RFID: Logistics Meets Identity

**BY ESTHER DYSON AND ERIC DEAN**

Eric Dean brings broad real-world knowledge to an assessment of RFID. We quoted him in the June 2002 Release 1.0, in his role as founding chairman of Liberty Alliance (2001 to 2002). At Liberty, he dealt first-hand with the challenges of how to integrate new identity systems into the legacy world, and fostered the group’s understanding that the challenges involve policy and business relationships as well as technology. Separately, he was CIO of United Airlines from 2000 to 2002, where he began the modernization of one of the largest and oldest legacy systems in the world. Before that, he spent 20 years at Arthur Andersen, joining the firm with a math degree from Indiana University. After gaining expertise as a consultant in online transaction processing systems and other technologies (including Tandem, Teradata and the like), he moved on to become CIO of Andersen Worldwide and later of Arthur Andersen, where his achievements included replacing the installed base of 125 Wang systems installed in 80 countries and moving to a more modern infrastructure including Lotus Notes, Microsoft Office and a global intranet. As an Andersen consultant, he visited many logistics operations. Here’s a practitioner who truly understands the tensions between the next new new thing and the constraints of everyday operations!

– Esther Dyson

On the one hand, this issue of Release 1.0 is about the next hot new, new thing: RFID, or radio-frequency identification, an existing technology based on two primary components (ID tags and over-the-air scanners). They are getting cheap and functional enough that new, critical-mass applications are emerging in supply chain and retail environments (to say nothing of “homeland security”). A hot new market, it’s already crawling with an array of mostly indis-
tinguishable start-ups promising cheaper chips, faster readers and the like. Better yet, there’s the scent of real ROI: more accurate tracking of goods leading to fewer errors, lower inventories and even better-stocked shelves, which lead in turn to lower costs, satisfied customers and higher revenues. (The dogs will never eat the dog food if they can’t find it on the shelf.) One problem: While the ROIs seem obvious and while RFID makes the “after” case clear, the “before” case, i.e. error rates and inefficiencies and their financial impact, can be hard to quantify precisely because the close monitoring RFID will provide isn’t available in the “before” case. Making such things visible – and correcting them – is the fundamental commercial potential of RFID, broadly drawn.

Some people call this consumer-goods-centric part of the market “Auto-ID”; it’s the intersection of RFID technology with retail-specific infrastructure. From the point of view of customers, the ability to recognize goods “automatically” – because RFID signals do not need line-of-sight or human handling to scan and recognize goods electronically – is more important than the RF technology used.

On the other hand, there’s a bigger story here: The initial premise of RFID is logistics: transient information about where goods are, where they are destined, who has title to them as they pass through a distribution chain. The promise of RFID is to make each item visible to the readers that scan them and the IT infrastructure behind them with little or no human manipulation of the object. But if you build those investment-returning systems with some basic object identification standards in place, you get persistent identity of all these objects (almost) for free, at least so long as the object keeps its original tag. What happens if you can identify every commercially produced product in the world, pretty much wherever and whenever you might want to, both as a kind of thing and as a particular instance of such a thing?

Suddenly, two new kinds of application may become practical. First, because the object’s identity can be recognizable across multiple
owners and through multiple events in its life (maintenance and repair, extreme conditions, etc.), you can develop comprehensive history information for it. This is the kind of information we resist generating – especially in a single place – about individual people, for reasons ranging from privacy (however defined) to the fact that people are malleable and may not want to carry their history with them through life or across contexts. But for things, with no personal identity of their own, the convenience and tidiness of being able to access all the information about a particular object (pointed to by a tag) across all systems may make a lot of sense. Good examples are products such as cars and airplanes where detailed maintenance histories can be relevant not only to the current owner but to prospective owners, or products such as perishable foods and drugs where detailed temperature histories can be crucial to quality and safety.

Second, because the means of recognizing an object with an RFID tag need not require a human to manipulate either the object or the device recognizing the object, there is the potential for developing applications that continuously monitor storage spaces such as shelves and cabinets, and that respond to changes such as the removal of a particular bottle of pills from the medicine cabinet or the addition of a new shirt to a wardrobe. Such capabilities can enable unattended real-time monitoring of display cases of valuable products (increasing exposure to customers without increasing theft rates) or home applications such as monitoring adherence to drug regimens or automated valet systems that not only know what color that tie is but have the taste (!) programmed in to warn you it won’t go with that shirt.

**Embedded in the legacy world**

One important challenge developers of these applications face, just as they do with identity management systems for people, is that the new applications will generally have to coexist with and deal with the constraints of a huge installed base. And indeed, much of the “RFID” spending will go to build out and enhance the legacy systems that already track these objects with different identifiers and varying qualities of information, including not just corporate applications but also an installed base of RFID chips and readers and bar-code scanners that use proprietary signaling protocols to communicate with one another.

Another part of the spending will go to buffering corporate systems from too much information (RF-spam). From the retailer’s point of view, you don’t need these details when things go well, but the avoided costs of things going wrong – loss,
shrinkage, counterfeiting, mishandling – are great enough to pay for a system that may seem like overkill when things go smoothly.

In order to lower the barriers to adoption, there are initiatives to standardize the protocols between tags and scanners, and at least one vendor (SAMSys) is offering multi-protocol programmable readers. Moreover, the scarcity of applications of RFID technology in retail today may mean the installed base of RFID technology is not much of an impediment in this market. Nonetheless, it will be a factor in some areas, and in other areas the installed base of bar-code scanners and related infrastructure will be the legacy that RFID will have to replace — or adapt to. In theory, you could build similar systems using data from bar-code scanners, but in practice bar-code scanning would not be used the same way. It requires line-of-sight and human intervention, the cost of which is a barrier to the quasi-real-time monitoring of RFID. Moreover, at least current bar-code standards do not track individual object identities. That requires a simple addition to the numbering standard... and many more complex additions to the corresponding back-end systems.

There are many other challenges to be met in defining and adopting new RFID/Auto-ID standards as well: engineering around the physical constraints of radio signals and the virtual constraints of legacy IT systems, and handling the myriad unique circumstances of logistics projects.

One other feature of RFID to bear in mind: There are many nuances in the physics of just how the chips and readers are configured. There are high-frequency and ultra-high-frequency configurations, where the chips can be read only from very close or from as far away as three meters, respectively. But there is not a single, one-size-fits-all physical design that can be stamped out and applied to anything. This may tend to make the technology market more specialized and possibly more fragmented. But on the other hand, the incredible variety of sizes, shapes, and other physical characteristics in the objects to be tagged, and the variety of processes through which they may pass, make it unlikely that one size could ever fit all anyway.

For the rest of this issue of Release 1.0, we focus almost exclusively on the market for RFID technologies in the consumer products world — ranging from retailers to distributors to manufacturers to manufacturers’ suppliers. The market-size excitement is in the newer, mass-market applications of RFID, which should help drive the overall annual RFID market from $1 billion currently to $7 billion by 2006, give or take a year or two. RFID saves labor costs in a variety of ways (in activities ranging from taking inventory to tracking shipments), but it also offers a host of benefits with less
direct but nonetheless real economic impact in reduced errors and improved perfor-
(see box, above.)

You could call the new, consumer-goods part of the market Auto-ID, because it is
driven by the economic potential of being able to automatically identify things,
whether through radio-frequency communication or some other means, without
human intervention. But we feel uncomfortable using a term so closely identified
with a single institution, especially one still in formation: the Auto-ID Center at
MIT, and a (partial) successor organization, AutoID Inc. (see page 12.) There’s more
to all this than either a single technology (RFID) or a single standards organization.

RFID technology is already in use or being developed in other markets: Car keys use
RFID; many tolls get charged with RFID; smart cards (especially in Europe) use
RFID; cargo containers are tagged with RFID. The consumer packaged goods world,
though, looks set to provide a model of the mutually reinforcing impacts of drop-
ning prices, increasing functionality, standardization, and an attractive, credible
ROI. Just as with the World Wide Web, the benefits of being able to share informa-
tion across boundaries – in one case, Websites; in this case, logistics information –
can lead to an unexpected range of additional capabilities, many of which may stim-
ulate their own new markets. Although much of the logistics information will be
proprietary, other kinds of information will be publicly available – subsidized by the
commercial impetus behind the efficiencies of shared logistics information.

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<th>BOX OF BENEFITS</th>
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<td><strong>Security/regulatory</strong></td>
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<td>• Tracking of airline parts, guns, and the like</td>
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<td>• Customs clearance/enforcement</td>
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<td>• Food and other perishable-product safety</td>
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| • Detection of counterfeit articles and tracking of grey-
  market goods (in theory) |
| • Other law-enforcement uses (but beware of privacy 
  issues) |
| **Supply chain/Life cycle** |
| • Tracking & positive identification (for efficiency and 
  security) |
| • Faster and more accurate receiving and shipping |
| • “High-resolution” recalls (targeted to a specific produc-
  tion batch, for example) |
| • Environmental monitoring, sorting and recycling |
| **Retail** |
| • Reducing out-of-stocks and finding inventory in the back 
  room (leading to increased sales) |
| • Reduction/detection of theft |
| • Generation of and fast response to market feedback |
| • Automated checkout (only when 100 percent of goods 
  tagged) |
| **Home** |
| • Smart appliances |
| • Point-of-use ordering |
| • Warranty and maintenance administration |
| • “Upgrades” and product reconfiguration |
| • Finding Y that goes with X you already have |
| • Managing drug interactions, monitoring compliance |
| • Matching pairs of socks (just kidding!) |
Evidence of life

Visibility will also drive the new market. The scoop in RFID Journal that got everyone’s attention last November – Gillette’s commitment to purchase 500 million tags from Alien Technology – is peanuts by retail standards. Gillette produces billions of blades and millions of razor handles (or “shaving system” components) per year. “We needed to get below 10 cents per tag,” says Gillette spokesman Paul Fox. “And we got it.”

Earlier this month, at a major retail industry IT conference/trade show, Wal-Mart CIO and SVP Linda Dillman confirmed that by 2005 Wal-Mart expects (read, will require) its top 100 product suppliers to tag each pallet or case they ship to Wal-Mart. That “expectation” means about 4 billion tags per year. Wal-Mart also de facto pledged its allegiance to the community’s about-to-be-born standard-bearer, AutoID Inc.

Wal-Mart chose to make its announcement at the Retail Systems conference rather than preaching to the converted at the companion RFID Journal Live! conference. The Wal-Mart session was positioned as one of several tracks, but it filled a 300-person room with about 40 standing along the walls. Later that day, the inaugural RFID Journal Live! conference attracted about 450 people, including 20 VCs. When VCs congregate, when vendors get orders for hundreds of millions of things (even small ones), when giants such as Wal-Mart start promoting something, when customers as well as press and analysts take heed of industry announcements, when SAP blesses something, and when unusually clueful trade groups coalesce major commercial players around standards, it’s clear something is about to happen.

The big question is whether this broader vision of RFID is inevitable, or whether it’s a deceptive illusion that we can cost-effectively track billions of little items in order to make it easy to focus on the exceptions. Today, it’s a matter of faith that it saves money to catch mistakes early and to remedy them easily. And it’s a matter of trust from consumers that RFID will deliver genuine benefits and will not be used in ways they don’t want or know about. We believe

“[RFID] is really a breakthrough technology and I think it will definitely change the way we are doing supply chain in the future. Is this a product today? No, but we are doing pilot projects and we will be ready earlier than everybody else to give you this technology in order to get competitive advantage.”

– Henning Kagermann, co-chairman and CEO, SAP
that RFID can deliver on both those promised, but only if its promoters and implementers effectively address both technical and policy questions.

But first, a little background on how all the pieces fit together.

**How RFID works: All together now!**

Much of the press coverage of RFID has focused on the tags and whether they can be made for under 5 cents apiece. But the widespread roll-out of RFID (or even Auto-ID) will require a broader infrastructure than just the radio-frequency devices and standards the terms refer to, just as “the Internet” comprises much more than just routers and TCP/IP plus the DNS.

In the case of RFID, the pieces are:

**The tags.** The “intelligence” in the tag is a tiny, usually passive silicon chip, which looks like a grain of sand or piece of dust on its own; earlier versions looked like... semiconductors, a centimeter or two across. “It’s the amoeba of the computer world,” says industry cheerleader Kevin Ashton, executive director of the Auto-ID Center. “You’ll never see a computer simpler than this.”

To be useful, each chip must be connected to a small, (physically) flexible antenna that picks up the RF signal and enables the tag to broadcast its presence and identity back to a reader. The resulting tag or label must be anchored to some object that can be handled physically. Usually, an identity number is programmed into the memory of each tag as it is applied to its object, by a signal sent via radio frequency (in the reverse of the process of reading the tag).

There are many forms this basic technology can take and many ways it can be integrated with other systems. There are passive tags that have no power source (battery) of their own but get sufficient power to respond from the RF signal transmitted by the scanners. There are active tags that have their own power supply. There are tags made from chips that are laser-written with an ID number when they are manufactured, tags that can be radio-programmed only once – Write Once, Read Many (WORM) or One-Time Programmable (OTP) chips – and tags that can be reprogrammed as often as you like. There are tags that simply signal their own ID numbers and other data, and tags that are combined with various kinds of sensors. And finally, the tag may not be a tag; it could be a chip embedded in almost any device or product, as long as it has an antenna to receive and return an RFID signal.
As for the antenna – some kind of conducting surface large enough to reflect a signal – it can be a “traditional” wire or coil, but (at least for ultra-high-frequency systems) it can also be just a thin shape of metal painted, printed or etched onto some surface. Printed antennas using conductive inks are one hot new area of interest in RFID.

**The readers.** The readers get the ID and any other information off the tag and put it into some kind of information system. They are actually the expensive part of the system, but (fortunately) fewer of them are needed. Current readers cost hundreds or thousands of dollars, and because they have a range of a few meters at best, there need to be lots of them for the kind of broad, real-time monitoring the visionaries espouse. With stricter RF regulations in Europe, the readers’ range is even shorter there than in the US. The big problem with the readers is cost; you do not need one per item, as with the tags, but you need one per some small number of locations if you want continuous monitoring. The readers are connected some way or another to the rest of the world, in as many ways and configurations as can be dreamed up by their users. In the future, according to the gospel of Auto-ID, they will connect to a variety of standard software components.

**The standards.** Each chip contains ID information. While heretofore that information was typically meaningful only within a specific (closed) context, the forthcoming AutoID Inc. standards aim to change that. An important element in the emergence of the Auto-ID portion of the RFID market is the forthcoming open Electronic Product Code (EPC) standard and communication protocols and Object Name Service (ONS). These standards will be managed by AutoID Inc., a new organization being created jointly by the Uniform Code Council, managers of the Universal Product Code (UPC) bar-code standard, and the European Article Numbering Association (EAN), which covers most manufacturers outside the US. (This handover is in progress now, and many issues are still under discussion; UCC was one of the initial funders and a founding member of the Auto-ID Center. Separately and unrelatedly, EAN is changing its name to GS1.)

AutoID Inc. is licensing technology and other intellectual property from the Auto-ID Center, but evidently it did not want the hyphen. [We asked, but no one would tell us what happened to it!] Its intent is to define the standards, broadly referred to as “the EPC Network,” for a single, unique item number that can allow literally every single consumer product to be tagged with a globally unique number (as opposed to the UPC, which simply identifies what kind of article something is). The intent behind ONS is to provide a rapid, reliable means of locating information about items tagged with an EPC number, the same way that the Domain Name System
allows your browser to find the Web server you want to reach. (The ONS uses the Domain Name System as its top-level resolution mechanism, sending updates and queries for each number to the proper server. One part of the four-part EPC code is a unique manufacturer/owner number, which references the proper server and the primary “owner” of the data about the product; of course, that owner can redirect queries elsewhere – to a shipper’s database, for example.)

In principle, the primary purpose of the ONS is to point to Physical Markup Language (PML) servers containing logistics information in PML, a variant of XML that covers things such as storage, shipping, delivery, shelf life, and what Uniform Code Council chief technical officer Bernie Hogan calls “EDI-like information.” (EDI refers to electronic data interchange, the current standard for representing transactions between businesses, with data such as “advance ship order” or credit terms.) “These transactions depend on trading relationships as well as logistics,” says Hogan. “Where we can play a major role as a standards organization is setting the business context in a standardized way, so that there’s common vocabulary.”

While none of these standards are fully baked yet, they offer both a vision and some initial specs to move towards. The joint presence of the AutoID Inc., Wal-Mart, Gillette, Procter & Gamble and a host of other vendors and users (i.e. retailers) makes the market direction pretty clear.

The back-end information systems. Most of the information in an RFID system is not in the tags; it’s in some kind of back-end system to which the tags point. Presumably, the EPC will become the global pointer to such systems. Today, the information is indexed either by a semi-unique number (a UPC or EAN number, which points to a generic product description rather than an individual instance and history) or by a locally unique number (something internal to a specific company).

The use of RFID will allow companies to collect more information about objects in the value chain, much more frequently. The back-end databases the tags point to – which can be as closed or as open as their owners wish – may contain all kinds of information about the tagged object, including its manufacturing history, the invoice that refers to it, repair history, ownership history, or any other information someone wants to attach to this particular object or to the class of objects that contains it. Note that from the privacy angle, it’s the databases rather than the RFID tags themselves that should be the focus of concern.
But most of these new systems will depend on and/or provide data to existing back-end systems and databases. RFID-generated events will turn into records of sales and receipts populating SAP systems. RFID systems will reference existing product databases for descriptive information. This landscape of existing systems, and how difficult it will be to integrate them with a newly standardized item code and with transactions originating from or destined for RFID-enabled systems, will largely determine how quickly and how fully RFID fulfills its promise in consumer product value chains.

The Ringleaders: Current Events

As noted, by 2005 Wal-Mart expects its top suppliers to tag their shipments – which it hopes will spur technology vendors to provide ever lower-cost tags and readers to make its vision work. At the announcement, Wal-Mart’s Dillman was joined by Mike DiYeso of the Uniform Code Council, who clarified the UCC’s own plans. In conjunction with the EAN, it will license technology and intellectual property from the Auto-ID Center to create a new organization to become the root registry and standards-keeper for the EPC Network.

The meaning of all this: Henceforward the standard for identifying most commercially produced mobile things in the world will be in the hands of the UCC – the people who created the ubiquitous UPC (the bar code on everything from a can of Canfield’s seltzer water – 78400 00730 1 – to a copy of Poetry magazine – 0 74470 77746 5). Or at least that’s what the UCC, Auto-ID Center, Wal-Mart, Procter & Gamble and others are hoping. Five billion items are UPC-scanned daily, DiYeso noted, and its member companies number more than 1 million.

The new outfit, called AutoID Inc., will take over the Auto-ID Center’s administrative/political duties; the Center will likewise lose its hyphen and become the AutoID Lab as of November 2003. Center founder Kevin Ashton, who was sitting with us at the Wal-Mart/UCC session, said, “It’s like watching your kid graduate,” as he wiped away an imaginary tear. But, he noted, this is not the end; it’s just the beginning. “Standards get made in the marketplace.”
Auto-ID: From Center to Inc. (minus the hyphen)

While RFID technology was progressing at its own pace as a relatively expensive tool for applications such as turnpike toll collection and employee identification systems, a few people saw its broader possibilities in the consumer products world. . .if the costs could come down. And a few vendors realized they could lower their costs. . .if they could get the volumes up. However, the traditional RFID component vendors, including TI and Philips, as well as the traditional article-tagging companies – Checkpoint Systems (as opposed to Software) and Sensormatic – weren’t in there early. Instead it took a new generation of vendors, and also some customers. . .

In the late ‘90s, at MIT’s Distributed Intelligent Systems Center (DISC), research chairman Sanjay Sarma was working on manufacturing automation. He says, “We had already figured out that the network was important to keeping costs down, but we had not started working on how to identify objects. When Kevin [Ashton] joined the Center and we started expanding into retail and consumer packaged goods, we expected the RFID hardware vendors to come rolling in, but they were dubious. So we started working on our own tags, and a few intrepid companies like Alien and Rafsec joined us.”

The other side of the story begins with Ashton, a mild-mannered junior brand manager at Procter & Gamble in the UK, working in “beauty care,” primarily Oil of Olay. When senior managers visited stores, he recalls, employees were forewarned and took care to restock the shelves and make everything look good. The managers never knew how prevalent out-of-stocks were; in one case, shelves in four out of 10 stores were out of one of Ashton’s products – Oil of Olay ColorMoist Lipstick, hazelnut shade – though there may well have been piles of it in the back room. “The Queen thinks the whole world smells of fresh paint,” he comments. “But we could do the greatest marketing in the world and it would come to nought if the shelves were empty when the consumers came to buy.”

Overall retail industry estimates are that out-of-stocks run about 2 to 3 percent in most stores, generally peaking above 10 percent after the Saturday shopping rush. The figures vary from product to product and from retailer to retailer, but the industry agrees that out-of-stocks are a huge problem. “And note too that this is an average,” says Ashton. “It includes all the cold cures that are nicely in stock during the summer, and all the products that aren’t selling, and so on. These ‘subsidize’ the out-of-stocks in key lines and make the averages look much better.” With encouragement
from P&G, Ashton started looking into RFID technology in 1999, and chanced upon the DISC at MIT. Things moved quickly, and a few months later, he found himself in charge of the newly named successor to DISC, the Auto-ID Center. Its new sponsors were P&G, Gillette and the Uniform Code Council.

The Center now has raised about $20 million and still has a few million left, says Ashton. It also has about 40 eager graduate students around the world doing everything from pilot projects to academic theses on arcane topics such as “Information Visibility and its Effect on Supply Chain Dynamics” and “The Reader Collision Problem.” It works closely both with customers and with vendors, including startups such as OATSystems, Alien Technology, Matrics and ThingMagic, as well as more mature technology companies who have started to recognize the market’s potential. The Center has been key in visible pilot projects with partners/sponsors including Wal-Mart, MeadWestvaco, Gillette, Accenture, and Tesco, but other pilots are happening independently, including Benetton’s (see page 26) and Prada’s store-specific projects.

As the Center cedes many of its activities to a new nonprofit but business-oriented organization called AutoID Inc., MIT’s newly renamed AutoID Lab (and corresponding labs at Cambridge University in the UK, the University of Adelaide in Australia, Keio University in Japan, and the University of St. Gallen in Switzerland, which has a strong program in retailing), will continue to do research and supply it to AutoID Inc. and others under license.

**AutoID Inc.: Sans hyphen, with business mission**

AutoID Inc. will officially start operations November 1 this year, headed by Dicki Lulay, currently a senior VP at the Uniform Code Council who previously worked in business development in the food industry, most recently at McCormick Foods. She has extensive international experience and what she calls a “consensus-building background.” Lulay sees her role as taking “a platform that’s been successful and commercializing it. We really want to be neutral, with a global focus, available and useful across everything. We want to provide opportunities for pilots and test cases, and let people show how they can share the value, build business cases. I’ve observed that people who are involved in this and have a success become evangelists; they volunteer to participate and share savings.” On the other hand, she notes, “They often have an internal challenge within their own companies, people asking ‘what’s in it for me?’ So we have to help them to sell up within their own companies rather than across companies.”
AutoID Inc. will face all the challenges any such organization faces as it succeeds: Critics will assail it as a monopoly, while others will challenge the whole idea. But taking the organization out of the university setting and into an industry-led operation makes sense. The movement is ready for prime-time.

AutoID Inc.’s mission will be to foster the use of the technology and coalescence around standards, to set some policies for its use, to manage the assignment of code numbers to manufacturers/data owners, and to maintain the integrity of the EPC registry and the constituent databases. Call AutoID Inc. another ICANN; there are many similarities, including the name and the architecture of its ONS. Much like the DNS, most of the RFID IT infrastructure will be managed in a decentralized way: Manufacturers or shippers of products (whoever tags the products) will maintain and control the data concerning the items they tagged and are responsible for. AutoID Inc., much like the DNS root server system, will simply redirect queries to the responsible registry. Logically, the system will be a hierarchy; in practice, like the DNS, it will most likely comprise a number of redundant resolving servers so that there is no single point of failure.

The biggest challenge will be to get users to share their data – not because they are unwilling, but because they are too busy, or they use some other system already or they don’t want to incur the potential incremental cost. Says Walt O’Maley of Sun, who is an enthusiastic supporter of AutoID but also a realist: “Even supply chain partners don’t share all that much data.” On the other hand, the ONS should make it easier to do so, and easier to add new partners without either side going to any trouble. If companies with market power such as Wal-Mart and P&G lead the way and show the commercial benefits of collaboration, the others will follow.

Indeed, the long-term purpose of RFID technology, for most players in the consumer products value chain, is to enable tagged articles to carry their identities with them across environments – but only where commercial interests and business relationships motivate the holders of that information to make it available.

A challenge to that integration is the variety of different coding systems in use today. At one manufacturer we talked with, for example, individual items are tagged with four separate bar code tags as they go through their life cycles, and only one of them has a standardized number for the SKU type (stock-keeping units, or product IDs unique to a particular chain or store), let alone the individual object. A lot of business processes will have to change to get down to one number, particularly to get to
one new number different from any of those already in use. (Or to quote Casey Stengel: “All right everyone, line up alphabetically according to your height.”)

AutoID Inc.’s challenge will be not only to get people to use the system the way it intends, but also to encourage them to find other creative ways to use it. One of ICANN’s failings has been an inability to distinguish creativity from inappropriateness in how people use the DNS to do things it wasn’t designed to do. We hope that AutoID Inc. will foster experimentation around its standards. The mission should be the innovation and value that the standards can foster, not the standards themselves.

On beyond the point of sale
Much of the creativity will be in new uses for product data, as such data becomes increasingly accessible outside the supply chain and as the products themselves are in the hands of the consumers. The challenge is to make sure that those new applications visibly benefit consumers as individuals, rather than merely further serve the interests of suppliers and merchants.

Fortunately, the Auto-ID Center is conscious of this issue. Last November, the Center published a report entitled “Why technical breakthroughs fail: A history of public concern with emerging technologies,” by one Brian Cantwell. A Harvard junior, he is the son of Dick Cantwell, the man spearheading Gillette’s RFID initiative. His paper attracted a lot of attention within the RFID community, and resulted in the Center’s creation of an “international public policy council,” led by Elliot Maxwell. Maxwell has a broad background in public policy work in the US Government, including most recently a stint in the US Commerce Department defining the specs for ICANN as part of the Interagency Committee that crafted Internet policy for the Clinton Administration. He started his career on the Senate’s Church Committee (1975) investigating CIA misdeeds, and then joined the Chairman’s Office at the FCC in 1978. Next, he spent ten years doing corporate strategy at Pacific Telesis before rejoining the government. The policy council is about as independent as any such body can be; it’s fair to say that its members are respected individuals who would resign rather than compromise their integrity. Other members include Simson Garfinkel, a well-known US-based researcher with a focus on privacy and security, as well as academics from Australia, Switzerland and Japan.

Maxwell and his team get to explore all the non-technical challenges that RFID faces, and there are quite a few of them. (See page 30.) In addition to privacy, they include other aspects of post-sale use of the chips. “What sort of infrastructure should be
Maxwell asks. “They think about this a lot in Europe, with their focus on the life-cycle of materials. There isn’t a similar push in US but these are all global companies. We need one system rather than several, and we need to talk to these other communities before we make too many decisions. We need an infrastructure for policy as well as technology.”

Wal-Mart: Build it and we will come

This market is lucky it has Wal-Mart leading the way. When we went to visit Imperial Sugar (on unrelated business) last March, the company showed us its award-winning sugar-tracking system, accessible through its website. Like many US vendors, Imperial counts Wal-Mart as its largest customer. But does Wal-Mart use the Imperial Sugar website to track its orders? Of course not. Imperial sends information to Wal-Mart’s system, using formats specified by Wal-Mart.

But now, Wal-Mart wants to see the development of an open standard that anyone can use, because it wants that same open market to share the costs of building out the necessary infrastructure.

Tagging and then tracking pallets and cases that previously were not identified is one thing; re-tagging or re-numbering products that were already defined in some other way in their manufacturers’ ERP and SCM (supply-chain management) systems is something else. It’s likely that anyone who redesigns any system will use the AutoID/Wal-Mart standards. What’s not clear is how quickly they will do so. Wal-Mart’s aim in all this is to speed things up by eliminating any doubts as to which standard will prevail, regardless of when. It is using not just its own purchasing power but its convening capability, making the market more visible and encouraging companies to change faster than they might otherwise. The visibility of the market will also encourage investment: Investors are far more willing to live with the uncertainties of timing as long as they know they are backing the right technology.

“A field test is not a pilot,” says Dillman, as she describes Wal-Mart’s initial field tests. The tests aren’t using technology that could be deployed at scale, but they are surfacing problems so that they can be fixed early. Last year, the company tagged 500 pallets of paper towels, and it is currently tracking six SKUs, from Kraft, Unilever, Coca-Cola, Johnson & Johnson and P&G. Starting in June, it will join a test with Gillette (see page 24). And over the next year, it will start
tagging pallets and cases in some of its distribution centers. Next, the company plans to start tracking individual high-value items such as drugs, electronics and jewelry.

Wal-Mart’s field tests have been encouraging, Dillman says, but they have revealed a long list of issues that need fixing: from interference between the RFID systems and other wireless communications, to large and obtrusive readers in awkward locations, to the fact that the components are still just too costly to roll out on a broad scale. Dillman showed a photo of the underside of a smart shelf that looked like a rat’s nest of wires (with which MeadWestvaco might take issue; see page 21.) . . . And not everything is reliable yet.

Dillman is clear about her goal: to challenge technology developers to build the IT products and infrastructure she and her suppliers will need, and to encourage other potential technology customers — Wal-Mart’s competitors — to build up the demand that will spur the manufacturers to scale up and share development costs. Dillman’s predecessor Kevin Turner, who spoke at our PC Forum in March, told RFID Journal’s Mark Roberti in May: “It’s not about being the only one. It’s about being first. That’s Wal-Mart’s competitive advantage.”

Usually, new standards are espoused by upstarts. In this market, the huge deployment challenges may just meet their match in the array of industry giants lined up to use the technology and share its benefits.

**The Vendors: Helping Objects Sing their Own Praises**

The Auto-ID market is heating up. Many of the players in it are existing RFID companies, such as TI or Philips or Accenture, who have rediscovered RFID as a new market with retail/supply chain as a customer base. Other vendors are start-ups, in what is likely to be a crowded market. And ironically, most of the costs of rolling out RFID will not be the billions spent on tags and readers; the product vendors are busy making those products better, smaller, cheaper and more reliable. Much of the money — and effort — will be spent in-house and with consultants installing the components and integrating them into existing infrastructure.

What follows is a sampling of the vendors in a variety of categories; they are only a few of many. Alien is mass-producing chips for tags. OATSystems is building infra-
structure software. MeadWestvaco is a packaging company turned integrator with an edge in reader systems and antennas.

Although the vendors and AutoID Inc. have a pretty clear idea of what the landscape will look like (give or take a year or two), their customers’ problem will be to cope with the transition: How do we incorporate EPC codes and the ONS into our ERP system? Should we replace our bar codes with RFID tags, or use both?

**Alien Technology: IC, call home!**

The irony of RFID chips is that they come in such numbers that you have to handle them more like a liquid than like a collection of things, even though their function is to identify objects uniquely. Alien Technology’s edge is to manufacture them cheaply enough that you can afford to add identity to things as cheap as a $7 pack of razor blades or a T-shirt, or as small as a syringe or a bottle of pills or even individual pills.

The company began in 1995 as Beckman Displays, founded by Steve Smith, a Berkeley professor who still shows up at the company once a week; he’s a technical advisor and board member. The company is run by Stav Prodromou, a long-time semiconductor executive (most recently at Peregrine Semiconductor and founder of Poquet PC, the first to offer a sub-laptop PC; formerly with Mattel, Fairchild and TI). It is funded by VCs including CMEA, Adams Street Partners, Rho Capital, New Enterprise Associates and Sevin Rosen Funds, as well as industrial investors including Avery Dennison, Dow Chemical, Philips and Toray International, the maker of the machines that Alien uses to turn speck-size chips into usable components. (Alien holds the underlying patents, and Toray has built the machines to implement them.)

Alien’s edge lies in its production processes, called Fluidic Self-Assembly and developed by founder Smith. Fluidic Self-Assembly breaks two constraints facing RFID tag assemblers: It can handle tiny integrated circuits (ICs, or chips) that can cost less than a penny, and it can do so in huge quantities and at a very high speed.

The process works by using gravity and the law of large numbers to place tiny chips (fractions of a millimeter in size) onto a plastic film in orderly rows. Alien uses semiconductor chips of its own design manufactured by a standard third-party wafer fab and then processes the wafers in a unique way yielding shaped ICs that it calls
NanoBlock ICs. Fluidic Self-Assembly handles many thousands of these tiny NanoBlock ICs by suspending them in a liquid that looks like water but is as valuable (and controlled as tightly) as the vaunted formula for Coke. The slurry of ICs is poured onto a rolling film containing carefully placed and shaped holes that are exactly the shape and size of the NanoBlocks, so that they fall into place and “self-align.” Once in the film, the tiny circuits can then be assembled into RFID tags with conductive metal leads and antennas in more conventional roll-to-roll processes that borrow from well-developed high-speed printing and label converting approaches.

The technology allows Alien to package more than 2 million ICs per hour in one $10-million production line vs. the current industry-standard process (limited to handling much larger and more costly ICs) with throughput of about 10,000 units per hour on a $1-million line.

Alien ships rolls of its packaged ICs, called “straps,” to partners such as Avery Dennison, CCL Label, Rafsec Oy of Tampere, Finland, and a host of others. These tag assemblers and label converters then “convert” these chip assemblies by the millions into tags and labels designed to be applied automatically to Gillette’s razor packages (or whatever). Meanwhile, Gillette will need to add another quick step (or replace the bar-coding step) to its production process to get the tags on the packages and zap them with their new unique IDs without adding much time or cost. (At this point the tagged products are probably still mass-handled, but virtually they exist as individuals.)

Given the small cost of each individual thing, much of the value-added in the RFID business is the ability to subtract or minimize handling costs: Any increment multiplied by 500 million is pretty large. Alien’s ability to make the tags cheap but easy to handle both manually and electronically is key in the process.

Alien’s initial plan was to use these chips in flat-panel displays, but the small display market did not ramp as the company expected. The change in focus corresponded with the founding and rapid growth of the Auto-ID Center, which promised a market and a platform for Alien’s technology. “It became clear that Fluidic Self-Assembly was a perfect match for RFID; we could attack a larger market with much more capital efficiency than what we saw in displays,” says Prodromou. Also around that time, the company acquired WaveID, an eight-person RFID start-up that brought in a ready-made RFID/supply-chain systems team, including VP of corporate development and product strategy Tom Pounds. The current fund-raising round is the first to target the RF strategy exclusively, Pounds notes.
Alien currently has one pilot production machine running, and is gearing up capacity for a billion-unit annual run-rate by the end of 2004. With the system running as planned, packaging the ICs to fill its order of 500 million tags from Gillette would take about ten days of full-time production, says Pounds. Currently, Alien manufactures only ultra-high-frequency chips, which are more popular in the US, but there’s no reason it couldn’t use this process with different chips as the market evolves.

**OATSystems: Getting signal from the noise**

OATSystems wants to be the standard-setter for the industry, but more along the lines of Linux than of Windows. Its Senseware software suite is RFID middleware that manages and monitors the RFID readers and other sensors, collects and processes the data and then presents it to users or applications. The basic function of OAT’s Senseware software suite is to help set up a hierarchical system of RFID readers and other sensors and to translate the low-level data they capture into something that’s intelligible to commercial applications such as ERP, SCM, CRM (customer resource management) and SRM (supplier relationship management).

RFID systems generate so much data that a lot of it needs to be filtered for exceptions (i.e. data not as expected; the stuff you anticipate can be ignored) as early as possible. The vast majority of messages are the equivalent not of FIFO or LIFO (for inventory transactions), but FISH: “first in, still here.” There are points where all you need is aggregates, and points where you want to be able to know something specific about a specific item. Senseware strips away all the “still-here” data so the applications can focus on exceptions: things where they shouldn’t be, things not where they should be, and values that don’t match certain predetermined ranges.

In addition, expected or normal events can be confirmed and the related data collected (an invoice and account number associated with a delivery confirmation for a particular ordered product, for example). The system converts the readers’ data into alerts, reports and forms covering things such as inventory by location, shipment creation (describing what’s in a shipment) and so on. It understands basic concepts such as containers that hold collections of things, delivery, in or out of stock, and various kinds of time. Indeed, the vast majority of data a Senseware installation handles stays local and never gets to the corporate systems; they simply aren’t equipped to handle the orders of magnitude of signal volume that Senseware can eat for breakfast.

Everything is based on Web services, so the integration effort should be minimized; however, there’s a lot to do in figuring out how to handle all the data and make it
useful. OAT expects to work with a variety of systems integrators, software vendors and other partners, including Accenture, IBM, SAP, Intel, Sun, i2 and the like. In theory, you simply add some data that lets existing systems work better, often by adding just two major functions around the new data – querying for specific items, and exception alerts and handling. “The first step is simply better inventory visibility and removing the manual processes in the organization – typing in data, scanning bar codes, reading code dates,” says OAT president Karl Waldman. “You can catch and avoid errors early, before they become expensive. The next steps are ‘game-changing’: taking your data and improving your operational performance in real time – days and weeks, not months and quarters.”

OAT is involved with one of the most visible customers of all, Gillette. Says Waldman: “Right now people think it’s all or nothing. They say, ‘If it’s not subpenny [per tag] then we can’t do it.’ But there’s a lot they can do right now that will pay off [as for Gillette]. They should look at what’s high-margin, high-value, ‘high-regulatory’: pharmaceuticals, for example. Certain retailers sell guns or cigarettes, the kind of things you want to control and track. Or look at the warehouse, as Gillette is doing.”

The company has a special history vis à vis the Auto-ID Center. OAT co-founders Laxmiprasad Putta and Sridhar Ramachandran were graduate students MIT in the late 90s; Sanjay Sarma was Putta’s advisor when he was running DISC, the Center’s predecessor. The two students later founded Auripay, a developer of secure payment systems for e-commerce. After selling Auripay in 2001, they founded OATSystems to resume some of the work they had started at MIT three years earlier, but with an extra grounding in high-speed transaction systems. The overall approach is that of a transaction system, a near-real-time monitor looking at discrete events.

Their first contract was from the Center – to develop the specs and then a reference implementation of the Savant (the Center’s name for the software defining an RFID reader, including limited processing of the data) and the Object Name Service. That contract de facto provided the company’s initial funding; it has no outside investors. The company has been careful to observe the distinction between the open software and APIs Putta and Ramachandran developed there, and its own toolkit and infrastructure software that make use of those standards.
Aptly, Putta had earlier worked at i2 Technologies (1998 to ‘99, between MIT and Auripay) as a senior engineer implementing supply-chain systems. He was hired into i2 by Waldman, whom he recruited into OAT in 2002 as president.

Waldman led i2’s Retail Consulting Practice and developed it into a $24-million per year business. Although Waldman concentrates on the marketing and business side, he is no slouch as a techie either: He has built and implemented a number of computer systems including genetic-algorithm scheduling solutions. At BBN, he applied GA’s to scheduling computer repair technicians and at i2 to scheduling manufacturing lines. He has also built a number of real-time multiprocessor sonar systems and underwater vehicle simulation systems for DARPA. He started his career at the US Navy’s David Taylor Research Center R&D lab.

OATSystems is profitable, with headquarters in Watertown, MA. It currently has about 40 employees, half in the US and half in Hyderabad, India.

**MeadWestvaco Intelligent Systems: Antennas on parade**

MeadWestvaco is a century-old, $8-billion paper company that has reinvented itself over the past 10 years as a high-end packaging provider, and it spends a lot of effort on understanding its customers’ needs. “We don’t make a lot of cardboard boxes,” says Ronnie Hise, general manager of MeadWestvaco Intelligent Systems (MWVIS) and a 20-year employee who has done everything from running a production plant to starting new business areas. “Our packaging is used in demanding, high-end applications, where the owner of the product inside the package needs some particular feature or other – for example: unique design, conformance to rigorous pharmaceutical or food industry standards, or uniformity/reliability for high-speed filling lines.” Since the products themselves are typically higher-priced, these packages often contain an EAS (electronic article surveillance) tag. MeadWestvaco applies hundreds of millions of the tags onto packaging each year for its customers, for everything from DVDs to pharmaceuticals and cosmetics.

MeadWestvaco also makes the cartons and carriers for multi-packs of soda and other canned beverages. It owns and maintains millions of dollars worth of packaging machinery around the world, including the machines that put Coke cans into their carriers for many Coke bottlers. In addition to manufacturing the packaging substrate (paper and plastic) and building customized packaging machinery for many consumer products manufacturers, it also designs and installs the retail displays for its trademarked At-A-Glance line of planners and organizers. Accordingly, the com-
pany takes a broader view of retail RFID technology and its context than most players, understanding the environment into which the new RFID capabilities must fit.

Although the company’s traditional market is manufacturers and packagers, in RFID it is focusing on the retailers. “That is where most of the value lies, and that is where our packaging interacts with the consumer,” says Hise. The barriers to adoption are lower, he adds: “Retailers can capture value from our solution one store at a time, one department at a time, without having to convince multiple players to participate, as in supply-chain solutions. [By contrast,] you can’t outfit four dock doors in a distribution center that has 96 doors and get much incremental value from an RFID solution. All the doors have to be outfitted to get the value.” But if you can reduce out-of-stocks in one high-value section of a store – such as DVDs – you get the full benefits of that particular investment required without much upfront cost, other than back-end monitoring systems and software.

“Retailers we are working with have told us they don’t want to deal with a consortium of companies to evaluate this new technology; they want one throat to choke,” says Hise. “In our trials with Tesco and Entertainment UK [EUK], we have provided everything to make the system work. The same will be true for [the next trial at] CVS/pharmacy. Regarding the actual implementation, virtually all the store has to do is run power to our system and provide us access.”

MeadWestvaco developed the networking antenna hardware that works with existing store fixtures, and drives the system using standard, commercially available RF readers (from Philips in this case). Hise’s team designed and developed the low-level software and firmware to control the system, specified and procured the tags (from strategic partner Rafsec), developed the tag programming system that generates the EPC numbers, and handled the site assessment and installation chores. It is even hosting the application for Tesco and EUK.

“We’re beginning with the problem and developing the appropriate solution, rather than developing the technology and trying to fit the problem as an afterthought,” Hise asserts.

The real work, he says, has been in the months leading up to the trials, working closely with the retailer’s organization to understand the business case and establishing success criteria and ROI measurements. Right now, MeadWestvaco has two trials focused on item-level tracking in retail stores, one in the US and one in the UK. The US trial will begin in the third quarter, tracking prescription drugs with CVS/phar-
macy to provide enhanced customer service, facilitate drug recalls, and allow pharmacists to spend more time with customers. (In the long run, pharmacy/medical applications should be a sweet spot for RFID.)

The UK trial is going on right now, with Tesco, the UK’s leading retailer (980 stores and counting), and EUK, which provides category management services for Tesco’s entertainment media products such as DVDs. The Tesco project entails managing the inventory of DVDs on the shelves and in the secure back room, starting in a single store in Sandhurst, outside London, with another store coming soon. That means not just tagging the DVDs, but retrofitting existing metal fixtures and shelves with reader antennas to track the tags. Altogether, the company has retrofitted an entire aisle of DVD display units (or gondolas) holding more than 1000 DVDs, each now with a unique identity. It was all carefully orchestrated: a team from MeadWestvaco came in to redo the shelves over a Saturday night; the store manager came in the next morning and said that the shelves looked exactly the same. “That’s the effect we want,” says Hise. “No [visible] change.”

But underneath, the shelves now have hundreds of reader antennas. These antennas are not the same as the antennas in the tag on each DVD, but are extensions of the RF reader. Given that each reader currently costs over a thousand dollars, this is a useful twist on the technology. In the MeadWestvaco system, one reader can serve up an RF signal to many antennas, thus amortizing the cost over a wide area. The capacity of a single reader is not limitless, says Hise, but he hasn’t reached the limit yet. In the Tesco test, a single reader can check for the presence or absence of a thousand different DVDs in a matter of minutes. “Other people talk about multiplexing; we talk about networking,” says Hise. “We can address antennas in any predetermined sequence the user desires. We can monitor some parts of a store in near real time, and just check inventory overnight in other sections, all using the same reader.”

The basic idea of multiplexing readers is hardly new, but MeadWestvaco seems to have figured out how to do it on a scale that will be hard to match. MeadWestvaco has applied for patents on its antenna technology, and won’t say much more about it – except to stress that everything complies with the Auto-ID standards. In addition to multiplexing antennas physically, the challenge is to sequence the readings properly so that the reader can keep straight which reading came from where. (That’s a software capability OATSystems is developing, too.)
Just like Wal-Mart, at this point MeadWestvaco is more interested in creating competition than in beating it, and might consider licensing its technology. “Competition has to develop, or there is no market for our products and services,” says Hise. He was disappointed to hear so many people at the recent RFID Journal Live! conference dismiss item-level tagging and reading as being several years off. With its huge customer base and its initial lead, MeadWestvaco should only benefit from the confidence generated by a broad range of suppliers.

The Users: RFID in the Field

The companies below include a supplier of goods (Gillette) and two retailers with different business models (Benetton and Woolworths).

**Gillette: Currency conversion**

Gillette is enthusiastic enough about RFID that it is running three trials. Gillette VP of global marketing services Dick Cantwell serves as chairman of the Auto-ID Center’s Board of Overseers, and is likely to stay involved with AutoID Inc. The products for all of them are Gillette’s various shaving systems. The company has been so successful in marketing them that they serve almost as a currency in the underworld – as well as a highly desirable item for legitimate consumers. Gillette estimates that it sells about 1.5 million packages of shaving products a day, all over the world. Many of them sell for $10 or more at retail, and they are (for now) easy to move around and hard to trace. They are also hard to keep in stock: It’s almost as if there were a shelf in a store offering $10 bills. By tagging them with RFID, Gillette hopes to make them easier for itself and its shippers to track, and harder for other people to steal.

Gillette is participating in three trials: an internal distribution center pilot, a wide-ranging field trial over 18 months with a variety of Auto-ID Center partners, and its widely publicized “smart-shelf” project.

The first trial, at Gillette’s packaging and distribution center in Fort Devens, MA, is the initiative that should lead to the demand for the famous 500 million tags that Gillette plans to order from Alien Technology over the next couple of years. Right now, the company is attaching tags to cases of its “female razor product,” which comes in a variety of versions – Venus, Passion and Crystal. The product arrives at
the center to be packaged into individual boxes and then into cases, which are already tagged; the tag is zapped by an employee wielding a reader/writer that records the unique ID and enters it and associated data into a database that Gillette maintains; it also provides access to that database to its shipping partners and the retailers who have ordered product. (In time, the tag reading/writing should be performed automatically as another step in the packing process.) Thus, the goods themselves are not tagged but they are tracked by association with the case they are in. Of course, this all assumes that the case is being filled properly, with the right number and kind of goods.

The purpose is to monitor the accuracy of the system in tracking cases as they come through the packaging center into inventory and then out as a customer [retailer] orders them. For now, the tracking is happening only inside the distribution center and at the loading dock, although the goal is to extend it to the shipping cycle. But even this limited implementation is valuable, says Gillette spokesman Paul Fox. “First of all,” he says, “we pay by the number of packages packed [by a third-party vendor operating inside the DC], and it’s useful to have a system that can accurately track the number of packages packed. Then there’s the value of knowing precisely what we have in inventory: If someone orders 100 cases of Crystal, they don’t want 80 Crystals and 20 Passions. Currently, the system requires human intervention and that can generate errors. . . .”

Overall, the benefit is increased accuracy and fewer errors. Gillette can’t really estimate an error rate; it doesn’t know what’s happening now. RFID gives it the ability to find out the error rate, and simultaneously to reduce it. “We don’t even know how many errors we have,” says Fox. “But you know error is going to creep into the system. With our volumes, even fractions of a percentage amount to millions of dollars. And it translates into poor customer service, so anything we can do to reduce errors is valuable for us, and it will be valuable for any other manufacturer or retailer.”

The field trial is a cross-company pilot using individually tagged products from Gillette and Procter & Gamble in supply chains and stores, in partnership with Wal-Mart, Home Depot and Target. The aim is to see what kinds of problems and opportunities arise. These trials have just started; there are no results yet.

Finally, the smart-shelf project is the sexiest of all — so sexy, in fact, that the Auto-ID Center uses a demo version of the “real” demo at its Cambridge, MA, location. The
basic idea is that the shelf contains readers that monitor in real time for the presence of a variety of Gillette shaving systems (or, in principle, any other tagged items). It notices when any product needs restocking, and can send an alert to the back room or to a pager (for example). Better yet, it can detect when more than, say, three items are removed simultaneously, often signifying a theft. According to the design, the system can send a more urgent alert, can photograph the vicinity with a video camera...or it could simply announce: “Thank you so much for your interest in our Gillette products!” perhaps scaring a thief away. However, the current trial systems simply focus on shelf replenishment. Presumably the privacy implications, even for supposed thieves, are still too hot to address.

This shelf was co-developed by Gillette and the Center, with help from vendors including OATSystems. The shelf has been in operation for a few months at Tesco in Cambridge in the UK, and is just now being installed at the Metro Store of the Future in Duesseldorf, Germany, and a Wal-Mart at some location to be determined. For the record, Tesco says only that the purpose is to increase employee and customer welfare, and that results are not yet in.

“They’re seeing the bottom line that we’ve been talking about,” says Fox. “A core goal for us is that the products are on the shelf when consumers want to buy.... For the retailers, it wastes all the hard work that they put into building consumer loyalty. It’s not just that they didn’t sell a $6 pack of blades, it’s about everything else they won’t buy.”

Benetton: United colors of sweater #672-53-8935

In an interesting contrast, Benetton, based near Venice in Treviso, Italy, is pursuing a different approach driven by its specific business model. CIO Terry Glenn Phipps, a transplanted American, is starting at the retail end and working his way back up the supply chain and logistics processes.

Phipps is an unusual CIO. He is not a career IT guy; rather, he has been an independent entrepreneur and investor since the age of 18 when he started his first business importing Italian designer plastic laminates (!) to the US. Through a chain of events including the development of a groupware system intended to link architects, interior designers and other professionals in Los Angeles in the early ‘90s, Phipps got involved in an early next-generation bar-code company called Bluewater Digital. (“The conversion from bar-code to true believer in RFID came later,” says Phipps.)
In due course a mutual acquaintance hooked Phipps up with Luciano Benetton, the chairman of Benetton Group, who asked Phipps if he wanted to put all the pieces together at Benetton. “Luciano Benetton asked us to do with technology what Benetton had done with communication in the last ten years, which is to use it as a way to provoke the market,” says Phipps. He had become an entrepreneur in order to do things the way he likes them done, and in Benetton he saw an opportunity to do just that at scale, with the added benefit that it was connected to the design business that was his first love anyway.

Benetton, in the meantime, is in the midst of broader changes. It is moving from close management by the family that founded it to a new structure where professional management runs the day-to-day business. A new CEO, Silvano Cassano, had taken charge just a few weeks before we visited Benetton in May. There is a lot of new blood at senior levels, which could make for a tumultuous time in which to sustain a major effort such as the Tiempo Real project – Benetton’s internal working name for its RFID initiative. Phipps, though, remains optimistic that the goals he joined Benetton to pursue are in reach. Cassano and his new management team, says Phipps, “really embraced the initiative [after a recent demo]. They want to move the technology out of the lab and into the stores. And to demonstrate their seriousness they have committed to implementing it in one of Benetton’s owned and operated mega-stores in the next 90 days.”

Benetton manufactures apparel and accessories, which it distributes exclusively through independently owned retail stores, apart from a few Benetton-owned mega-stores, all of which sell only Benetton brands. In this unique manufacturer/retailer relationship, which has the exclusivity of a franchise relationship but lacks the other usual contractual conditions, Benetton the manufacturer sees the retailers as its customers. For Benetton to succeed, the retailers must succeed, and the initial impetus behind the Tiempo Real project is precisely to help the retailers. The hope is that RFID will help bring Benetton’s small specialty retailers the sorts of inventory information and control that have previously been affordable only for giants such as Wal-Mart.

If the benefits prove out in the initial implementation in Benetton’s mega-store, Phipps expects word to spread among Benetton’s close community of retailers. Already, Phipps says, the buzz among the retailers is positive: Virtually all the retailers he has discussed the project with have been excited about the potential both for theft control and for greatly enhanced inventory management. Using hand-held readers,
store employees could take inventory overnight in just a couple of hours, compared to the usual days-long, once-a-quarter, error-prone process now in use. Taking inventory even once a week could dramatically improve store-owners’ understanding and control of their operations, allowing them to focus more on hot-selling, high-margin goods and to mark down the poor sellers quickly (and avoid re-ordering them). The net impact of such an improvement for each retailer would be dramatic, and in the aggregate the net impact for Benetton could be substantial as well.

The price tag is attractive too. Leveraging Benetton’s scale, Phipps estimates a cost of around $5,000 per store for readers and other infrastructure, a price none of the retailers could likely get for itself, though additional software and hardware, and associated costs, could be needed for stores that do not already have basic inventory control and related systems.

There are, as with any such project, many issues to be dealt with. In some countries, regulations on radio-frequency transmissions may affect deployment possibilities, a consideration Benetton has taken into account by basing its solution on the ISO 15693 standard, which is accepted worldwide, even in restrictive countries such as Japan. There will also be issues about appropriate use of the information developed. Interestingly, in Benetton’s case such issues involve not only consumer privacy but the relationship between the retailers and the manufacturer. Phipps believes Benetton has addressed both of these aspects of appropriate use. From the consumer end, Benetton plans to remove RFID tags from garments when they are sold, thereby eliminating the potential for further information being collected about those garments. With its retailers, the plan is for the entire RFID initiative to be an opt-in choice for the retailers; once a retailer has opted in, it will retain control of the data collected and share with Benetton only the information it wants to share.

Stung by some negative publicity over privacy issues provoked by a premature and perhaps overly “visionary” press release from supplier Philips, the company is downplaying its RFID efforts so far, promising among other things that tags won’t retain their data after consumers buy the goods. In doing so it is partly being careful to sustain its long-standing public commitment to consumer interests including privacy. But it is also protecting its relationship with its retailers by not getting ahead of itself with them.

Benetton is at one end of a spectrum of how to use RFID in retailing, with Wal-Mart/Gillette at the other end. Gillette’s pilot always-on smart shelf (Page 24) can detect activity in the store in real time, whether it’s a would-be thief taking six pack-
ages at a time, or the gradual depletion of stock during a busy morning. Such approaches generate lots of information that can be discarded locally and they require relatively sophisticated monitoring capabilities. In return, they provide instant alerts about important (in the aggregate) events. Benetton’s approach is less ambitious technologically, but in return for less timely information, the system is much simpler and the benefits both real and credible to its retailers. While Gillette and Wal-Mart are eager to use and promote standards and interoperability, Benetton (for now) doesn’t need them, since it operates in a closed loop with its retailers.

**Woolworths UK: By dolly and tote**

In the US, the industry hopes for a boost from “homeland security” spending; in the UK, it has already gotten one from the UK Home Office (akin to internal affairs) and its “Chipping of Goods” initiative, which allocated about $9 million to eight demonstration projects to define the benefits of tagging goods. Among them was a trial in which Woolworths tagged its carts and dollies (rather than individual items). “Item visibility does not require item tracking,” asserts Woolworth’s Geoff O’Neill, director of strategic projects. You can get a pretty good idea of where things are simply by tracking the totes and dollies, since (in theory) they carry what they are supposed to carry.

The ROI is much easier to see, because the tags can be used over and over again, and stay affixed to each cart or dolly. The information they point to is updated each time they are loaded and unloaded. Aside from that, notes O’Neill, the project enables Woolworths to keep better track of the equipment itself: The entire fleet of 16,000 dollies and 90,000 roll cages is worth more than $10 million all by itself.

The benefits from the trial were quite real, he says, though most of them were calculated rather than observed because of the recurring problem of lack of “before” data. “We have not yet got numbers that we can publish,” says O’Neill, “but we are running the trial for another six months to establish the complete business case for further internal funding.”

Like most real-world installations, the system is not RFID-only; it comprises a combination of in-place readers where the dollies are loaded, GPS to track the drivers’ progress, and then drivers using handheld readers when they deliver the goods. Woolworths was also careful about how it introduced the technology, which is wide-

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<tr>
<td>Headquarters: London, United Kingdom</td>
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<td>Founded: 1909</td>
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<td>Key metric: 16,000 tags used in current trial (combined dollies and carriages)</td>
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<td>URL: <a href="http://www.woolworthsgroupplc.co.uk">www.woolworthsgroupplc.co.uk</a></td>
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ly considered a good way to monitor employee performance in the field. “We were a little nervous about how the drivers would react, but we are pitching it and they are taking it positively, and as a way to prove their innocence rather than to determine their guilt,” says O’Neill.

According to O’Neill, the in-stock percentage in an earlier item-level project back in 1999 appeared to have been increased 6 points, from about 82 percent to 88 percent availability, which should have resulted in an increase in sales. Shrinkage of the goods in the test seemed unusually low, but it’s hard to know how much that was due to the new systems, and how much was due to the attention being paid to them. Regardless, the technology was not adopted, says O’Neill: “It was not yet robust enough for commercial application – at least the way we wanted to use it. This included limited read/write range of about a meter. The relatively low average item price in Woolworths and the relatively high tag costs meant that item-level tagging was not a commercially viable proposition on our product range; that’s why we opted for tote/dolly tracking instead.”

Woolworths is leery of giving out numbers, but O’Neill goes so far as to say, “If our shrinkage in 2001 was about $75 million, of which $45 million is estimated to be in supply chain, a 10 percent reduction could equate to savings of about $4 million. . .not so bad on a circa $2-million investment.”

The Issues: Am I My Product’s Keeper?

There are a lot of parallels between personal identity and – call it “object identity.” There are also lots of ways the parallels break down. For starters, each person born is in charge of his own identity; there’s someone there paying attention. By contrast, most products are born without an identity, though they certainly have characteristics, makers and other associated information. To the extent that the information is explicit, it resides outside the product; it doesn’t know itself. So RFID is in a sense a way of conferring DNA, or an identity that is inherent rather than attributed (in theory at least, and as long as the tag stays on the mattress).

The big metaphysical – and IT – question is, What will actually happen? Will products actually carry their identities with them through life? or only through point of sale? When Alice purchases a rice cooker, for example, will a pointer simply change in the maker’s registry – or is there a way she can add it to her own registry?
The answers may be different for food that is consumed or for pencils, for example, but it could be useful to be able to maintain the identities and care instructions for clothes and appliances. It’s useful for my bicycle to be ID’d so I can identify it (and so can the police) if it goes astray. And as noted, people use RFID to unlock (and find!) their cars, to pay tolls, and to pass through various checkpoints and registration spots at work and elsewhere, and police use the records of many of those transactions to track suspects.

In the personal identity world, we have the notion of federated identity; the unique individual (however defined) is the token by which different records are linked. In the RFID world, we’re just starting with the notion of identity. If we think about these questions from the start, can we do a better job of keeping the world straight? Do we want to? Individuals are comfortable maintaining multiple identities or at least multiple facets of their identities — two addresses, for example, for weekday and weekend or home and work; a different last name for dealing with the stepkids’ school officials; a “duh” password for a host of online content sites and more serious security for communicating with merchants who have your credit card. Will it be the same for products? Or will the EPC ultimately establish and maintain its hold as the one true place where movable things are identified and classified? What are the benefits and what are the costs?

So far we have heard of just one entrepreneur who has glommed on to the idea of providing a service to help consumers track their own goods, and even that effort is not yet ready for prime time (nor is the product ID infrastructure there yet). But over time, such a third-party registry-cum-applications would make sense. Just as consumers use banks to keep their money, it’s unlikely they would manage their personal registries themselves; product-ID banks would compete for the consumers’ business, perhaps offering pre-identified toasters.

**Privacy: Where the data are**

Vendors such as Benetton have promised to deactivate the tags when a person buys something in a shop. But despite the obsession with tags among investors and self-styled consumer advocates, the real issue is around personal data and RFID is not the tag; a thing keeps its identity regardless of what happens to its tag. The issue is who has control of the data the tag generates. However, the industry has yet to make that point clear.
Most tags don’t carry much more than their own identity: what kind of thing they are attached to, plus a unique serial number. The interesting data comes from the context: where the item travels, who purchases it, and so forth. The EPC directory of numbers is de facto public, and it will probably be fairly easy to determine who tagged any particular item by looking up the manufacturer code in the ONS. But that’s like a domain name; it gives you the pointer to the source, but it doesn’t necessarily give you access to the data.

And you can rest assured that IBM, for example, is not about to provide public access to its tracking information; that’s between IBM and the logistics suppliers it uses, and perhaps the retailers it is shipping to. Likewise, Banana Republic is not going to let anyone (other than its selected marketing partners) know who purchased that cunning red linen sweater. Most of the data generated by the movements and readings of the tags will be as proprietary as most business data is today.

There are legitimate privacy issues, however. The sheer volume of data extant in the world is going up, with a likely big push from RFID, and if you cross-reference such data you can find out a lot. For now, though, the RFID numbers are indexed around the products, not around the people. That is, you can find all the people who purchased red linen sweaters, but you can’t (because of RFID) find out all the things Juan or Alice purchased. (You could, of course, if you had access to all of Banana Republic’s data and Benetton’s and Nordstrom’s and all the other places they buy their clothes — and if you knew how to link the IDs Juan and Alice each have with those retailers.) Some records may be more accurate because of RFID, but it doesn’t make much difference to know which sweater out of the lot Juan is wearing and which went to Alice.

Where such things do matter is with food and product recalls, where you may want to be able to find a particular item and the particular customer who bought it. When consumers have some form of RFID reader at home we could imagine an on-line check over the Internet — initiated by the individual.

The more scary scenarios have to do with people’s things being recognized as they walk along the street. Industry experts dismissed such scenarios out of hand, both because human bodies tend to block the weak radio signals that make it all work and because the current effective range of RFID readers is about 3 meters. But the paranoid can always assume such obstacles will be overcome by yet more advanced and no doubt nefarious developments — such as that currently contemplated to recognize travelers in airports.
Or imagine this: When you go out with someone for the evening, do you have a scanner that will enable you to determine whether he has condoms in his pocket—and if so, what brand? (Are they new, or has he been carrying them around for months, hoping to get lucky?) Is that a real Rolex? (Yes, we know, at the sidelines CIOs are muttering under their breath: "Would that we could build such a powerful system. Right now we can barely keep track of our own employees!")

So at least for today such scenarios based on RFID of objects are far from being realistic...or from having any kind of business justification, for that matter. (Nordstrom's could right now put people out on the sidewalk to drag shoppers in, but it doesn't, because it knows that would annoy them.) Moreover, the same scanner that lets you read your dinner partner's tags should also let you read your own to make sure they are deactivated. . . But we can imagine the spam now: "So powerful the CIA has banned it! Read deactivated RFID tags for only $79.99!!

In short, unless the industry addresses—and makes impossible—these scenarios, it will not succeed.

**As long as it's my data. . .**

On the plus side, you can imagine a system that manages interactions between products—pharmaceuticals, for example, or that automatically monitors the products in your household and prompts you to reorder—most likely with a shopping list application that says, for example: "You have reached [based on past consumption patterns] one week's supply of the following products. Check the ones you wish to reorder: Sun-Maid Cinnamon Swirl Raisin Bread. Swiss Miss Sugar-Free Cocoa Mix. 16-oz Grape-Nuts Flakes. . . " Of course, there needs to be a lot of software to manage all this, from recognizing the incoming signals to fetching product IDs from the Web and recognizing what kinds of things fit into what categories.

These kinds of applications should be in consumers' control. The software for drug interactions will come from manufacturers and—this is where public access to product data comes into play—from third parties and medical experts (or more likely, health insurance companies) who understand the interactions between drugs from different manufacturers. The data gets integrated in the consumer's home, though there may be a system by which the client's health

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<td>• Applications of semantic analysis.</td>
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<td>• Enum and registries.</td>
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<td>• Reputation systems.</td>
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<tr>
<td>• Location-based services.</td>
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<tr>
<td>• And much more... (If you know of any good examples of the categories listed above, please let us know.)</td>
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An insurance company monitors whether the customer actually removes the pill jar from the medicine cabinet every evening at 10 pm.

You may find this creepy, or you may find it a great way to foster health-care compliance, reduce medical costs and perhaps even increase the general welfare. It all depends on exactly how these systems are rolled out, how much choice individuals have in their use, and what restrictions are placed on the collection and use of the data. You can have software that monitors drug interactions without reporting back who took the drugs...or you can wire a system precisely to monitor and report on users. It’s up to organizations such as the AutoID Policy Council, the press and other public-interest groups to make sure that the consequences of such systems are visible, and that users have a choice in their adoption.

**Will the dogs’ handlers use the dog food?**

Finally, the first place that RFID will have an effect outside the implementer/retailer community is not among consumers, but among the workers who use it, who are monitored by it, who possibly even are replaced by it.

RFID appeals to the orderly among us: It promises total control, avoidance of error, optimization, etc. Smart and people-sensitive businesses have to love it. It does not punish people for their errors; it helps people to avoid committing them. Rather than catch thieves, RFID should prevent theft.

In theory, the reductions in shrinkage and inefficiency will allow businesses to increase their profitability and share at least some of their gains with their workers as well as their customers. The market should work and the increased tidiness should benefit good people and penalize the bad people who steal or commit careless errors.

You’d think that employees would welcome benign improvements in technology that would enable them to do their work better....

But this blithely sanitary view of the world dismisses human nature as an error rather than a reality. In practice, things aren’t that simple. We in the tech community all know the history of groupware tools designed to foster more effective collaboration: rejection with attitudes ranging from indifference to hostility. People working in distribution centers, on loading docks and sales floors are hardly more likely to identify with management than those who sit in front of computers in nice
air-conditioned offices. The RFID community would do well to think about these issues in advance.

Most of these policy questions aren’t at all new, but we still haven’t figured out what to do about them. RFID just pours a little more data onto the fire.
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