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Find products that can help you deploy RFID successfully, such as Technology Solutions (UK) Ltd.'s <u>1153 Bluetooth Wearable UHF RFID</u> Reader. It's designed to read and

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Most-Read Stories in November

- Kizy Tracking Solution Uses Cellular Network to Locate Goods
- RFID Sets Sail With Quantum of the Seas
- The IoT Challenge
- Iron Mountain to Introduce RFID-Ready Boxes for Records Storage
- Norwegian Apparel Company in Good Mood Over RFID

Top 10 Search Terms On RFIDJournal.com

- 1 Supply chain
- 2 NFC
- 3 Warehouse
- 4 Internet of Things
- 5 Security
- 6 American Apparel
- 7 Automotive
- 8 Cost
- 9 Sensor
- 10 RTLS



Not yet, but we're looking into it and would appreciate more information

19%



The Inside Scoop

What are end users saying behind the scenes? Why should the RFID community be optimistic about the industry? Who's spreading misinformation? Get insight and perspective at the RFID JOURNAL Blog.



Ideas Exchange

RFID JOURNAL maintains an Ask the Experts forum, where you can submit questions about RFID technology and its applications. Your questions will be answered by RFID JOURNAL editors or outside experts. Recent questions include:

- Can on-metal RFID tags survive high temperatures?
- What are the benefits of using standardized RFID tags and readers?
- How is RFID being used in the defense and homeland security industries?
- Can BAP tags report product storage temperatures?
- How can we implement RFID at our electronics and home appliances retail stores?

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RFID Journal has created a series of DVDs containing presentations by end users, recorded at various live and online events.

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RFID Journal holds several face-to-face conferences every year, as well as a number of online virtual events and webinars. These events feature end users speaking objectively about the business reasons that they deployed an RFID system, the technical hurdles they overcame in doing so and the benefits they now achieve as a result, as well as presentations by academics, vendors and other experts. Many of the sessions were recorded, and we have compiled these recordings into seven DVDs that are available for purchase for only \$99 or free with a one-year premium membership to *RFID Journal*. Hear presentations from *RFID Journal* events, including:

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Enabling the Internet of Things

This year, there has been a lot of hype about the Internet of Things. There are many different visions of the IoT, and many different definitions. But in its strictest sense, the IoT is about linking objects to the Internet. Passive and active RFID systems provide connectivity



for a multitude of low-cost items, containers, tools and other assets. Still, for the IoT to be valuable, there must be a way to share information about objects with corporate software systems. The EPC Information Services (EPCIS) offers that.

EPCIS is a set of software protocols that allow a company to share data captured by bar code, RFID and other systems with various internal software applications. The same protocols also allow machine-to-machine communication and sharing of

data with business partners.

As our cover story in this issue explains, EPCIS bridges the physical and business worlds. Data from RFID tags and other IoT devices is stored in a database called an EPCIS repository. The EPC Core Business Vocabulary provides common definitions for all the data that populates EPCIS events, to ensure that departments within a company and business partners speak the same language. The EPCIS repository interfaces with internal and external systems via a second component, an EPCIS Accessing Application.

While all this might seem complex and ultra-technical, it is essentially a set of standards for sharing information via local-and wide-area networks—a layer that sits atop existing Internet standards that enable global communication. EPCIS also provides context about data captured—the *what*, *when*, *where* and *why* related to a tag read or some other IoT data captured.

This is an exciting development for businesses. Just as the Internet made sharing computer data cheaper and easier, EPCIS and IoT technologies will make capturing and sharing data about products in the supply chain, work-in-process and other activities easier and less expensive. One area in which this could have a big impact is the cold chain. Our Vertical Focus story in this issue reveals that more companies are using RFID sensors to monitor the condition of food, pharmaceuticals and other products. EPCIS allows for the sharing of this condition data so companies can make smart decisions.

Passive sensors may well proliferate into many other areas as innovators find new ways to harvest energy from ambient RF energy. This issue's Product Developments story looks at some of the advances in energy-harvesting techniques and how they are being used to power RFID tags and sensors.

Many businesspeople still have a hard time grasping exactly what the IoT is. The concept is likely to evolve over time, but imagining a world in which RFID transponders and inexpensive RFID sensors capture information about everything happening in the real world—and share the data via the EPCIS—is a pretty good way to grasp the power of the Internet of Things.

Mark Roberti, Founder and Editor

out in front

SENSORS

Wireless Sensor Networks in the Sky

Researchers at Singapore's Nanyang Technological University have successfully launched the world's first ZigBee-based network of satellites with cameras and sensors.



Kay-Soon Low is on a mission to launch sensor-equipped satellites into space.

WIRELESS SENSOR NETWORKS (WSNs), which use radio waves to communicate with each other and transmit data, are being employed for a variety of applications, such as monitoring animal habitats, the condition of engines on ships, and lighting and air conditioning in buildings. Recently, researchers at the Satellite Research Centre (SaRC), at Singapore's Nanyang Technological University, took WSNs to new heights. On June 30th, they launched two sensor-equipped satellites into orbit. The mission could pave the way for future generations of tiny satellites that identify smog levels, detect early signs of earthquakes and monitor other land-based activities.

Kay-Soon Low, director of the SaRC and an associate professor in the university's School of Electrical & Electronic Engineering, has been working in the WSN field since 2005 and has experience using ZigBee systems for industrial and medical applications. When he became director in 2009, creating WSNs in space seemed a natural extension of his earlier work.

"My vision is to develop the SaRC into a centre of excellence in nanosatellite technology and distributed space missions for remote sensing and communication applications," Low says. "The eventual goal is to fly several miniature satellites in formation to perform collaborative sensing."

The SaRC team believed that using wireless technologies, such as IEEE 802.15.4 and ZigBee, could be a cost-effective and lightweight way to equip satellites with sensors. But the transceiver hardware had not been qualified for use in space. The researchers designed the launch to determine whether the communication hardware could survive the space environment and the vibrations to which the hardware would be subject during a launch.

They launched the VELOX-I, which consists of a nanosatellite weighing just 4.25 kilograms (9.4 pounds) and a piggyback picosatellite named VELOX-PIII weighing 193 grams (0.425 pounds). Both miniature satellites were equipped with a ZigBee wireless network and small sensor nodes that perform functions such as sensing and data-gathering.

The research team estimates the satellites

can communicate with one another at a distance of a little more than 4 kilometers (2.5 miles) in space, due to the absence of signal attenuation caused by fading and diffraction. "Two or more satellites carrying cameras and various instruments to detect various signals from Earth can cover a range of places for observation," Low says. "Communication among the satellites is necessary to coordinate the tasks and control the satellites in real time."

"The VELOX-I mission was a success," Low says. The results of the team's work was published recently in a special issue of the journal Unmanned Systems (World Scientific).

"Besides capturing the Earth image with our in-house design camera—the primary payload of the satellite and conducting several in-orbit navigation experiments, we have successfully tested the WSN hardware and demonstrated that it can survive the launch and space environment," Low says. "This will pave the way for us to move forward with our work on formation flying of satellites."—*Mark Roberti*

ENVIRONMENT

RFID Could Help Save Sea Animals

Tags could identify missing sections of fishing nets, enabling them to be retrieved from the ocean before they entangle dolphins, porpoises, turtles and whales.

MANY INDUSTRIAL FISHING OPERATIONS USE massive seine nets, and often, as the nets are hauled in with a catch, pieces tear away. Environmental groups estimate these "ghost nets" account for 100 million tons of waste annually, or as much as 30 percent of the plastic pollution littering the world's oceans. Worse, the nets often entangle and kill whales, Energy (BLE) beacons, which could be attached with plastic zip ties. But the BLE tags added too much weight to the net, and the beacons were only useful while their battery lasted.

The team developed a new set of prototypes that used light, thin sheets of polyethylene with d2w additive, which makes the plastic biodegradable. The sheets were laser-cut in a



Team members (from left): Alejandro Plasencia, Joan Farré and Roberto Pla

dolphins, tortoises and other marine life.

Alejandro Plasencia and a team of students at the Elisava Barcelona School of Design and Engineering created the Remora Project to explore practical ways to clean up marine pollution. "We wanted to develop a project for the fishing industry that turned sustainability into a driver of profit," Plasencia says.

The team decided to use a radio device on sections of net, so fishing vessels could identify when pieces of seine were lost at sea and quickly recover them, thereby avoiding potential fines. The first prototypes were injectionmolded plastic cases housing Bluetooth Low pattern that limits the size to the minimum required to house an embedded passive RFID tag and enable it to be attached to the net.

The team proved RFID tags could be used to identify sections of netting, and then developed a reader that fits around the opening where the net is pulled onto the deck, and a smartphone application that shows, based on the tags that were not read, which sections of the net are missing. A fishing crew could retrieve the missing pieces or give the coordinates of the ripped seine to a net recycling

organization. The team is also developing industrial fishing nets fabricated with the d2w additive, which causes the net to biodegrade after 4 years (the end of its normal life cycle).

The system is still a couple of years from commercialization, but Plasencia says: "Three associations have offered to help us search for financial aid, and two companies that manufacture biodegradable thermoplastics have offered us their help. We will investigate which biodegradable plastics resist ultraviolet light and salt water exposure, and which respond better to laser cutting and electronic printing." -M.R.



Net Loss— Marine Life

Tons of fishing gear lost or abandoned in oceans annually: 640,000

Number of whales, dolphins and porpoises caught in fishing nets annually: 300,000

Number of turtles and tortoises caught in fishing nets annually: 250,000

Number of seabirds killed annually due to ocean pollution: More than 1 million

Number of marine animals killed annually due to ocean pollution: More than 100,000

Number of seals, sea lions and whales killed annually due to discarded fishing gear: 136,000

-Rich Handley



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perspective THE STORY BEHIND THE NEWS



TRENDS

Apparel Edges Toward the Tipping Point

This year, more retailers announced plans to introduce or expand itemlevel RFID initiatives, bringing the sector closer to the critical mass needed to propel industrywide adoption.

THE YEAR BEGAN with an announcement from Kohl's, a leading U.S. department store chain, that it was using radio frequency identification to manage inventory of footwear, denim and men's basics across all its stores and distribution centers. New RFID apparel retail deployments are being announced monthly, indicating that the sector is moving toward a tipping point.

While the pace of deployments is accelerating, how long will it take for apparel retail to reach critical mass? It's difficult to say. The following five conditions must be met for a new technology to reach mass adoption, according to Geoffrey Moore's well-established technology adoption lifecycle model:

- 1. A global technology standard
- 2. A problem no other technology can solve
- 3. The "whole" product
- 4. A technology "gorilla"
- 5. And a critical mass of users

In retail apparel, there is consensus that passive ultrahigh-frequency RFID based on the EPC Gen 2 standard is the technology to employ. No other technology can cost-effectively solve the problem of inaccurate and poorly maintained inventory. There is not yet a "whole product," at least in the way Moore means. You can buy tags, readers and software from one or more vendors, but each deployment is still customized.

One company has not emerged as a "gorilla," Moore's term for a dominant player. Checkpoint Systems, Tyco Retail Solutions, Xterprise/SML and several other RFID providers are each winning some projects. Over time, retailers will likely embrace one solution over the others and the vendor of that solution will emerge as the gorilla, with the largest market share.

Known Unknowns

Each new customer win by an RFID provider takes that company closer to gorilla status and the market closer to critical mass. But there are still some "known unknowns" that is, information we know we don't know that is needed to predict when critical mass might be reached.

We don't know how long it will take retailers currently using RFID to tag 100 percent of all apparel, and we don't know how long it will take suppliers to begin tagging at the source. Both scenarios are critical for large-scale adoption of RFID. The faster retailers bring their suppliers on board, the more likely suppliers will integrate RFID into their manufacturing operations and tag all items for all retailers. Once suppliers are tagging all their products at the source of production, retailers not using RFID have an incentive to install readers and use the tags for their own benefit.

We don't know how many retailers are already using RFID in their operations and have not publicly announced their projects or future plans. RFID Journal is aware of several major retail chains worldwide that have rollouts well under way but will not confirm this information for the record. There could be many other retail projects going on under the radar, which would mean we are closer to critical mass than anyone realizes. We don't know how long it will take for retailers just beginning down the RFID path to deploy the technology. Early adopters, such as Macy's and Bloomingdale's, took five or six years from initial pilots to large-scale rollouts. Kohl's went from no RFID projects to a chainwide rollout in just two years. Retailers new to RFID will benefit from the learnings of early adopters and will be able to roll out quickly, but no one knows exactly how fast.

Unknown Unknowns

There are also unknown unknowns, as former U.S. Secretary of Defense Donald Rumsfeld called them: Things we don't know we don't know. There could be unexpected events—the introduction of new RFID readers that dramatically reduce deployment costs, for instance, or a major announcement from a new retailer or pressure from institutional investors to adopt RFID—that could propel adoption forward. There also could be a lawsuit or other unexpected event that has a chilling affect on the technology's adoption.

RFID Journal believes the pace of adoption will continue to accelerate, with more apparel retailers adopting RFID in 2015. And companies that have already rolled out the technology will expand aggressively. This year, Macy's said its RFID-enabled business lines saw a 10 percent improvement in yearover-year sales compared with lines that were not RFID-enabled. With that kind of benefit, retailers are going to work intensively to get RFID into as many departments as possible.

Certainly, some unforeseen event could impact apparel retail adoption—positively or negatively—during the next two years. Absent that, we believe the sector will reach a tipping point in 2017 or 2018, which will lead all midsize and large retail chains to adopt the technology. And from there it will spread rapidly to jewelry, sporting goods, home furnishing and other sectors. —*Mark Roberti*



RFID Journal is aware of several major retail chains worldwide that have rollouts well under way but will not confirm this information for the record.



European Retailers Lead the Way

Retailers worldwide have been adopting radio frequency identification. Brascol, a wholesale outlet in Brazil, consumes 70,000 passive ultrahigh-frequency RFID tags daily, making it one of the largest item-level deployments to date. U.S. retailers are beginning to warm up to RFID. But European retailers have been the most aggressive in deploying the technology.

At Inditex's annual general meeting, in July, Pablo Isla, the chairman and CEO of the Spain-based multinational clothing retailer, unveiled ambitious expansion plans for using RFID. One of the world's largest fashion groups, Inditex operates more than 6,300 stores worldwide, and its brands include Zara (its biggest division), Massimo Dutti, Bershka, Pull&Bear and Stradivarius. The group owns the majority of its stores, and designs and manufactures almost all its clothing.

Isla reported that RFID is already being used at all Zara's distribution centers and more than 700 of the approximately 2,000 Zara stores within 22 countries. He added that his company plans to install the technology at all Zara stores by 2016, with a gradual rollout across the rest of its chains.

The company has already implemented RFID at all its stores throughout Spain, the United Kingdom, Ireland, Portugal, Norway, Sweden, Finland, Switzerland and Austria. It has also deployed the technology at some of its stores in Italy, France, Poland, the United States, Belgium, Luxembourg, the Czech Republic, Slovakia, Hungary, Russia, Bulgaria and Croatia. By the end of 2014, Isla said, the firm expects to add Hungary, Poland, Belgium, the Czech Republic, Slovakia, Bulgaria, Croatia and Serbia to the list of countries in which all its Zara stores have fully implemented RFID. By year-end, the company also expects to have added Canada, Greece, Mexico and Romania to the list of countries in which it has



partially deployed the technology.

Last year, Marks & Spencer, another major European chain, announced plans to use RFID on all nonfood items across all its stores, and it began implementing the technology this year. During the course of 2014, other European retailers—including Decathlon, a French sporting goods manufacturer and retailer with 700 stores in 18 countries, and Asda, a U.K.-based chain owned by Walmart—jumped on the RFID bandwagon. Though these companies declined to be interviewed by RFID Journal, vendors issued press releases about their deployments.

Here are articles RFID Journal published this year about European retail RFID deployments:

Sandro Ferrone to Expand RFID Deployment

Already using Tageos passive UHF RFID tags to track its merchandise at its factory and primary distribution center, the Italian clothing company is preparing to deploy the technology at a second DC and its stores.

British Clothing Retailer Sees RFID as 'Enriching Experience'

Giulio is using privacy-protecting RFID technology from Friendly Technologies to determine which garments shoppers are interested in, and to prompt a touch screen to display information about those products.

Online Furniture Retailer Adds RFID to Its Brick-and-Mortar Showroom

Made.com is providing customers at its London showroom with tablets that they can use to read NFC tags to learn about each product, while giving the retailer access to data about shopper behavior and preferences.

Small Stores in Norway See Payback From RFID

The retailers are using a low-cost solution from Front Systems, consisting of passive UHF RFID labels, as well as inventorymanagement software, readers and printer-encoders.

Coccinelle Finds RFID Virtually Eliminates Out-of-Stocks for Store and Online Sales

The Dutch clothing retailer is attaching UHF RFID tags to garments, and is using handheld and point-of-sale readers to track which inventory is at stores and available for online sales.

Intersport Expects RFID to Boost Its Sales, Decrease Its Costs

After carrying out a one-store pilot of a combined EAS and RFID system from Cross Point and RFKeeper, the international athletic-goods retailer is installing the technology at other sites.

Heidi.com's New Store Uses NFC RFID to Enable Omnichannel Shopping

The Swiss clothing company has installed virtual shopping kiosks so customers can shop not only for garments at its flagship store, but also for those available via its website, as well as receive personalized services and promotions. *—M.R.*

Top 10 Stories of 2014

It's been an eventful year. Here's a look back at some of the biggest stories we covered.

RFID Brings Greater Efficiency, Product Visibility to Interstate Batteries

Replacement automotive-battery supplier Interstate Batteries announced it is in the middle of a "validation phase" of a pilot project to evaluate an RFID solution it developed with Minnesotabased technology firm Seeonic. The project, which began in November 2013, involves the deployment of 2 million RFID-tagged batteries, 2,200 RFID-enabled storage racks and 29 RFID-enabled trucks. The goal is to facilitate replenishment by letting the company know the product inventory at each dealership or store, as well as what is in transit in the delivery trucks at any given time.

NXP Seeks to Drive NFC Phone App Use in Cars

With many experts predicting cars will be a huge part of the Internet of Things, NXP Semiconductors took a step toward enabling "connected car" applications by using Near-Field Communication technology to integrate a driver's mobile phone with a vehicle's operation. The company launched a new automotive portfolio, beginning with its NCF3340 NFC controller. The NCF3340, which consists of a high-frequency RFID reader chip that interfaces with a vehicle's controls and



other electronic components, meets the Automotive Electronics Council's Q100 Grade 3 requirements for operation across a car's full temperature range.

RFID-Reading Drone Tracks Structural Steel Products in Storage

While not one of the largest RFID deployments, even within the steel industry, Age Steel's use of an RFID reader mounted on a small unmanned aerial vehicle (UAV), commonly called a drone, took the technology to new

heights. The Steel Yard Autonomous Tracking solution, provided by UAE technology services startup Exponent Technology Services, enables Age Steel to quickly and accurately track the locations of pipes, plates and other metal products stored onsite.

Inditex CEO Announces RFID Expansion Plans

At Inditex's Annual General Meeting, Pablo Isla, the chairman and CEO of the Spain-based multinational clothing retailer, unveiled his company's ambi-



Zebra Technologies announced it would acquire Motorola Solutions' enterprise business for \$3.45 billion. tious expansion RFID plans. One of the world's largest fashion groups, Inditex operates more than 6,300 stores worldwide, and its brands include Zara (its biggest division). The group owns the majority of its stores, and designs and manufactures almost all its clothing.

International RFID Institute to Deliver Certification Exam at RFID Journal LIVE! Europe 2014

The International RFID Institute, a not-forprofit organization founded to promote professionalism in the RFID industry through standardized certification examinations, held an RFID Certified Associates exam in London on Oct. 23, in conjunction with RFID Journal LIVE! Europe 2014. The exam will replace CompTIA RFID+, which was discontinued, and help ensure that companies hire knowledgeable RFID professionals.

Macy's Expands RFID and Beacon Deployments

The retailer has begun tagging fashion garments at its Macy's and Bloomingdale's stores, to help make sure the merchandise is on the sales floor and to reduce the need for markdowns. Macy's also indicated that RFID-enabled departments saw a 10 percent increase in year-over-year sales, when compared with year-over-year sales in departments that have not yet been RFID-enabled.

MagicBands Bring Convenience, New Services to Walt Disney World

This spring in Orlando, Fla., Walt Disney World began providing a dual-frequency RFID wristband known as the MagicBand to all its resort guests staying at a Walt Disney World hotel. Guests staying elsewhere can purchase an RFID-enabled ticket at the theme-park gate, which provides streamlined access through park entrances and other MagicBand features. Disney's use of RFID is likely to spur adoption by other theme and amusement parks globally.

Airbus to RFID-Tag and Track All Parts Made In-House

Global aircraft company Airbus announced the use of hybrid RFID Integrated Nameplates to supplement its standard, non-RFID nameplates on parts. When attached to a part, the RFID version provides identifying information not only in text and bar-code form, but also by means of its passive EPC Gen 2 tag. The announcement moves the airline industry a step closer to universal tagging of airline parts with RFID.

Zebra Buys Motorola Solutions' Enterprise Business

RFID, bar-coding and real-time location system (RTLS) technology company Zebra Technologies announced it would acquire Motorola Solutions' enterprise business for \$3.45 billion. The sale gives Zebra control of Motorola Solutions' RFID hardware business, as well as its mobile-computing, bar-coding, card-printing and cloud-based device-management technologies. Zebra will operate the combined businesses, adding Motorola Solutions' technology and personnel to its own, under the Zebra name.

Kohl's Rolls Out RFID for Select Product Categories at Its Stores

Department store Kohl's completed its installation of an RFID solution to track garments in select categories at its stores and distribution centers. The technology was deployed by Checkpoint Systems, which provided middleware, integration, hardware, tags and labels. The deployment followed a pilot undertaken at 25 stores to gauge the effectiveness of reading passive EPC Gen 2 UHF tags on garments during inventory counts. Now, a large number of strategic apparel items, including footwear, denim and men's basics, such as underwear and T-shirts, are being tagged at various points along their supply chains, and then counted during regular inventory cycle counts via handheld readers. -M.R.

10 Predictions for 2015

It doesn't take a crystal ball to see what's in store for the coming year. Business trends and news are pointing the way.

Apparel retailers will continue to adopt RFID. Retailers understand the technology's value has been proved and are moving directly to trials and rollouts.

A major nonapparel retail chain will roll out RFID chainwide. Jewelry, home furnishing and home improvement retailers are exploring RFID's benefits. Expect one to unveil big plans in 2015.

Interest in RFID will expand across all industries, driven by news of big retail deployments. RFID Journal is already seeing an increase in interest from manufacturers, medical device companies and other sectors.

Continued expansion of the Airbus RFID initiative will drive adoption in the airline industry. Maintenance, repair and overhaul (MRO) companies are beginning to take advantage of RFID tags on parts of new Airbus planes, and it's likely airlines will start to see the benefits as well.

Consolidation in the RFID industry will continue. With short-term prospects still fairly weak, some RFID companies will be forced out of business or purchased by larger firms.

Microsoft, Oracle and SAP will continue



to sit on the sidelines. As more customers begin to request integration of RFID applications, the software giants will eventually catch on to RFID's importance.

Accenture, Capgemini, Deloitte, Ernst & Young, and IBM Business Services will continue to ignore RFID. There isn't enough revenue to get the big consulting firms excited, but that will likely change in 2016 or 2017.

Venture capitalists will come back into the market. They were burned when the

market didn't materialize quickly after the early RFID mandates. But news of significant deployments will start to rekindle interest.

The Internet of Things will continue to generate a lot of buzz. The release of the Apple Watch will fuel more IoT hype.

Political uncertainty in the United States will slow economic growth and lead to delays of some RFID projects. Expect constant confrontation and inaction on budgets, tax cuts that are going to expire and other issues. —M.R.

UNLOCKING THE INTERNETOF THINGS

By Samuel Greengard

The key is **EPCIS**, a universal business language that brings value to IoT applications.

Norsk Lastbaerer Pool (NLP) is an Oslo-based company that manages returnable transport items (RTIs) for manufacturers and retailers in Norway and Sweden. It uses radio frequency identification to track and manage approximately 900,000 pallets and 1 million totes that are shipped to roughly 750 customers at 1,000 locations, nearly 98 percent of the Norwegian retail market. Each pallet is identified with four EPC Gen 2



ultrahigh-frequency RFID tags, to ensure the pallet can be read from any angle when it passes through an RFID portal, and each tote is identified with two tags. The tags are read when the RTIs arrive at NLP's main distribution center and when they are dispatched to a customer warehouse. At some customer locations, the tagged pallets and totes are read when they are sent to a retailer DC. In addition, some customers use the tagged RTIs to manage product shipments.

The RFID solution helps NLP better manage inventory and automates manual processes, such as paperwork. Some of NLP's customers use the system to improve their own supply-chain processes.

In Fukuroi City, Japan, a large agricultural center for rice, tea, melons and other products, logistics for individual farmers is prohibitively expensive. To streamline commerce, farmers attach RFID tags and bar codes to food packages and crates to identify their produce. Buyers then aggregate the goods to facilitate delivery, using a packaging and product management system, and to track shipments through the supply chain.

What these deployments have in common is that they both use the Electronic Product Code Information Services (EPCIS) standard to share data with their supply-chain partners and gain visibility into their business processes. EPCIS is the driving force behind the Internet of Things, in which any type of captured data on physical items is tracked and managed as the items move from company to company and country to country. That's because EPCIS gives businesses a common language to interpret the data.

> here is an incredible amount of data moving around," says Ken Traub, president of Ken Traub Consulting. "But you have to have the right data to get business value. The EPCIS data model is unique in the way it connects RFID and bar-code data to business processes. With-

out EPCIS, an IoT platform can connect 'things' to the Internet, but the data might not have business meaning. EPCIS data makes it possible for businesses to build applications that derive real value from connected devices."

Traub, who helped create the EPCIS standard, which was introduced in 2006, says companies are increasingly putting EPCIS into production. While numerous pilots worldwide have proved its business value, he acknowledges that companies first had to get comfortable using RFID, and they did so with deployments within their own operations. Now, they have millions of tagged assets and other things, and they're looking at optimizing their supply chains to achieve additional benefits. "They turn to EPCIS, which offers a solid foundation for doing this," he says.

"Businesses need to think about how to put EPCIS to use, and how it can help them operate more efficiently and cost-effectively," says Gena Morgan, program manager at GSI US, an organization that helps establish standards for supply-chain management. "The technology is applicable across a wide range of industries and

"EPCIS puts information in the hands of people when and where they need it-and it ultimately drives better decision making."

-GENA MORGAN, GS1 US

environments. EPCIS puts information in the hands of people when and where they need itand it ultimately drives better decision making."

Most Industries Can Benefit From IoT Apps

NLP and Fukuroi City are just two examples of the companies and organizations that are adopting or piloting EPCIS to improve supplychain visibility. Some companies, such as those in the food and pharmaceuticals industries, are relying on the technology to meet government traceability regulations (see "In Pursuit of Fresher, Safer Foods and Drugs" on page 24). Others are adopting the technology to improve business processes. Tine, the largest Norwegian dairy product cooperative, uses RFID and EPCIS to track its RTIs and shipments. City'super, a high-end supermarket and retail chain in Hong Kong, is managing shipments of perishable items with temperature sensor RFID tags and EPCIS, to detect and minimize financial losses from potential food deterioration. EPCIS

can also be used to track the raw materials that go into a finished product, to facilitate recalls (see Tracking Transformations).

Construction, energy, logistics, rail and port organizations are also beginning to adopt EPCIS for supply-chain management and safety improvement. In these sectors, which often involve transporting assets between countries, it's particularly important to have a standard language for sharing information, Morgan says. In Scandinavia, for example, the Swedish, Norwegian and Finnish railway transport agen-

> cies are using RFID and EPCIS to track national and international trains, to improve operations.

> Manufacturers can benefit from using RFID and EPCIS to facilitate electronic proof of delivery from their suppliers, to reduce errors (see An Impartial Observer). And once that process is in place, they can use the technology to automate vendormanaged inventory and replenishment (see A Win-Win for Suppliers).

> Apparel retailers are nearing the tipping point in using RFID for in-

store inventory management (see Perspective on page 10). They are beginning to require their suppliers to RFID-tag items at the point of manufacture. "I am not aware of any retailers or suppliers using EPCIS to share data," says Bill Hardgrave, dean of Auburn University's Harbert College of Business and founder of the RFID Research Center. "But for RFID to be completely effective, it must be used throughout the supply chain. The visibility provided by RFID is only possible if supply-chain partners share data, and this includes retailers, who must be willing to share data such as receipt of goods with their suppliers. It would be inefficient to create proprietary solutions to share information. EPCIS provides the common framework."

Bridging the Physical and **Business Worlds**

EPCIS bridges the physical world, where RFID tags and other IoT devices capture information, with the business applications their



supply-chain partners use. EPCIS is an open standard, so it allows for the acceptance of data from just about any type of data-capture technology—including RFID, sensors, bar codes and mobile phones—via the Internet.

At the core of a typical EPCIS deployment is a database, called an EPCIS repository, that serves as an enterprisewide hub for storing the captured data, such as the location or condition of products and shipments, that originates from a company's operations, Traub says. From there, the company can allow the data to flow to any business application that needs it.

How? The EPCIS repository interfaces with internal and external systems via a second component, an EPCIS Accessing Application. "It is responsible for addressing specific business needs by extracting data from the EPCIS repository as required and then delivering it in whatever form applications require," Traub says. "The legacy systems that companies already have in place, including enterprise resource planning and supply-chain management, are often recipients for EPCIS data, and an EPCIS Accessing Application adapts the high volume of EPCIS data to the capabilities of the legacy system." At the same time, newer applications designed specifically to process EPCIS data may connect directly to the EPCIS repository.

EPCIS succeeds at bridging the physical and business worlds because it standardizes the data flowing from IoT devices to business applications in a way that allows data to be shared with multiple applications and across companies. This begins with common identification for products, locations and other realworld things. Every company and organization has its own way of identifying goods or parts, but to achieve "joint visibility," says Ian Robertson, CEO and president of Supply Chain

5 Steps to Using EPCIS Here's how to use the Electronic Product Code Information Services standard successfully, says Ken Traub, president of Ken Traub Consulting.

Establish the business goals and benefits your company hopes to achieve.

Build the system methodically by identifying the business processes and steps in which EPCIS data will be generated, and designing the data content carefully. "If EPCIS data is welldesigned and constructed, there is greater flexibility and freedom to change things in the future," Traub says. Deploy the hardware and software systems, including middleware, that can generate and connect EPCIS data, as well as front-end and mobile enterprise systems with which you can put the data to maximum use. Get familiar with EPCIS by using it within your organization to let different business units share information (see EPCIS for Internal Projects). To learn how to use EPCIS to share information with your business partners, see How to Deploy EPCIS and "Supply-Chain Visibility" on page 39.

Many organizations use off-the-shelf EPCIS software systems, implement data capture within the enterprise, and expand the platform and initiative over time, says Gena Morgan, program manager at GS1 US, which helps establish standards for supply-chain management. —S.G.

RFID Consulting, supply-chain partners need to speak the same language. "The Electronic Product Code standards were developed precisely for this purpose," he says (see The Language of Business). Recently, GS1 developed an RFID standard for identifying automotive components and parts so they can be tracked in the open-loop supply chain (see A New EPC on the Block).

In addition to having common identification, it's important to add context so IoT data can be related to business processes. "There is a key difference between a raw tag read and

"Many different business applications can run off the same EPCIS data, maximizing the return on the investment made to capture the data."

-KEN TRAUB, KEN TRAUB CONSULTING

EPCIS data," Traub says. "A raw tag read lacks the context of where and why the tag was read. The EPCIS data model includes dimensions of what, when, where and why, so it not only identifies the object being tracked but also the date and time, the location and the businessprocess step being carried out." A business application seeing an EPCIS event not only knows the RFID tagged product was seen at the loading dock, but why it was there; it was, for example, being shipped, received or returned.

By including the where and why dimensions, EPCIS hides the type of reader and tags, reader position and other operational details that are irrelevant at the business level. This has a double benefit, Traub says. Many different business applications can run off the same EPCIS data, maximizing the return on the investment made to capture the data. At the same time, companies can evolve their RFID infrastructure to take advantage of the latest

tag and reader innovations without concern about disturbing existing applications that consume the EPCIS data stream.

Companies have a wide choice of software products that store and process EPCIS data, from standalone software to add-on features of legacy and cloud-based systems, both proprietary and open-source. Most EPCIS software comes with fine-grain access control to help organizations protect intellectual property and maintain strong security. This means a manufacturer can view data about, say, product demand and inventory levels in stores, but a supply-chain part-

> ner might see only basic shipping information. Yet, both could have access to relevant regulatory data.

> "Today's supply chains have many more demands on them than only a few years ago," Morgan points out. "EPCIS makes it possible for organizations to connect diverse data points in a relational way."

Return on Investment

"EPCIS does not require a huge IT investment and a huge chunk of time to implement," Morgan says. "It is already a mature and viable

technology, and a proven tool."

The Fukuroi City project has resulted in sales gains for participating farmers by a factor of 2.8, says Jin Mitsugi, associate professor at Keio University, who worked on the project with Tashiro Takashi, at Daiwa Computer. The efficiency of the system—sorting and packing processes take place roughly 26 times faster than before-allows farmers to wave shipping costs for orders above approximately U.S. \$50, he says. In addition, Fukuroi City is using the EPCIS platform to track and manage relief supplies identified with RFID and bar codes.

At NLP, inventory accuracy has improved to nearly 100 percent, according to Tom Romanich, the company's business manager. Missing RTIs have become outdated, Romanich reports, a substantial savings considering an RTI can cost U.S. \$70. The pallets and totes are also tracked through the washing process.



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NLP's inventory-management application extracts all data from the EPCIS repository, which enables managers to better understand the flow of RTIs and analyze their lifespan, to determine when they need to be replaced. The company now plans to add temperature sensors to better detect conditions during shipping, so it can boost quality control.

The flexibility of EPCIS was critical to adoption, Romanich says. "We have developed an open-loop system that works for us and our

"We have developed an openloop system that works for us and our customers. We can use the system and customize it to our exact requirements, while customers can use the EPCIS data how it works best for them."

-TOM ROMANICH, NORSK LASTBAERER POOL

customers," he says. "We can use the system and customize it to our exact requirements, while customers can use the EPCIS data how it works best for them. They often have a very different approach."

One NLP customer, a major Norwegian retailer, uses the tagged pallets to track when goods have been delivered. "The system queries for the serial shipping container code (SSCC) and automatically adds dozens of pallets at a time to existing inventory, with no human interaction," Romanich says. "The truck driver simply unloads the truck, and RFID and EPCIS handle the rest. This scenario is repeated over several thousands of pallets a week. The process removes about 45 seconds of labor per pallet." He estimates that the 45 seconds saved per pallet equates to more than U.S. \$80,000 per year.

The system also trims roughly 24 hours of shipping and transport time as goods move through the supply chain, Romanich says. In the past, the pallets or totes would sit in a warehouse until someone scanned them into the retailer's enterprise resource planning application. Now, he says, the process occurs automatically.

In spite of the potential benefits, Romanich says, the biggest challenge has revolved

around motivating customers to tap into the system and integrate their data. NLP logs every internal transaction, both receiving and sending, and the database could provide broader functionality and capabilities with partner data. "We cannot force them to use the system," he says. "We simply try to demonstrate the benefits."

But, Romanich adds, customers are beginning to understand the benefits of EPCIS. "Over the last couple of years, we have noticed an increased interest in using the EPC of the tote or pallet to improve and automate internal processes," he says. "NLP thinks this is just the beginning of a future where NLP pallets and totes will be used for

food tracking, internal automation and better RTI inventory control in the Norwegian retail market."

During the next few years, Morgan believes companies across a wide swath of industries will come to recognize the benefits of EPCIS. The continuing evolution of the technology and standards—along with packaged software designed to handle various tasks related to EPCIS—will pave the way for more sophisticated and automated functionality. "As organizations become aware of the power of the technology and the granularity of the data it can deliver, adoption will accelerate and efficiency gains and cost savings will result," she says.

"EPCIS intersects with mobility, big data and the Internet of Things," Traub says. "It's an important piece of the technology puzzle."



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Fresher, Safer, Foods AND Drugs

Soon, RFID-monitoring perishables in transit and storage will be the new normal.

By Jennifer Zaino

FOR MORE THAN IO YEARS, RFID vendors, logistics providers, research organizations, and food and pharmaceutical firms have been developing and piloting the use of RFID to monitor perishable goods in the cold chain. The stakes were high and the challenges formidable. The goal was to track the temperature of perishables in real time during transit, to control exposure to excessive heat or cold and enable companies to be proactive should an incident occur. Temperature fluctuations of just a few degrees can lead to spoiled goods and thousands of dollars in damages. But early RFID sensor tags suffered from temperature and time-keeping inaccuracies, and when those issues were addressed, tag costs remained high. And, like companies in other industries, food and pharmaceutical firms were reluctant to embrace an emerging technology.

Today, RFID has a bright future in the cold chain. RFID sensor technology has matured, early adopters in the food and pharmaceutical sectors have proved the business case, and government regulations are propelling adoption.



According to a 2013 Frost & Sullivan study of RFID in the global cold-chain market, from 2014 through 2020 the technology will grow an estimated 25 percent in food supplychain management. This area constitutes almost 80 percent of the total RFID cold-chain market, says Nandini Bhattacharya, a Frost & Sullivan senior research analyst. Growth has been triggered by key regulations such as the U.S. Food and Drug Administration's Food Safety Modernization Act (FSMA) for traceability and similar European Union mandates designed to facilitate recalls, as well as the FDA's Hazard Analysis & Critical Control Points (HACCP) requirements that food handlers develop strategies to internally manage food-safety processes, she says.

While the pharmaceutical and biomedical cold chain comprises just 20 percent of the total RFID cold-chain market, Bhattacharya expects it will see a high growth rate of 45 percent to 50 percent by 2020 (see "RFID Proves Its Value in the Pharma Cold Chain" on page 28).

Joining the Food Cold Chain

Meeting government regulations is not the only reason RFID is heating up in the food cold chain. Monitoring perishable foods is smart business. Logistics providers want to improve service for their clients, and retailers want to reduce waste and retain customers.

That's why, in 2013, Hy-Vee, a chain of 236 supermarkets in the Midwest, and its wholly owned subsidiary Perishable Distributors of Iowa (PDI), began RFID-tracking shipments of fresh meat, seafood and dairy from its suppliers to its distribution centers (see <u>Hy-Vee Supermarkets Track Perishables to En-</u> <u>sure Freshness</u>). And that's why Hy-Vee also began tracking the temperature of perishables from PDI DCs to Hy-Vee retail stores.

Since this spring, Hy-Vee has been using TempTRIP ultrahigh-frequency RFID tags to monitor additional temperaturesensitive products, including all frozen goods, deli meats, prepared salads, ice cream and produce, says Kyle Oberender, PDI's director of safety. What's more, he says, "we now have nearly half of our retail stores connected online with readers, with the other half to be wrapped up around the end of the calendar year. Procedures, policies and training have been more fine-tuned, and the overall outlook is very good with the results we are seeing."

This will mark the first time RFID readers have been installed at every one of a supermarket's retail stores for outbound-to-retail temperature tracking, says TempTRIP CTO Leland Curkendall. "Traditionally, it's been from the supplier to the distribution centers," he says. With the retail RFID infrastructure in place, it becomes easier for store managers to make smart merchandising decisions to support customer retention.

Say, for example, an RFID read at a store shows that one shipment of blueberries had experienced temperature variation exposures that were enough to significantly affect shelf life. If the affected blueberries have only five attract and retain customers, and customers will have a more favorable experience with the products when they get them home."

RFID temperature-tracking solutions are being deployed worldwide. In Sweden, for example, SydGrönt, which facilitates sales, logistics and distribution of produce from farmers in southern Sweden to major grocery chains, is using CAEN RFID's semipassive UHF logger tags and easy2log software. On a large scale, manual temperature loggers aren't useful, says



Hy-Vee is tracking the temperature of perishables from its distribution centers to retail stores, to enable store managers to make smart merchandising decisions to support customer retention.

> days of shelf life left rather than the expected 10, the store manager could put them out at a discounted price so they would move quickly, Curkendall says. That way, everyone wins—the store doesn't take the big hit it would have if the berries went bad and remained unsold, and the customer gets a good deal, too.

> "If you can keep I percent of customers from switching because they didn't like your produce, that's a bigger play than simply rejecting spoiled products," Curkendall says. "By limiting the stress of acceptable incoming products, grocers will have better products to

SydGrönt's IT manager, Martin Dahn, in a YouTube video about the project. RFID automates the process, making it very easy.

A new division of a large third-party logistics provider has multiple RFID cold-chain trials under way for its global network of growers and the groceries, restaurants and other venues they supply, says Michael McCartney, managing principal at QLM Consulting, which specializes in cold-chain management. While McCartney is not at liberty to name the logistics provider, he says, "They are very interested in providing premium services to their suppliers."

New Cold-Chain Applications

Cold-chain monitoring doesn't stop when perishables arrive at retail stores. To ensure food safety, most states require stores to keep track of temperatures in coolers and freezers, says TempTRIP's Curkendall. Typically, employees read temperature gauges on these cases twice a day, and write down their readings to provide an audit trail for regulatory agencies. The manual process is time-consuming and error-prone, he says.

TempTRIP is piloting a cooler- and freezermonitoring solution with two U.S. supermarket chains, which Curkendall can't name at present. TempTRIP installed UHF RFID tags in the cases; employees remove the tags, take them to the stockroom to be interrogated by a handheld reader, and then replace the tags in the cooler.

To facilitate the process, the company is developing a key fob RFID reader that employees can attach to their key chains or belt loops. When the key fob is waved over a UHF RFID tag installed in a case, it will read and immediately send the log data (date, time and temperatures) and cooler ID via Bluetooth to an application on an Android mobile phone or tablet, which will upload the data to TempTRIP's website. Then, the tags will reset and restart. "All the results are on the Internet and can be seen from anywhere," Curkendall says. "This approach decreases transcription errors, increases accuracy, decreases manual workloads and provides a good audit trail for regulatory agencies." The device should be available first thing next year, he says.

TempTRIP is also running home-delivery trials in the United States and Europe with some unnamed retailers. Tags are placed in outgoing bags at a retail store or distribution center, and are later removed by the delivery driver so they can be reused. Right now, the tag data has to be uploaded to a Web application when the driver returns, unless he or she has a handheld reader in the truck. Curkendall says the key-fob readers, in conjunction with mobile device software, will make this option more attractive to potential customers. Drivers will be able to verify that food temperature ranges have been stable before they deliver products.

This shows consumers the retail brand cares enough to monitor their couriers and create an audit trail to ensure compliance with temperature specifications, Curkendall says. "Home delivery is really no different in a way from delivery to distribution centers," he says. "The same kinds of things [that affect food temperature ranges] can go wrong, like doors left open on a truck or refrigerators not as cold as they should be."

Another RFID cold-chain application on the horizon is thermal mapping of DC cold rooms to determine the location of hot and cold spots, McCartney says. This allows distributors to store perishables that are more sensitive to high temperatures in the colder areas and those that are less sensitive in warmer areas.

"There is a four- to five-degree shift in any given cold room," McCartney says, and research has shown that a 2 percent change in temperature can reduce perishables' shelf life by 50 percent. Real-time active RFID systems that relay temperature information wirelessly are more efficient than having employees manually poke around with temperature recorders (and likely going only as far as their arms can reach) to understand whether products are being stored in the right places.

"Oftentimes, it's a big revelation for [companies] to see wide swings in temperatures in any given cold room," McCartney says. "This is a huge area where there are a lot of efficiencies to be gained." One brand-name supplier of organic produce has already redesigned its entire cold-storage distribution system to take advantage of the information RFID is providing, he says.

Cost of Cold-Chain Control

Cost has been an issue when it comes to taking advantage of RFID for food cold-chain applications. But the emergence of battery-assisted passive (BAP) RFID has helped in addressing this, Frost & Sullivan's Bhattacharya says. BAP is less expensive than active RFID, and it has technological advantages over sensor-



vertical focus: cold chain

One brand-name supplier of organic produce has already redesigned its entire cold-storage distribution system to take advantage of the information RFID is providing.

--- MICHAEL MCCARTNEY, QLM CONSULTING



"Margins in the food industry are tight, so companies are cautious to avoid any unessential expenses."

CAEN RFID

embedded passive RFID, which can be used for cold-chain monitoring in smaller areas and for simpler applications that require recording of maximum and minimum temperatures.

"Recent technological advances make it possible for BAP tags and readers to have high memory, higher read range, faster read rates, and better performance in the presence of liquid, metal and concrete, and in extreme temperature conditions," Bhattacharya says. "All this is available at a much lesser cost, which makes the total cost of acquisition affordable in medium and large projects. The advantages over passive and active RFID make BAP a hot technology choice for cold chain at present."

Still, margins in the food industry are tight, says Stefano Coluccini, CMO at CAEN RFID, so companies are cautious to avoid any unessential expenses. For premium products, it makes sense to incur extra costs, he says. Chocolate maker Lindt & Sprüngli, for example, uses CAEN's temperature technology to assure the correct transport environment for its products.

Hy-Vee and PDI require suppliers to purchase TempTRIP's read-write tags. PDI receives more tags than it needs for outbound deliveries to stores, so it has worked out a return-refund arrangement with TempTRIP, Oberender says. This helps PDI recoup some of the cost of its RFID infrastructure. When necessary, PDI works out funding issues with its suppliers.

While cost can never be ignored, what can't be underestimated as a key factor in moving RFID forward in the food cold chain is that "the importance of freshness continues to be at the forefront of everyone's mind," McCartney says. Walmart and other big retailers, he notes, are beginning to push product sustainability as a



RFID Proves Its Value in the Pharma Cold Chain

WHEN IT COMES TO TRANSPORTING temperature-sensitive pharmaceuticals, biomedical supplies and other life-sciences products, RFID has become an invaluable tool. A number of logistics and cargo services companies, including DHL Global Forwarding, Medlog, Panalpina and Southwest Airlines Cargo, rely on RFID temperature solutions to monitor the condition of products during transit or storage (see RFID Helps Medlog Monitor Pharmaceutical Cold Chain, Global Logistics Company Monitors Shipments' Temperatures and Southwest Accepts RFID Device to Track Cargo Temperatures). RFID-tracking shipments improves customer service, ensures the safety and efficacy of products that can impact patients' health, and enables companies to meet government regulations.

By summer 2013, DHL Global Forwarding's LifeConEx group had deployed an RFID infrastructure at more than 15 certified life-sciences stations worldwide, to apply and read sensor tags on containers and pallets of temperature-sensitive health-care and pharmaceutical products. Each sensor tag, manufactured by CAEN RFID, consists of an EPC Gen 2 passive ultrahigh-frequency RFID inlay integrated with a battery-powered temperature logger. The tag's identification number and temperature recordings are captured and then forwarded via a wireless connection to DHL's LifeTrack platform, where the data is interpreted. If temperature readings have deviated from acceptable levels, the system alerts the Global Monitoring Team, which keeps all stakeholders informed in near real time.

Today, DHL Global Forwarding has more than 68 major lifesciences stations worldwide equipped with RFID technology. "It has almost tripled," says LifeConEx CEO David Bang. "What our customers are constantly looking for is visibility, compliance and proactive intervention," he says. "The more dynamically we use technology to offer that to them, the better the customer value is." A large biotech scorecard measure for suppliers. "Temperature variation is a key component of how fresh things really can be kept, and [these retailers] are looking for any type of supply-chain optimization to reduce shrink and increase freshness," he says. "When it comes to fruits and vegetables and other perishables, RFID offers a huge uplift in managing the temperature of those assets throughout the cold chain."

Using RFID presents the opportunity "to not just control shrink [from overripe produce], but reduce overall food waste," McCartney adds. More than 36 million tons of food ends up in landfills, where it breaks down to produce methane, a potent greenhouse gas that contributes to climate change, according to the U.S. Environmental Protection Agency. Businesses that accumulate that waste have to pay haulers to dispose of their trash. The FDA cites another economic benefit: Companies that donate wholesome, edible food to food banks or food rescue organizations can claim tax benefits, as well as feed those in need.

It may have taken 10 years to get here, but all the pieces are now in place for widespread adoption of RFID in the cold chain. "As a result of mandates and regulations, participants in the supply-chain ecosystem need to adopt cold-chain monitoring solutions," Frost & Sullivan's Bhattacharya says. "Also, due to higher consumer awareness, supply-chain participants from the manufacturer to the seller are now increasingly using cold-chain monitoring technologies. Technological advances, price decline of RFID tags and convergence of multiple technologies with RFID will boost adoption of RFID in the short term, mid-term and long term."



It may have taken 10 years to get here, but all the pieces are now in place for widespread adoption of RFID in the cold chain.

company, whose name Bang says he can't publicly disclose, has leveraged the service and—in conjunction with timely interventions based on temperature readings and process-management advances— "reduced discarded or damaged products by 30 percent."

DHL Global Forwarding is now offering some customers active GSM (Global System for Mobile Communications) and GPS (Global Positioning System) devices for more real-time tracking. Last year, the U.S. Federal Aviation Administration ruled that small cargo and consumer devices can remain on, in airplane mode, during flights. "There are clearer guidelines now in that area, which promotes the ability to work on more real-time technologies... and promotes a more automated understanding of where a shipment is," Bang says.

A technology-agnostic approach is necessary, Bang notes, because not every technology can be applied equally everywhere. Some geographic areas, for example, may not have the ability to put an RFID infrastructure in place, "so maybe automatically uploading data through a GSM or GPS network is better and more efficient," he says. The same customer might use multiple technologies to monitor the same shipment, he explains, to ensure the best visibility and intervention options.

DHL Global Forwarding is also using temperature data to help customers be proactive about future shipments. Customers, for example, could re-engineer their packaging and processes based on real data versus assumptions, Bang says, often in ways that can save them money.

Government Regulations Spur Adoption

DHL Global Forwarding's customers also have access to all temperature readings relevant to delivered shipments. They can produce reports for clients and regulatory agencies to show the products were shipped at safe temperatures. Bang and other cold-chain experts believe pharmaceutical and biomedical suppliers will increasingly turn to RFID and other technologies to support regulatory requirements.

"If you distill things to a basic level, regulatory bodies want organizations to demonstrate that they have a risk-based approach when it comes to handling pharmaceuticals or biotech or diagnostic products," Bang says. "The technologies we are talking about help us and our customers have a better understanding of what risks are out there and more proactively, holistically and comprehensively address them."

The U.S. Food and Drug Administration's track-and-trace mandate doesn't specify that RFID must be used for drug serialization as an anticounterfeiting method (see RFID Takes a Back Seat When It Comes to Electronic Pedigrees). But some pharmaceutical companies are considering using RFID to identify prescription drugs. "I can't think of something that would be as cost-effective [as RFID] to use," says Michael McCartney, managing principal at QLM Consulting, an RFID consulting firm that specializes in cold-chain management. "And if you have to track [drug pedigrees to combat counterfeiting and fraud], you might as well monitor the cold chain, too."

Stefano Coluccini, CMO at CAEN RFID, agrees. "If you want to use serialization effectively, you need to use RFID," he says, because it's not practical to rely on 2-D bar codes that would require manually scanning millions of drug containers at every checkpoint. "Already some of the most advanced pharmaceutical companies are piloting RFID for serialization, and as they build that infrastructure, having RFID temperature loggers will be more natural, too," he says. "They can use the same technology for serialization and cold-chain monitoring." -J.Z.



Energy-Harvesting Tags by BOB VIOLINO

RF energy can charge or operate a wide range of low-power devices.

ENERGY HARVESTING IS A PROCESS by which energy is captured from a variety of sources in the surrounding environment—radio waves, thermal energy and ambient light, for example—and converted into electrical energy. RFID providers have developed energy-harvesting tags that can power themselves as well as small devices.

Battery-free RFID tags can reduce deployment costs. What's more, energy-harvesting tags are opening the door to innovative RFID applications.

"In some instances, a battery is just not an option or can't be counted on



The NTAG I²C harvests energy from the RF field emitted by NFC-enabled mobile phones or other NFC reader devices.

VICTOR VEGA, NXP SEMICONDUCTORS for the long term," says Victor Vega, director of NFC/RFID solutions at NXP Semiconductors. "Imagine in California, where we have our fair share of earthquakes and structures need special earthquake cross-sectional beams for stability," he says. "After a quake, it may be necessary to check the integrity of the beams. But if they are concealed behind drywall, that's a problem. You could have a battery on a sensor and maybe a cut-out in the wall to enable an occasional battery replacement, but that's not viable."

Instead, Vega says, "you could place the sensor on the beam, connect it to a flex circuit board, and the tag antenna part is just behind the drywall. On the finished side of the wall is a 'test here' indicator. You tap and energize the sensor to read if the beam is stressed or OK. No batteries, no special cables with ever-changing connectors."

Here's how companies can use the energyharvesting tags available today, and why the Internet of Things—with its promise of ubiquitous tagging and sensor monitoring—is driving research and development efforts.

NXP SEMICONDUCTORS

NXP Semiconductors' NTAG I²C NFC chip won the 2014 RFID Journal Award for Best New Product (see <u>Smarter Things</u>). The chip combines passive high-frequency Near-Field Communication technology with a built-in I²C interface, enabling users to communicate directly with any tagged item via an NFC reader.

The transponder chip also features energyharvesting capabilities that enable it to provide energy to other low-power components. "With the NTAG I²C, we added a power-harvesting feature," Vega says. "Not only does the chip rectify power for itself, but it provides quite sufficient power for other devices as well."

The NTAG I²C harvests energy from the RF field emitted by NFC-enabled mobile phones or other NFC reader devices, Vega says. "It captures the alternating current/RF energy, converts it to a usable direct current [DC] power and includes a vout [voltage out] powerharvesting output to drive other peripheral components [that need] DC power," he says.

The company has created a development kit that demonstrates how the NTAG I²C can use the harvested energy—typically, 3 volts—to power itself, an NXP microcontroller, an NXP temperature sensor and an LCD display. "It's quite impressive to see how much energy can be captured from the available RF energy—no batteries required," Vega says. The kit provides an embedded electronic design platform and includes hardware and software tools. Developers can port their own code into the platform and quickly assess feasibility for their custom applications, with minimal development time and cost, he says.

The NTAG I²C is modular, so it can work with a variety of sensors, providing power to



The NFC chip can energize low-power devices.

the sensors and communicating via the I²C serial interface. The data from an external sensor, such as a temperature monitor, can be fed to the NTAG I²C and redirected, for example, to an RF reader device.

Most interest in NXP's energy-harvesting chip seems to be in wireless configuration and diagnostics/reverse logistics, Vega says. To illustrate the first case, he cites the example of pulling parts off an assembly line, waiting to connect them to a power source, waiting for them to boot up, and then downloading configurations or updating firmware. This takes time and contributes to higher costs. "Being able to wirelessly configure electronics without powering up the main board and eliminating a configuration connector makes this an attractive solution," Vega says.

"On the reverse logistics side," Vega says, "let's say an electronic device or appliance fails. It doesn't turn on, so no information can be gathered. With the ability to communicate with the passive NTAG I²C, you could use a low-power diagnostics module, tap on the tag and extract the last recorded diagnostic codes to get the electronic serialization, model, warranty history and other information—all from harvested power." It's also possible to use the pass-through mode, like a modem, to download firmware patches, he says.

Some Leading Providers of RFID-Energy Harvesting Tags

Company	Product	Technology	Key Features	Industries	Applications
NXP Semiconductors www.nxp-rfid.com	NTAG I²C transponder chip	NFC	Chip rectifies power for itself and other low-power devices, such as sensors and LCD displays.	Consumer appliances and electronics, smart meters	Administrative access to consumer electronics devices, self-serve maintenance, firmware updates and warranty registration
Powercast and Vanguard ID Systems powercastco.com vanguardid.com	High-Function RFID tag	EPC Gen 2 UHF RFID	Tag provides RF-to-DC conversion, to power itself and onboard sensor or display; read range is 25 to 30 feet; tag is designed for harsh environments.	Health care, manufacturing, supply chain	Monitoring equipment; tracking temperature of items during manufacture and in supply chain
STMicroelectronics st.com	M24LR16E-R	NFC	Tag converts ambient radio waves emitted by RFID reader- writers and NFC phones or tablets into energy to power its circuits and small electronic devices.	Health care, consumer electronics, manufacturing, retail	Monitoring equipment; firmware updates; powering electronic shelf labels, computer peripherals, phone and tablet accessories, and personal health-care products



Batterypowered tags tend to be too expensive for many applications, such as tracking the movements of cold-chain goods from a processing plant to a store.

CHARLES GREENE, POWERCAST



The RFID NFC tag can power small electronics.

STMICROELECTRONICS

STMicroelectronics (ST) offers a 16 kilobit dynamic RFID NFC tag that includes energyharvesting capabilities, as well as password protection and electrically erasable programmable memory. The M24LR16E-R also features an I²C interface that can be used for in-field product upgrades and software enhancements, according to an ST spokesman.

The M24LR16E-R's RF interface can convert ambient radio waves emitted by RFID readerwriters and NFC phones or tablets into energy to power its circuits and enable complete battery-free operation. The company says the M24LR16E-R can also harvest enough energy to power small electronics, including shelf labels, personal health-care products, computer peripherals, and phone and tablet accessories. The tag does not include sensors but can be used in environmental monitoring systems.

POWERCAST AND VANGUARD ID SYSTEMS

Powercast and Vanguard ID Systems have partnered to develop an EPC Gen 2 ultrahigh-frequency RFID tag that harvests energy. The High Function tag, introduced in April, is designed to fill a void, says Charles Greene, chief technical officer at Powercast. Basic passive UHF tags are becoming more pervasive and are lowcost, he says, yet their functionality is limited without a power source. Battery-powered tags tend to be too expensive for many applications, such as tracking the movements of cold-chain goods from a processing plant to a store. What's more, they may not operate well under some extreme conditions, such as packed in ice.

The High Function tag uses Powercast's RF energy-harvesting technology to provide RFto-DC conversion. The tag, which includes an RFID chip and Powercast's integrated circuit, receives energy from an RFID reader. Because the tag has extremely high RF-to-DC conversion efficiency and sensitivity, Greene says, "we can provide more power and a longer read range." It can deliver 10 times the power of a standard passive RFID tag, he says, and has a read range of 25 to 30 feet.

The High Function tag is protected by Tes-



The UHF energy-harvesting tag is also waterproof.

See the complete table of contents at www.rfidjournal.com/howtochoose



How to Choose the Right RFID Technology for Your Application

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"The potential for energyharvesting tags is limitless, but will depend on the needs of the customer and the applications."

MICHAEL LIARD, RFID ANALYST lin, a waterproof synthetic printing sheet provided by Vanguard. "Teslin acts like Bubble Wrap to protect the RFID inlay from the elements and any other harsh environments," Greene says. Vanguard's manufacturing process makes the tag waterproof, weatherresistant, flexible and reusable, he says.

The tag can also power onboard sensors and displays, Greene says. Tags available or in development now include temperature, vibration, humidity, tilt or moisture-content sensors and visual indication displays. "The tags are typically battery-free but some contain a rechargeable battery," he says.

"Most of our applications are in supply chain, industrial monitoring and manufacturing processes," Greene says. The High-Function tag, for example, can measure vibrations on machinery at a manufacturing facility. The collected data could indicate a potential problem with a piece of equipment before it fails, saving the company the cost of having to shut down a manufacturing process.

The health-care industry is another good fit for the High-Function tag, Greene says. "Our tags allow for real-time monitoring of blood, vaccines and other medical supplies' temperature throughout their journey from manufacturer to facility," he says.

POWERING THE INTERNET OF THINGS

While few companies offer RFID energy-harvesting tags today, that's likely to change given the ongoing research and development in the field. Polish Bluetooth beacon technology startup Ifinity, for example, is preparing to pilot its energy-harvesting AirBeacon. The battery-free button-size device, which doesn't have to be plugged into an outlet, draws power from ambient RF signals. And a group of researchers from Intel Labs has partnered with several university researchers to develop a power-harvesting NFC tag that can store sensor data and display it on an electronic paper screen, by using power harvested from a user's NFC mobile phone during tag reads.

"A number of companies, labs and startups are developing energy-harvesting RFID tags, but many companies are not fully prepared to unveil their offerings publicly," says Michael Liard, an independent analyst focused on RFID technology. "Energy-harvesting solutions are still in a nascent stage, with value propositions and business cases under evaluation or being determined through proof-of-concept deployments [and] implementations."

Most development efforts are concentrated in the arena of sensing and monitoring applications and solutions, Liard says. The power being harvested by tags will be used to power sensors attached to tags, he says. "Longerrange—which requires more power to deliver—is another area of development in this corner of the RFID market," he adds. "Exact cost savings are determined by the application and the use case. Energy-harvesting tags are also being positioned as a 'green' choice alternative to battery-powered counterparts. Energy-harvesting features also better position RFID and NFC tags against low-cost, lowenergy technologies such as Bluetooth."

Liard foresees applications in the area of IT asset management and data centers, where environmental data can augment identification. "I also see promise in industrial markets such as oil and gas, food safety and security, and manufacturing," he says. "The potential for energy-harvesting tags is limitless, but will depend on the needs of the customer and the applications. These types of tags bring us beyond the basic visibility conversation to one centered more on enabling end users to capture multiple value propositions—for example, visibility combined with enhanced awareness and monitoring."

Growing interest in the Internet of Things, in which consumer devices and industrial items will be tagged and monitored via the Internet, will likely drive demand for energyharvesting tags. Ubiquitous tagging could be expensive, but these tags could cut costs by pulling energy from the environment to power wireless sensors and other devices. "Energyharvesting tags fit well within the IoT concept," Liard says, "as they represent the means to capture more information wirelessly."



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Supply-Chain Visibility

How to use EPCIS to share information with business partners.

By Ken Traub



IN MY COLUMN EPCIS for Internal Projects, I discussed the benefits of using GSI's Electronic Product Code Information Services standard within a company to share RFID data. Business partners can also benefit by using

EPCIS to share information regarding the location of products and other assets, gaining visibility across the supply chain.

In order to share data, all business partners must be able to understand the data. This requires strict adherence to the EPCIS standard and the EPC Core Business Vocabulary (CBV), which provides common definitions for all the data that populates EPCIS events.

Decide what EPCIS data you and your partners need to share. You may collect EPCIS events internally for many steps of your business process, but only a few of these events are relevant to a trading partner and should be shared externally. Also, determine what data you would like to receive from your partners.

Consider the "choreography" of EPCIS data sharing: Will you automatically move some data to your business partners each time you ship a product? Or will you wait for your partners to request the data they want, using the EPCIS query language?

Set up your software. If you are already capturing EPCIS data internally, you have the most important components: the EPCIS capturing applications that generate EPCIS data from your own operations, and an EPCIS repository that stores the EPCIS data until you need it. If not, see How to Deploy EPCIS.

To share your data with other companies, you will need to implement an EPCIS accessing application—software that retrieves data from your EPCIS repository and sends it to your partners. Depending on the choreography, this software might do so automatically, in response to an internal trigger such as a product shipment, or it might respond to an incoming query. This functionality is integrated into most EPCIS repository software. In cases where it's not, it is typically easy to harness an enterprise application integration (EAI) platform to do the work.

On the inbound side, you will need soft-

ware to receive data from business partners and enter it into your repository. Your EPCIS repository or an EAI platform provides this capability as well.

Make sure the communication link is secured properly. EPCIS data is often shared using AS2, a secure communication protocol built on top of HTTP, widely used for electronic data interchange (EDI). Implementing AS2 usually requires "gateway" software to bridge your internal, secure network to the outside world. If you're already using AS2 for EDI,

you should be able to reuse that software for EPCIS.

Another option is to entrust your EPCIS data to a third-party cloud service, which can also share data with your business partners.

Ken Traub is the founder of Ken Traub Consulting, a Mass.-based firm providing services to companies that rely on advanced software technology to run their businesses. Send your software questions to swsavvy@kentraub.com.

RFID Adoption Is On Target

Retailers are deploying item-level tagging far faster than they embraced bar codes.

By Bill Hardgrave



RECENTLY, I RECEIVED a call from Virginia, an analyst assigned to examine RFID in the retail industry. She admitted knowing nothing about RFID when she got the assignment, but she had obviously done her homework. Virginia

was familiar with the RFID Research Center's findings showing inventory accuracy improvement, out-of-stock declines and other benefits of the technology. She also was familiar with the RFID efforts of major retailers, including Kohl's, Macy's and Walmart. She said that, according to her research, only 2.5 percent of all apparel items in the United States are currently tagged.

Then, Virginia asked: "Is RFID for real? If RFID provides such great benefits, why aren't all retailers using it?" For those of us working with RFID every day, it is easy to forget how adoption must look to an "outsider." There are quite a few reasons for the current state of adoption.

First, it has only been a few years since RFID was initially used for item-level tagging. Walmart's 2005 pilot, which asked suppliers to tag pallets and cases, ushered in the use of passive ultrahigh-frequency RFID on consumer goods. Walmart's initiative and similar projects paved the way for the shift, in 2008, to item-level tracking pilots conducted by Dillard's and Bloomingdale's.

Second, 2008 and 2009 were not the best years for U.S. retailers to take on large capital expenditures. The Great Recession put most large projects on hold. Third, as the country emerged from the recession, Round Rock Research (a "patent troll") threatened to sue companies for infringing on its UHF RFID patents, which significantly delayed adoption. Fourth, RFID adoption has had to compete with a near-ubiquitous technology— the bar code.

I believe, in the long run, bar codes and RFID will coexist in a portfolio of auto-ID technologies. Because of their similarities (both auto-ID, both used in retail), comparing the adoption rate of the two technologies puts the pace of RFID adoption in perspective. The

bar code's first retail pilots were conducted in the early 1970s; half a decade later, some 200 stores were using barcode scanners. Itemlevel RFID is roughly five years old, but the technology is already in use in thousands of stores. It took more than 20 years for the bar code to reach critical mass in the retail market.

RFID "insiders" would like to see a faster pace of adoption, and RFID "outsiders" question whether the technology will be-

come as pervasive as bar codes. Looking at RFID's brief history and the obstacles the technology has had to overcome, I believe its adoption is on target and we will see widespread use in the near future.

So, yes, Virginia, RFID retail adoption is for real.

Bill Hardgrave is the dean of Auburn University's Harbert College of Business and the founder of the RFID Research Center. He will address other RFID adoption and business case issues in this column. Send your questions to hardgrave@auburn.edu. Follow him on twitter at @bhardgrave.



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'RFID Buzz' Is a Double-Edged Sword

Hospitals need to curtail their excitement about the technology's benefits and cure one problem at a time.

By Harold Boeck and Ygal Bendavid



soon AFTER WE spoke at a conference on RFID in health care, we received e-mail from an attendee who wrote: "There's buzz around RFID at our hospital for a variety of applications. We are moving forward with some of these initiatives, focusing on instrument traceability, inventory management, and equipment/patient/employee tracking."

While we were glad the hospital had some RFID initiatives in the works, its approach had the classic signs of a project that was destined to go awry. In our response, we asked if the hospital had identified its biggest process inefficiencies and how RFID could help resolve them. Our mail was met with *radio silence*!

A few weeks later, we received a message from one of the attendee's colleagues asking if we had any thoughts on where he "might be able to find UHF RFID tags with switches." We replied that this was an unusual request and suggested that, prior to designing a custom system, he might want to explore the various RFID solutions on the market for hospitals. This mail, too, was met with *radio silence*!

We've seen these symptoms at other hospitals. As managers in different departments hear about how other hospitals are using the technology to save money or improve patient care, the RFID buzz gets louder, hospital administrators approve a pilot project and then the money, time and effort are squandered on an ill-conceived plan.

It's easy to understand why this happens. Hospitals face a lot of problems RFID can help solve, so it's tempting to dive in and tackle them all at once. But while the technology has become more reliable and easier to implement, there are no shortcuts when it comes to planning an RFID deployment.

Hospitals must first form a multidisciplinary team, with representatives numerous from departments including surgical, nursing, pharmacy, engineering and operations. Team members will need to identify many project opportunities, but they must then build a business case for each proposed project, documenting current process inefficiencies and how RFID will be used to address them, as well as the projected return on investment. Then they can assess risk and value to prioritize the projects. This structured, holistic approach, known as project portfolio management (PPM), will enable the hospital to maximize the value of its RFID initiative.

Finally, we can't emphasize enough the importance of education. Learning about RFID technolo-

tion. Learning about RFID technology and the hospital-specific solutions available will enable hospital administrators to decide which system to deploy—there's no reason to reinvent the wheel. What's more, administrators will develop an understanding of how to build on that system to address many other problems.

Harold Boeck and Ygal Bendavid are professors in the school of management at the Université du Québec á Montréal, and members of RFID Academia's research board.



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Join business professionals interested in learning how to benefit from the Internet of Things today. Attendees will hear from companies using IoT technologies to:

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