own UHF protocol. Originally, the center planned to have one protocol that could be used to communicate with different classes of tags. Each successive class of tags would be more sophisticated than the one below it. The classes changed over time, but here is what was originally proposed.

• Class 1: a simple, passive, read-only backscatter tag with one-time, field-programmable non-volatile memory.
• Class 2: a passive backscatter tag with up to 65 KB of read-write memory.
• Class 3: a semi-passive backscatter tag, with up to 65 KB read-write memory; essentially, a Class 2 tag with a built-in battery to support increased read range.
• Class 4: an active tag that uses a built-in battery to run the microchip's circuitry and to power a transmitter that broadcasts a signal to a reader.
• Class 5: an active RFID tag that can communicate with other Class 5 tags and/or other devices.

Eventually, the Auto-ID Center adopted a Class 0 tag, which was a read-only tag that was programmed at the time the microchip was made. The Class 0 tag used a different protocol from the Class 1 tag, which meant that end users had to buy multiprotocol readers to read both Class 1 and Class 0 tags.

In 2003, the Auto-ID Center transitioned into two separate organizations. Auto-ID Labs at MIT and other universities around the world continued primary research on EPC technologies. EPC technology was licensed to the Uniform Code Council, which set up EPCglobal as a joint venture with EAN International, to commercialize EPC technology. In September 2003, the Auto-ID Center handed off the Class 0 and Class 1 protocols to EPCglobal, and EPCglobal's board subsequently approved Class 0 and Class 1 as EPC standards.

Class 1 and Class 0 have a couple of shortcomings, in addition to the fact that they are not interoperable. One issue is that they are incompatible with ISO standards. EPCglobal could submit them to ISO for approval as an international standard, but it is likely that ISO would want to revise them to bring them into line with ISO RFID standards. Another issue is that they cannot be used globally. Class 0, for instance, sends out a signal at one frequency and receives a signal back at a different frequency within the UHF band; this is prohibited in Europe, according to some experts (European Union regulations are open to interpretation).

In 2004, EPCglobal began developing a second-generation protocol (Gen 2), which would not be backward compatible with either Class 1 or Class 0. The aim was to create a single, global standard that would be more closely aligned with ISO standards. Gen 2 was approved in December 2004. RFID vendors that had worked on the ISO UHF standard also worked on Gen 2.

Gen 2 was designed to be fast-tracked within ISO, but a last minute disagreement over something called an Application Family Identifier (AFI) is likely to slow ISO approval. All ISO RFID standards have an AFI, an 8-bit code that identifies the origin of the data on the tag. Gen 2 has an 8-bit block of code that can be used for an AFI, but it is not required under the standard. (Requiring the eight bits to be used for an ISO AFI would have limited EPCglobal's control over EPCs.) But vendors are making product based on the new Gen 2 standard, which paves the way for global adoption of EPC technology in the supply chain.

ISO Standards

ISO has developed RFID standards for automatic identification and item management. This standard, known as the ISO 18000 series, covers the air interface protocol for systems likely to be used to track goods in the supply chain. They cover the major frequencies used in RFID systems around the world. The seven parts are:

18000–1: Generic parameters for air interfaces for globally accepted frequencies

18000–2: Air interface for 135 KHz

18000–3: Air interface for 13.56 MHz

18000–4: Air interface for 2.45 GHz

18000–5: Air interface for 5.8 GHz

18000–6: Air interface for 860 MHz to 930 MHz

18000–7: Air interface at 433.92 MHz

EPCglobal's Gen 2 standard could be submitted to ISO under 18000-6, but it's not clear when that will happen or how quickly it will be approved. ISO slowed approval of 18000-6 to see if it could be aligned with Gen 2. EPCglobal has set up a committee to try to resolve the issue. Requiring an AFI would require going through a formal process of amending the EPC standard. End users would like there to be one international standard for tracking goods through the open supply chain using UHF RFID tags. But it could take another year before that finally happens.