Scanning the Horizon: A Skeptical View of RFIDs on the Shelves

November 13, 2003

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Abstract

Electronic Product Codes (EPCs), implemented through RFID technologies, have been proposed for enhanced management of supply chains, including in retail commerce. Advocacy for the EPC in commerce has focused in part on the benefits that it will provide to retailers, including in management of products on the shelves, and at point of sale. We believe that some of these envisioned benefits are illusory, and that retailers may see less direct benefit from the adoption of RFID than has been anticipated—even retailers who choose not to make use of RFID will bear some of the burden of its deployment by others.

Introduction

The Electronic Product Codes (EPC), defined through the work of the MIT Auto-ID Center, and now overseen by the organizations responsible for the previous generation of product identifiers, is poised to transform commerce. Where the Universal Product Code (UPC) is applied to items, the EPC is intended as a truly universal identifier, used to tag unique instantiations of items, as well as their aggregations in cases, pallets, etc. The EPC is designed for application all along the supply chain, including in the management of products on retail shelves through item-level RFID tagging; there is a policy debate as to potential risks to consumer privacy from RFID tags that persist on items, post-purchase.

While there should be gains across supply chains, from manufacturer to the retail store and beyond, we are skeptical of many of the scenarios for benefits to retailers, as tags emerge from the back room, and appear on the shelves.

The EPC and the UPC

In understanding the EPC, it is important to recognize that it won't replace the UPC but rather extend, complement and reflect it.

The EPC, as envisioned by the Auto-ID Center, takes two significant steps beyond the UPC[1]: it defines a sufficiently large name space to allow assigning IDs to every instantiation of an item (and not just the same ID on every unit of a particular product), and it is intended to be implemented using RFID tags. These are complementary but *separate* things. A simple, overarching, and broadly-adopted scheme for unique naming will allow for greater accuracy in exchanging information about specific items, e.g., in rapidly identifying items to be recalled because of a production error; perhaps more importantly, it would allow for inference, e.g., the discovery of a number of faulty products could much more readily lead to an inference as to where the problems in the production or delivery processes lie.

RFID *complements* this, in making it much more possible to collect data points along the route items travel, both from the items themselves, and from the aggregations (cases, pallets, etc.) the items were known to have been bundled into.

But items without RFID tags will nonetheless be assigned EPCs; compatibility interests would suggest that there will be good reasons to assign EPCs to most everything, long before the business case for actual RFID tagging can be made, or the technologies are sufficiently reliable for some of their envisioned applications.

The enormous scale of legacy point-of-sale systems will of course mandate that items continue to be marked with the previous generation of bar codes. And given that bar coding is sufficient for the completion of a sale—whatever its unique identity, a box of Wheaties is a box of Wheaties, when it comes time to pay for it—we should see considerable inertia. While the UPC namespace is cramped, it's not broken; the EPC isn't needed to fix it, for most point-of-sale applications. Indeed, it seems plausible that EPCs will effectively be UPCs: it will be useful to represent the EPC on the package in human-readable form (to accommodate damaged or destroyed tags, just as the UPC bar code is augmented with human-readable decimals), and the simplest means to do that would be to merely augment the existing UPC bar code with a separate unique serial.

Arguments for RFID on the Shelves

Pervasive, item-level RFID tagging—years off, if it occurs—is forecast to allow for applications within the retail sales environment, in interaction with customers:

"As the price of RFID continues to fall, there is interest in applications at consumer unit level, such as managing shelf inventory, preventing crime and identifying counterfeit products. I would call these medium term applications – not likely to emerge at scale until 2007 or 2008 at the earliest."[2]

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[1] Throughout, the UPC will be used as a stand-in for the various product code schemes now being unified under the Global Trade Identification Number (GTIN).

[2] Testimony of Kevin Ashton, Executive Director, Auto-ID Center, California State Senate Subcommittee on New Technologies Hearing on RFID and Privacy, August 18, 2003, http://www.autoidcenter.org/privacy_hearing.asp

Other analysis from the MIT Auto-ID Center has predicted that RFID tagging will reduce in-store losses, with benefits coming both from greater accuracy in logging the movement of goods, and opportunities for the actual interdiction of theft.[3]

Problems with the Model

Interrogation of RFID tags is, and will be, less than 100% reliable. Auto-ID Center field tests in 2001, assessing the performance of readers and tags in a real-world environment, suggest that RFID scanning will be perhaps more an art than a science.[4]

Systems relying on RFID recognition in a "friendly" environment, e.g., in sorting arriving pallets of product in a distribution center, can be engineered to be suitably acceptable. Radio interference can be minimized through shielding, selection of operating frequencies, etc. The retail store floor is a comparatively hostile environment, however: RFIDs will be scattered throughout the area[5], according to interests other than those of system managers.

Similarly, there should be far fewer concerns for malicious activity, e.g., in spoofing RFID tags, within the friendlier portions of the supply chain; the retail store environment will be open to all comers.

Skeptical Hypotheses

"Wireless checkout" is likely to be a pipedream, apart for a very few retailers with very specialized inventories.

> As manufacturers adopted UPC bar coding, retailers faced an increased likelihood that products sold in the stores bore bar codes. Tipping points, where the benefits of adopting code-scanning technologies at checkout outweighed the costs for particular retailers, came long before all products were coded (indeed, many products still *aren't* bar coded).
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> For RFID-based checkout to make sense, it must be the case that:
> - all products sold by a retailer are RFID tagged;
> - all tags function successfully (i.e., are accurately read in the variety of checkout circumstances);

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[3] "Prediction, Detection, and Proof: An Integrated Auto-ID Solution to Retail Theft," Robin Koh, Edmund W. Schuster, Nhat-So Lam, June 1, 2003.

[4] Auto-ID Field Test, "Lessons Learned in the Real World," Silvio Albano, Field Test Program Manager, document provided by Cryptome.org, http://cryptome.org/rfid/rfid-field-test.pdf

[5] Including RFIDs and RF sources brought in by customers: if there *isn't* a consumer backlash against RFID tags, post-purchase, then there will be all the more in the way of tags and their antennas cluttering the radio frequency environment.

- customers can't easily (or are not inclined to try to) defeat the tags.

These conditions seem unlikely to be met, save in very "friendly" circumstances, and not in the average retail store. While research and development of tag/reader technology is in its relative infancy, technologies to frustrate tag reading, e.g., by physically blocking signals, or through "blocker tags" disrupting the query process[6], will be conceived and implemented as well.

While this particular hypothesis might be seen as "shooting fish in a barrel," RFID-only checkout *has* been one of the images presented to the public, as an element of the future application of RFID, e.g., in television ads by IBM.[7]

If there is any significant consumer resistance to post-purchase RFID tags, retailers—including those who don't actually use RFID—will suffer the consequences.

There have been some concerns regarding RFID's potential to erode consumer privacy, by groups such as Consumers Against Supermarket Privacy Invasion and Numbering (CASPIAN)[8]; whether or not these concerns are overblown, they may affect consumers' attitudes toward RFID-tagged product.

The only parties the consumer knows are the manufacturer, and the retailer; the retailer is the only party in direct contact with the consumer. When there are a few manufacturer targets, they might be singled out for boycotts—if there are many, pressure may fall more on retailers for "aiding and abetting."

Certain products, such as razor blades, have been repeatedly cited as examples of a product likely to bear RFIDs, as a means to reduce theft. Given that the blades are sold across the spectrum of retailers, from $250B in annual sales Wal-Mart, down to "mom and pop" stores, some significant percentage will be sold in stores "below the RFID threshold," i.e., in stores where killing (or even detecting) the tag at point of sale is effectively impossible—a policy compromise that ensures that tags are killed at point of sale drops an "unfunded mandate" on smaller retailers. It is difficult to imagine scenarios that address anti-theft concerns— item-level tags that can't easily be defeated—yet accommodate the sub-threshold retailers' needs and possible consumer concerns.

For most retailer problems that RFIDs might solve, there will likely be better or cheaper solutions.

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[6] http://theory.lcs.mit.edu/~rivest/JuelsRivestSzydlo-TheBlockerTag.pdf, "The Blocker Tag: Selective Blocking of RFID Tags for Consumer Privacy," Ari Juels and Ronald L. Rivest and Michael Szydlo.
[7] "Supermarket," IBM Corporation, 1999, produced by Ogilvy & Mather.
[8] http://www.stoprfid.com/

Perhaps the most oft-cited prospective benefits of RFID to retailers have been in preventing theft/shrinkage, and in detecting out-of-stock conditions on the shelves. Neither of these problems seems easily solved via RFID; both might be addressed more effectively by other approaches.

Using RFID to monitor products on the shelves, e.g., to detect the removal of product by a possible shoplifter, requires a reader or readers, some system to interpret the collected data and, almost certainly, some human to interpret the system's output. A more cost-effective solution might be to enhance existing video surveillance; one would also expect that the videotape of a shoplifting incident would be far more compelling evidence (and actually useful in identifying a perpetrator) than an RFID transaction log. Given the ease of frustrating tag reading (e.g., by dropping the product into an RF-blocking bag, or overwhelming systems with chaff), it seems reasonable to assume that most anti-theft schemes will enjoy a short shelf life, so to speak, when encountered by criminals.

The various parties across supply chains have varying interests; gauging the value of RFIDs on products requires considering them in regard to each other, and not just adding them up.

Examples of RFID's benefits across supply chains assume a willingness, if not eagerness, on the part of various parties to pass information, e.g., to permit a 'just-in-time" approach to manufacturing that schedules production around the aggregation of events as small as a customer's pulling a lipstick from the shelf (or, just to be safe, its being rung up at the register). This presumes an unprecedented degree of collaboration, and disregards a much more complex economy for information.

Knowledge is power—if retailers readily disgorge information of interest to manufacturers, they may weaken their negotiating position vis-à-vis their suppliers.

And, to the degree that retailers are able to interrogate RFID-bearing items on their shelves, other parties, to include competitors, may be able to do so as well.[9]

Conclusions and Recommendations

RFID tags will likely be useful when the environment can be well controlled, or where sporadic reading is sufficient. That does not seem to be a good fit with the retail store sales environment.

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[9] 'Would Macy's Scan Gimbels? Competitive Intelligence and RFID," Ross Stapleton-Gray, RFID Privacy Workshop, MIT, Cambridge, MA, Nov. 15, 2003. http://www.rfidprivacy.org

Even if RFID tags should prove to be a bust at the far end of the supply chain, on retail shelves, RFID should still offer numerous benefits elsewhere, including in the stores, in the more "friendly" back office. The EPC, as a unique naming scheme, should also see considerable application, independent of its use with RFID tags, for assigning unambiguous names to products, their aggregations, equipment, precursor parts, etc.

A November, 2003 A.T. Kearney report anticipates that retailers will realize the greatest benefits of RFID.[10] That report focused largely on gains from supply chain efficiency, and the fact that the cost of the actual tagging occurs up the supply chain; we would suggest that some retailers will experience negative consequences, if there are issues of consumer acceptance of RFID tags, and certainly among "sub -threshold" retailers who have no direct interest in RFID, while the potential to use RFID to manage and monitor stock on the retail shelves may be oversold.

The information economy, between retailer and manufacturer, and with points in between, may prove interesting. While RFID may allow for every product to generate a stream of data points, those data are in the hands of those fielding the readers.

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[10] "Meeting the Retail RFID Mandate: A discussion of the issues facing CPG companies," http://www.atkearney.com/shared_res/pdf/Retail_RFID_S.pdf