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Advisory

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The Potential and Challenges of RFID Technology

by Russell Fox and Laura Newman Rychak

Pick up any grocery store item and you'll see the barcode that identifies to the supermarket's computer system the product you're buying. The latest development in monitoring and identification, Radio Frequency Identification (RFID), has been described as "barcodes on steroids."[1] From smart cards and gas station speed passes to animal tracking, this technology is becoming more versatile and its use more widespread. This client advisory discusses the potential and challenges of RFID technology. While issues such as the cost of RFID tags and the integration of this technology into business processes are important, this client advisory focuses on the challenges associated with regulation and allocation of radio spectrum used to support RFID, technology standardization, and privacy and security–issues that have received the most attention from government regulators, the RFID industry and the trade press.

RFID Basics

Many analysts have stated that RFID is not a replacement technology for barcodes; the two technologies serve different sectors. However, it is the contrast with barcodes that makes RFID capabilities most apparent. While inexpensive, barcodes generally lack the ability to identify individual products, and scanners must be positioned in a line of sight to read the barcode. RFID systems, however, can capture much more specific information, such as a customer's account number and contact information, in some cases at distances up to 300 feet away.

In their simplest configurations, RFID systems typically consist of a tag/transponder and a reader/transceiver. The tag is a microchip with an antenna, which has the ability to store unique information. The reader sends signals to the tag (also known as "interrogating" the tag) and the tag returns a signal back to the reader with the requested information. The RFID tag may be active, passive or semi-passive. Active tags are self-powered transmitters that operate with a battery at ranges of up to 300 feet from the reader. Because active tags are expensive (*e.g.,* more than $20 each), they are generally used to track big-ticket items, such as railroad cars and shipping containers. For now, passive tags are more popular for RFID use because the cost of passive tags ranges from 50 cents to a few dollars.[2]

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[1] Remarks of Senator Patrick Leahy, *The Dawn of Micro Monitoring: Its Promise, And Its Challenges to Privacy and Security,* Conference on Video Surveillance: Legal and Technological Challenges, Georgetown University Law Center (Mar. 23, 2004).

[2] Carol Sliwa, *Part 2: RFID Tags Get Cheaper,* ComputerWorld (Aug. 18, 2003), *available at* http://www.computerworld.com/softwaretopics/erp/story/0,10801,84004,00.html. Alien Technology Corp., an RFID manufacturer, anticipates reducing passive tag costs to as little as 5 cents by 2006.

A passive tag is cheaper because it lacks a battery and is non-operative until the reader transmits radio waves to its antenna. It is also more limited–it is generally used at distances of less than 10 feet. Once the reader's radio waves reach the tag's antenna, a magnetic field is created from which the passive tag draws power to transmit information back to the reader. A semi-passive tag uses a battery to operate, but it does not use the battery to transmit signals to a reader like an active tag. A semi-passive tag, designed to conserve its battery, remains dormant until the reader interrogates it. Semi-passive tags usually cost a dollar or more.

The other important difference between RFID tags is whether they are read-only or read/write. Read/write chips in RF tags permit the user to add information to the tag or write over existing information when the tag is within range of a reader. Read/write chips are more expensive, and are not used in standard product tracking applications. Read-only chips generally have information stored during the production process and cannot be changed later.

Uses of RFID

Many industries are embracing RFID technology. The Department of Defense (DOD) emphasized in a recent DOD RFID summit that it would be an early adopter of passive RFID.[3] Starting in January 2005, the DOD will require its suppliers' shipments to be passively tagged. Wal-Mart is also requiring its top 100 suppliers to tag goods at a case and pallet level.[4] In 2005, Wal-Mart anticipates high-ticket and/or high-theft items, such as electronics, tires and pharmaceutical products, to be individually tagged. Hewlett Packard, Wal-Mart's largest provider of electronic goods, is also requesting its Taiwanese suppliers to incorporate RFID systems by August 2004.[5]

While RFID has appeal for inventory tracking, other companies are exploring additional uses for this technology. For example, Federal Express ("FedEx") is providing some of its delivery personnel with Velcro wristbands embedded with RFID tags that will provide for keyless entry and ignition of delivery trucks.[6]

Future Enhancements to RFID

RFID systems promise innovation beyond today's applications. For example, KSW-Microtec is developing RFID tags that can be ironed or sewn onto fabric to streamline inventory management.[7] Paralec, Inc., another RFID innovator, claims it has developed ink that can be used as an antenna for RFID tags printed on paper and polyester, which could, in turn, be used as part of an item's packaging.[8] Other companies are developing RFID with intelligent software in order to automate decision-making. When RFID-tagged artillery arrives at a DOD warehouse, for instance, and the tags are scanned by a reader mounted at the unloading dock door, the intelligent software in the RFID tag could register that the goods are accepted and instruct the DOD accounting system to pay the supplier for these goods. RFID tags with radiation sensors are also being designed to track items, such as food, moving through a supply chain in order to alert staff if the item appears to have spoiled or been injected by a biological agent.

FCC Regulation of RFID

When a reader interrogates a tag and the tag transmits information back to the reader, the RFID system uses radio frequencies to transmit the signal. The Federal Communications Commission (FCC) has the authority to regulate radio frequency (RF) devices in different ways. Sometimes it issues licenses to entities, like cellular companies, that are authorized to use specific frequencies in particular areas. However, RFID devices are unlicensed and require no separate FCC authorization. Lack of FCC licensing has benefits and detriments. On the one hand, like all unlicensed devices, RFID technology lacks the interference protections and exclusivity rights accorded to licensed users. Unlicensed devices may also operate only with very low power, and other limitations designed to limit their potential to cause interference to licensed devices and other unlicensed technologies. On the other hand, unlicensed device manufacturers and consumers reap benefits from the FCC's unlicensed device rules, which encourage quick entry into the

[3] Presentation by Ed Coyle, DOD Logistics AIT Office, *DOD RFID Policy Update*, 2004 RFID Summit for Industry (Apr. 7, 2004), *available at* http://www.dodait.com.

[4] Presentation by Simon Langford, Wal-Mart, *RFID*, 2004 RFID Summit for Industry (Apr. 7, 2004), *available at* http://www.dodait.com.

[5] Amber Chung, *RFID demands generates worries*, Taipei Times, (Apr. 14, 2004), *available at* http://www.taipeitimes.com/News/biz/archives/2004/04/14/2003136642/print.

[6] Kenneth R. Carter Et. Al., *Unlicensed and Unshackled: A Joint OSP-OET White Paper on Unlicensed Devices and Their Regulatory Issues*, Federal Communications Commission (May 2003), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-234741A1.pdf.

[7] RFID Journal, *New Direct-To-Textile Washable Tag: KSW-Microtec has unveiled new washable RFID labels that can be attached directly to the fabric of the garments* (Nov. 11, 2002), available at http://www.rfidjournal.com/article/articleview/111/1/1/.

[8] Electronic Brochure, *Paramod Inks for RFID Antenna, available at* http://www.parelecusa.com/parelec2/products/Images/RFID.pdf.

marketplace to satisfy consumer demand. Moreover, FCC rules permit RFID systems and other unlicensed devices to operate on several bands, allowing manufacturers to find the band most suitable for their operations.

The following frequency bands are where RFID devices most commonly operate in the U.S.: 1) 125 KHz (or so-called low frequency, or "LF" band); 2) the 13.56 MHz (or, "HF" band); 3) the 433 MHz and 850-900 MHz bands (or "UHF" bands); and 4) the 2.45 GHz and 5.8 GHz (or microwave bands). Selecting the appropriate frequency for a RFID system depends on the type of application the RFID system will perform. LF tags, for instance, are ideal for scanning non-metallic objects with high water content (*e.g.,* fruit). HF tags have a short read range and slower data rates in comparison to higher frequencies, but are inexpensive and widely used for smart cards. UHF tags are more expensive and require more power than LF tags, but they provide a better range and faster data transfer. UHF RFID tags, however, need a clear path to the reader and do not pass through materials well. Thus, UHF tags are often used for electronic toll collection, pallet tracking and baggage handling. RFID tags in the microwave bands have a faster read rate than UHF tags, but microwave transmissions are more vulnerable to performance degradation near metals and liquids.

Summary of FCC RFID Proceedings

Over the last year, the FCC adopted important new rules governing RFID devices. In its most recent decision of April 2004, the FCC adopted rules to improve RFID system use in the 433 MHz band by increasing maximum signal levels and transmission durations for RFID use.[9] With these improvements, RFID systems will be able to read commercial shipping containers more rapidly and with increased accuracy. The FCC anticipates that these improvements will also provide significant homeland security benefits at ports, warehouses and rail yards in commercial and industrial settings because improved RFID systems equipped with sensors will be able to quickly identify whether tampering of a shipping container's contents has occurred. Importantly, the FCC limited these RFID signal and transmission enhancements to commercial shipping containers in industrial and commercial areas in order to minimize interference risks. The FCC selected the 433 MHz band for these RFID operational improvements because this band is also designated as unlicensed in other countries.

In a June 2003 decision, the FCC focused on improving RFID operation in several frequency bands, such as the 13.56 MHz band, by increasing the maximum field strength permitted.[10] This Order also permitted more technical flexibility in the band. The FCC reasoned that these changes would improve RFID tag operation in the 13.56 MHz band and increase the development of RFID tags because this band is available for unlicensed operation around the world. The FCC's 2003 decision also determined that tags and readers, which, like all devices that transmit RF energy, require equipment authorization, could be approved jointly under one FCC number or approved separately. The FCC noted that joint approval of tags and readers simplified filing requirements where devices are usually sold together, and it determined that separate authorization of tags and readers provided increased flexibility to manufacturers seeking to sell different combinations of tags and readers.

Spectrum

With inventory manufactured and shipped around the world, RFID systems can be most effective when they operate globally. In order for there to be global use of the same RFID device, the same spectrum must be allocated for RFID operations on a worldwide basis. Today, U.S. unlicensed operations conflict with the operations of several other nations. For instance, Europe uses the 868 MHz band for its UHF RFID use while the U.S. uses the 915 MHz band for its UHF RFID systems. Japan does not permit any RFID use in its UHF spectrum. As emphasized by Ruprecht Niepold, head of the European Commission Unit on Radio Spectrum Policy, finding common spectrum is a global issue.[11] Some within the industry advocate for more virgin spectrum and have identified the UHF band as ideal for RFID systems. However, other RFID sources contend that sufficient spectrum exists for current uses. These same advocates emphasize that a better understanding of future uses is needed, especially if high power bands are identified for RFID.

Standardization

Just as there must be standard spectrum allocations on a world-wide basis in order for there to be global interoperability, many industry participants

[9] *In the Matter of Review of Part 15 and other Parts of the Commission's Rules*, ET Docket No. 01-278, FCC 04-98 (rel. Apr. 23, 2004).

[10] *In the Matter of Review of Part 15 and other Parts of the Commission's Rules*, 18 FCC Rcd. 14741 (2003).

[11] Monika Ermert, *Interoperability and Privacy are Top Problems for European RFID*, Communications Daily, Vol. 24, No. 78 (Apr. 22, 2004).

believe that common operational standards are important as well. Several RFID standards currently exist: 1) ISO 11784/11785 (Animal Identification RFID Standard); 2) ISO ANSI/NCITS T6 256-1999 (Item Management RFID Standard); and 3) ISO/IEC 15693-2 (13.56 MHz Vicinity Cards and Smart Labels RFID standard). However, major users like the DOD, Wal-Mart, Campbell's, The Gillette Company, PepsiCo and many others have endorsed adoption of a common worldwide standard promoted by EPCglobal, Inc.[12] EPCglobal, Inc. is a joint venture between the Uniform Code Council (UCC) and EAN International to develop the Electronic Product Code (EPC) Network, which will provide for automatic item identification in the supply chain of any company in any industry. The EPCglobal Network was initially developed by the Auto-ID Center at the Massachusetts Institute of Technology (MIT). This proposed standard using EPC technologies is expected to be submitted to the International Standards Organization (ISO) for its review and ratification. Given the widespread support of the EPC standard development by major industry players, it may be the standard to watch.

Privacy and Security Issues

The benefit of RFID—which permits individual tracking and profiling—also gives rise to privacy and security concerns.[13] For example, RFID technology can be used to track products beyond the point of sale to ultimate purchasers. While tracking these products may be helpful for warranty and product services issues, it also presents serious privacy concerns and possible security issues. For example, terrorists could use RFID technology to track the shopping activities of a potential target.[14] Moreover, RFID tags may be hidden or embedded in a product or its packaging; thus, many consumers are unaware that their purchases are tagged.[15] RFID tags are also getting smaller. Hitachi's mu-chip is compared with grains of rice. Likewise, readers can be hidden or invisibly embedded. Examples include readers invisibly embedded in walls, doorways, carpeting, shelving and furniture. Thus, unauthorized readers may gain access to proprietary information.

Privacy advocates have described RFID as generating a "silent commerce" because consumers are unaware of where or how RFID technology is being used. Even humans can be tagged. The VeriChip Corporation, for example, provides personal verification systems by embedding RFID chips just under a person's skin. This technology can be used to verify a person's identity using a RFID reader at secure locations, such as government facilities, research laboratories and private facilities. Sponsors of the EPCglobal standard and some RFID manufacturers are trying to address these concerns. For example, EPCglobal provides the following guidelines on EPC for consumer products: 1) clear notice of EPC on the product or its packaging; 2) consumer choice on discarding, disabling or removing the tag; 3) consumer education by EPCglobal and companies using EPC tags; and 4) maintenance and protection of records generated through EPC in accordance with applicable laws. [16] These self-regulating efforts aside, RFID faces little or no privacy regulation to date.

Conclusion

RFID systems are the future of monitoring and identification. How the RFID industry and its regulators resolve the difficult issues of spectrum, standardization, privacy and security will significantly shape its potential as a helpful global tracking tool or a pervasive infringement on civil liberties.

[12] *See e.g., EPCglobal Board of Governors*, EPCglobal, Inc., available at http://www.epcglobalinc.org/about/about_epcglobal.html.

[13] Monika Ermert, *Interoperability and Privacy are Top Problems for European RFID*, Communications Daily, Vol. 24, No. 78 (Apr. 22, 2004) (noting a large German retailer discontinued RFID tag use in its customer pay-back cards after protests from consumer and civil liberties groups).

[14] *Id.*

[15] *See e.g.*, Presentation by Katherine Albrecht, *Consumers Against Supermarket Privacy Invasion and Numbering*, RFID Privacy Workshop @ MIT, (Nov. 15, 2003), *available at* http://www.rfidprivacy.org/papers/albrecht.pdf.

[16] *Guidelines on EPC for Consumer Products*, EPCglobal, Inc., *available at* http://www.epcglobalinc.org/public_policy/public_policy_guidelines.html.