RFID tags: driving toward 5 cents

Charles Murray - June 08, 2006

Makers of RFID chips and so-called inlays, which include the chip, antenna, and substrate, have been trying for years to reduce prices for RFID tags to 5 cents. However, these manufacturers hesitate to do so because those less expensive tags may lack the capabilities of their more expensive counterparts. "We've been talking about the mythical 5-cent price point for years," notes Mike Liard, RFID-practice director for Venture Development Corp. "Is it possible? Yes. But it may not necessarily be the type of tag you're looking for." As a result, most manufacturers haven't rushed to put 5-cent tags on the market. Instead, they've been content to cut prices at a steady rate of about 5 to 10% per year since 2000 while improving the technology. As a result, users of the tags are employing them in applications no one dreamed of a decade ago, despite their inability to reach the elusive nickel price.

At McCarran International Airport in Las Vegas, for example, operators attach "bag tags" with dual dipole antennas to luggage to ensure that RFID readers in the handling system can communicate with all bags, no matter their orientation on conveyor belts (picture). The technology, which Symbol Technologies developed, integrates two antennas 90° from one another; thus, the RFID tags can communicate with the airport's RFID readers, no matter how baggage handlers toss the luggage onto conveyor belts. "If you wanted to have a lower cost solution in which one antenna would work, the bags would have to be oriented in a certain way, and they'd have to pass the reader in a certain way," says Alan McNabb, senior director of product management for Symbol's RFID tags. "But with our tag, the orientation of the bag doesn't matter."

Such dual-antenna tags haven't reached rock-bottom prices, but at roughly 20 cents each, they offer capabilities nickel tags can't match. Similarly, retailers have begun using tags with specialized antennas to enable garments buried in stacks to successfully "talk" to RFID readers. Again, cheaper tags are unlikely to achieve such feats.

The bottom line is that while RFID vendors have been lowering their prices and improving their technology, they've been carving out new niches for themselves. Increasingly, RFID tags are finding use on pallets (picture), cartons, garments, luggage, DVD cases, pill bottles, and library books. And experts foresee their future use in low-cost, everyday items—from lipstick cases to cereal boxes.
Although they won't soon replace bar codes, they nevertheless offer non-line-of-sight capability, which means that they can gather information on their whereabouts without the need for individual handling. As a result, they can deter theft and counterfeiting.

"RFID is not labor-intensive," notes Sanjay Sarma, associate professor of mechanical engineering at the Massachusetts Institute of Technology and research director for MIT's Auto-ID Center. "It gives you information you can't get with a bar code, unless you have an army of people scanning every product."

Cost still key

At costs of 10 to 20 cents apiece, however, RFID tags are still far more expensive than bar codes, which is why the drive to 5-cent tags continues. "The state of momentum within the industry toward the 5-cent mark is healthy," Sarma says. "The good news is that it has gone beyond research. It's moved into development, and a lot of companies are looking to go to 5 cents."

Whether 5 cents is their ultimate goal, makers of chips and inlays alike have targeted lower cost. Chip designer Impinj Inc, for example, is cutting costs through a novel semiconductor approach that enables the company to apply low-cost CMOS techniques to RFID devices. Unlike conventional RFID-chip makers, which typically use extra photo masks and process steps to create onboard, nonvolatile EEPROM or flash memory on RFID chips, Impinj engineers use "self-adaptive silicon."

Using the technique, they create special transistors containing gates that store bits of memory. By fabricating such transistors, they can make nonvolatile memories without resorting to the extra photo masks and steps that EEPROMs and flash memory require. "Self-adaptive silicon enables us to make nonvolatile memory with the simplest of CMOS processes," says Dimitri Desmons, vice president of marketing for Impinj.

Impinj engineers say that self-adaptive technology can potentially cut pennies from chip costs (picture). Moreover, such technologies even further reduce costs when manufacturers combine them with high-volume-assembly methodologies, such as those that Alien Technology developed. Alien, which employs FSA (fluidic self-assembly), recently cut inlay costs to 12.9 cents each (picture). A company founder developed the technique, which he thought of while playing a child's game that required him to maneuver steel balls into tiny slots. The technique allows the company to package as many as 2 million chips per hour into RFID tags, compared with 10,000 per hour using conventional methods. The trick, the company says, is to suspend the tiny semiconductor devices in a liquid and then "flow" them across the holes; the devices then drop into these holes and self-align. The self-assembly technology combines with growing production volume to enable Alien to cut its tag costs by nearly 50%, down from 23 cents each.

Other vendors have attacked the cost issue from a different perspective. Symbol Technologies, for example, has cut the cost of its tags through multiple efforts, not the least of which is its move from silver to aluminum antennas. The company, which makes high-performance RFID systems, moved from the higher conductivity of silver to the lower conductivity of aluminum by developing an on-chip "charge pump" that helps boost the continuity and strength of RF signals coming to the antenna.

An Internet of things

Such technologies are making inroads for RFID. Symbol, for example, has placed similar technologies on pill bottles for the counterfeit-wary pharmaceutical industry. "The pharmaceutical industry has a huge issue with counterfeit products coming through the market," says Dirk
Morgenroth, marketing manager for RFID at Philips Semiconductors. "They've been very vocal about using RFID."

Manufacturers, including Philips, Texas Instruments, Impinj, and Alien, have also placed their RFID products on shirts, pants, and sweaters in the fashion industry, as well as in library books and on DVD and CD cases. The industry's biggest score to date, however, could be in the works in Europe, where rumor has it that the European Central Bank is working with vendors on weaving RFID into the fabric of its bank notes. The technology, most probably for incorporation into larger bills, would enable money to carry its own history. Hence, it would become more difficult for kidnapers to ask for unmarked bills. It would also enable law-enforcement agencies to "follow the money" in illegal transactions.

The project, which Wired and EE Times originally reported, was supposed to take effect in Europe's 2005 currency. Hitachi Ltd, which announced in February that it has developed the world's smallest RFID chip (picture), measuring just 0.4×0.4 mm×7.5 microns, has frequent links with the European reports. Hitachi, however, denies it has worked on such a project. A European Central Bank spokesman says, "We cannot say anything about this, and we've requested that our providers sign a mutual agreement not to talk about it."

Even if such projects never reach fruition, however, experts are confident that RFID will eventually be the backbone of a plan that researchers call an Internet of things. In this scenario, almost everything, large and small, connects through the Web. The plan, which hardware and software protocols describe, calls for all information on a product to be written in a code based on XML (Extensible Markup Language). The code, which forms a Web page for each item, would connect through RFID tags to Internet servers. Thus, anyone in any location could instantly identify all products. A broad coalition of corporate giants, including Coca-Cola, International Paper, Johnson & Johnson, Kimberly-Clark, Pepsi, Procter & Gamble, and others, have supported such efforts through MIT's Auto-ID Center.

Low cost is key to such plans, but researchers have worked that out, too. Ultimately, they say, everyday items will incorporate RFID, not on sticky tags, but through integration into the corrugate of cardboard boxes. Ongoing effort in this area will be one of the keys to lowering RFID cost, researchers say, because the technology eliminates the need for certain parts of the tag. Manufacturers would integrate such technologies during the cardboard-manufacturing process, thus enabling cost reduction.

"These RFID technologies will coexist with the bar code for a long time into the future," says Sarma of MIT. "But they will provide information that a bar code can't: 'Did the item go to the sales floor? Did the meat sit in the fridge long enough?' You can't know that with a bar code." Sarma says such technologies will become widespread when production volume reaches a tipping point. When that scenario happens, it will drive costs down to a level low enough to motivate use of RFID on everyday items. And with retailers—particularly Wal-Mart—pushing for RFID, the concept is realistic, experts say. "The question now is the tipping point," Sarma says. "When do you get to the percentage that causes you to say, 'I'm going to put the tag inside the corrugate?' In the next year, we could see it happen."

Design News is a sister publication of EDN. This article originally appeared in Design News' April 24, 2006, issue.