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## The Internet of Things

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The use of monitoring technology to track objects, appliances, animals, and, yes, even sometimes people is a fact of business for many companies. Using tags, sensors, and chips paired with wireless technology, they're gathering loads of data about the location, status, and other features of objects, ranging from tools needed at a construction site to a patient's whereabouts in a hospital to cars backed up on a highway. Once connected, though, there's the even bigger job of analyzing the information and getting it to the right recipients who can put it to use.

This is the nascent Internet of Things, where wireless networks of objects are being created using RFID, Bluetooth, GPS, and other technologies, working in tandem with cloud computing environments, Web portals, and back-end systems that seek out patterns of activity among the connected objects that promise to help enhance a range of business and other processes.

In theory, there are few things that can't be given a tag or sensor and connected to networks in order to share information. Businesses could then track and monitor just about every product in the supply chain, so inventory stock-outs will be a thing of the past, lost shipments a rarity, and shoplifting nearly impossible. Counterfeit pills would be easier to spot, traffic congestion easier to avoid, and equipment easier to track and keep operating. Getting to this interconnected world, though, takes some effort.

By creating a network of things that have sensors of some kind, "then we have the intelligence to examine patterns and trends that tell us a lot about our business's strengths and flaws -- indeed, about the systems and networks and patterns that exist in all aspects of our world," says Bill Hardgrave, director of the RFID Research Center at the University of Arkansas's Sam M. Walton College of Business.

Putting tags, sensors, or chips on objects requires businesses to decide which things can be monitored in a way that delivers business benefit. To make those decisions, companies must have a clear perspective on what data needs to be generated, who controls that data, and what they hope to deduce from it.

"Connecting the objects calls for companies to figure out a network, not only to collect the data from sensors, but to deliver it where it's needed. That includes deciding which systems, processes, or operations will leverage the data," says Michael Liard, practice director for RFID at market research firm [ABI Research](#).

Producing useful intelligence requires analytics to suss out what's really important from the mass of data collected. This often requires cooperation and planning among different people and organizations that have an interest in the data and the intelligence coming from it -- such as retailers and their suppliers, or doctors and their patients. That way, everyone in the data chain gets what they need in a manner most likely to yield tangible improvements to business.

## Range of Uses

Some applications related to the Internet of Things aren't new: Toll-collection tags, security-access key cards, devices to track stolen cars, and various types of identity tags for retail goods and livestock have been around for decades. More recent applications include embedded animal ID chips, asset management, baggage handling, cargo tracking and security, point-of-sale contactless payment, and real-time locating systems.

As the number of things that are being tracked and monitored has grown, the methods used to proactively pull, cull, and analyze data from objects, as well as derive new insights and solutions from the data, also have matured. More sophisticated tools such as embeddable chips, wireless RFID readers, GPS, and cellular phone technology adapted to tracking are providing new forms of visibility, says Hardgrave, who's also executive director at the University of Arkansas' Information Technology Research Institute.

While none of this tagging, monitoring, tracking, and analysis makes the objects themselves smarter, it does make their status in time and space more visible to those charged with tracking, monitoring, and using them to transact business.

In some cases, the information gathered is a matter of life or death. That's the case for Carol Kasyjanski, who recently received the first wireless pacemaker. It sends data about her heart's performance to her doctors at St. Francis Hospital in Roslyn, N.Y., via a home monitoring system and also provides her with audible alerts if something abnormal occurs. The pacemaker connects via WiFi to a home computer, which links to the doctor's office, where data is downloaded at least once a day. Alerts can be sent any time of day or night, even if Kasyjanski is asleep or otherwise unaware something is amiss.

Other monitoring and tracking systems have more everyday business uses, such as:

- Improving supply chains with tracking capabilities that let a maternity-clothes manufacturer know it should divert a shipment of dresses en route to one store to another that's close to running out
- Solving or averting problems, like sending a cellphone alert to San Francisco drivers that traffic is backed up at a particular exit ramp, and they should plan to use a different ramp
- Increasing efficiencies, such as enabling a utility in Oklahoma City to remotely switch off an electric meter in a just-vacated apartment over IP rather than sending out a truck to do the job

But challenges abound. "There's a big gulf between saying we want to put sensors on roads to count the number of cars that go over them and thereby measure traffic density, and actually doing it," says Ravikanth Pappu, co-founder of ThingMagic. It's not necessarily the technological challenges getting in the way, he says, but rather practical problems like finding the people who know how to embed sensors in roads, figuring out which laws you have to follow, and knowing how to replace a sensor's battery.

Costs are one of the biggest hurdles, especially when the benefits don't show a clear cash return on investment. A couple of years ago, gaming giant Harrah's Entertainment tested RFID-embedded poker chips in some of its 40 casinos. The chips interacted with readers installed under gaming tables in order to let casino managers track winnings with a far greater degree of accuracy than they had been able to before. The trial went well, but Harrah's discovered after discussing implementation plans with several vendors that the cost was prohibitive, a company spokesman says. Harrah's will reconsider the project at a later date, he adds.

But many companies are overcoming problems and successfully creating applications for this new Internet of Things world. What follows is a look at the some examples.

### **Tags Where They Matter Most**

OG&E Electric Services, which provides power to more than 750,000 customers in Oklahoma and Arkansas, last year began a trial in Oklahoma City that put smart electric meters in more than 6,000 apartments. The IP-based hardware and software from smart-grid network provider [Silver Spring Networks](#) can turn power on and off in apartments as tenants come and go, as well as report power outages. OG&E also is testing software-equipped thermostats from startup Greenbox that, combined with real-time alerts to customers and sharing time-of-use pricing with them, could help people lower their energy bills and can cut back on heavy use during peak hours.

Coca-Cola has also developed a beverage dispenser, being tested this summer in California, Georgia, and Utah fast-food restaurants, that will track information about more than 100 different sodas, juices, and flavored waters customers can buy. The drink dispenser, dubbed Freestyle, contains 30 flavor cartridges, each tagged with RFID chips. As customers choose flavors or blend unique combos, an RFID reader in the dispenser captures info about the selections and pushes it over a private wireless network to an SAP data warehouse, which crunches the data to pinpoint regional preferences, gauge the reception of new products, and help fast-food outlets decide which drinks to serve.

### **ENVIRONMENTAL SIDE BENEFITS**

**Better tracking and monitoring of things can have wider benefits beyond the immediate goals of the supply chain or other application involved. Some of these benefits are environmental.**

**Picture an RFID-equipped recycling container that sounds an alert when trash is thrown in that doesn't have the appropriate RFID tags and can't be recycled. Or consider sensing and tracking technologies that maintain perishable products at optimal temperature and humidity levels, alerting personnel via email or cellphone when conditions threaten the products. These systems save companies money by reducing spoilage, and they also can slash waste and conserve fuel.**

**In other cases, making processes more efficient can mean less fossil fuel burned. For example, retailers use automated systems to monitor stock levels that signal when inventory is low, so trucks deliver only to the sites signaling that they need a delivery, resulting in fewer trips.**

**Or there's the company that has always run its refrigerated trucks at a certain temperature, knowing it takes two gallons of gas per hour to run at that temperature, says Bill Hardgrave, director of the RFID Research Center at the University of Arkansas's Sam M. Walton College of Business. The company installs sensors that indicate it can turn up the temperature two degrees without compromising product quality and use a half gallon of gas less per hour, he says, and fuel savings quickly add up.**

The Mobile Millennium Project has thousands of volunteers in the San Francisco Bay Area with GPS-enabled phones on which they've downloaded the project's Java app. Sensors on major roads track the phones as they're driven around and combine data from them with other traffic data to provide participants with traffic information that can help them avoid fuel-wasting traffic tie-ups.

RecycleBank's use of RFID-tagged recycling bins to reward households for recycling has obvious benefits, both environmental and financial: People using the bins are recycling more, landfill deliveries are down, and the amount that cities using the system spend on waste disposal is down, says Rafael Mena, RFID marketing manager at [Texas Instruments Inc.](#) (NYSE: TXN), which developed the technology with RecycleBank. The \$25,000 required to purchase the RFID-tagged bins and outfit a truck with scales to weigh the bins is recouped in savings on landfill disposal fees, he says.



RecycleBank sometimes is criticized for “bribing people to do the right thing,” says chief operating officer Scott Lamb, or even encouraging people to create more waste by giving them points for it. To answer critics, RecycleBank lets people donate the points they earn from recycling to local schools and other causes rather than redeeming them at local stores for more stuff.

The [Mobile Millennium Project](#) , developed by [Nokia Corp.](#) (NYSE: NOK), [Navteq Corp.](#) (NYSE: NVT), the [University of California at Berkeley](#) , and the California and U.S. departments of transportation, melds data culled from thousands of volunteers in Northern California who've downloaded the project's Java application on their GPS-equipped cellphones. As people drive around with the cellphones in their cars, sensors along major routes collect data. The system uses data-sampling technology that makes the GPS-based position information anonymous and aggregates it into a single data stream. It combines the GPS data with traffic-sensor feeds to provide traffic congestion information that's pushed back to the phones, letting

drivers plan their best routes. Google has something similar in the works, trying to get customers with Google Maps for mobile devices to let it collect anonymous data to follow traffic patterns.

RecycleBank works with cities including Hartford, Conn., and Mesa, Ariz., to help them persuade people to recycle more paper, glass, cans, and plastic by offering households points they can redeem at Starbucks, movie theaters, and various local stores. Through a system of RFID-tagged recycling bins affiliated with a specific household, whose contents are weighed aboard specially equipped trucks, consumers rack up the points. Consumers visit RecycleBank's Website to check their point balance and choose rewards.

Tomorrow's Mother -- a maternity clothing maker that has been absorbed into the holding company TM Apparel -- tapped Seeonic for an RFID system to improve visibility into its supply chain. Seeonic incorporated ThingMagic's commercial tag readers into clothing displays it designed with Italian manufacturer Permasteelista. The readers monitor the coming and going of garments from the rack as customers try them on and clerks return them. They track specific characteristics of garments such as size and color and send data back to Seeonic via a cellular link. This data is used to track inventory and buying trends, while ensuring that retailers order the right number of garments to replace ones purchased. Seeonic markets the system as a software-as-a-service offering, with its SightWare hardware and SmartWatch software.

Colden, a workplace safety consulting firm, uses RFID tags on respirators to help industrial clients whose workers are required to wear respirators, to improve compliance and keep better records. As a respirator is checked out, used, and returned, the system tracks which employee has it, when it's due for cleaning, and whether it's been returned to the proper location. The system saves "at least several hours a week compared with a human being looking at each serial number and writing it down by hand," says Chris Wesley, a principal at Colden.

Ford Motor is marketing RFID as a way to help tradespeople and contractors keep from leaving tools behind at work sites. "It could be a \$2,000 signal-strength reader, or a \$3 Phillips-head screwdriver," says Bill Frykman, development manager at Ford Work Solutions. "To the extent that you need it and don't have it, it represents lost dollars and lost productivity."

Tool Link, developed with ThingMagic and toolmaker DeWalt and built into the beds and dashboards of certain Ford trucks, lets customers input all items they would need for particular job, attach RFID tags to that set of tools, and get an alert if they turn the ignition key and one of those tools isn't in the truck when the system scans the interior.

## **What to Connect?**

Companies face many challenges when it comes to building the right network. First, they may mistakenly assume that they know exactly where to capture the most meaningful data along many links of a supply chain or other process.

"It's very cumbersome for most enterprises to identify their supply chain challenges," says Tim Payne, supply chain management research director at Gartner. "Five or six years ago, we said, 'Well, we'll put tags on everything as it passes through the supply chain from one organization to another.' But in reality, when companies have tried that, it's been much harder."

The challenges go beyond just getting a tag on each thing.

Every tagged item must be linked into the network at the right point in a process to deliver information about where the problems are. For example, if one of the respirators that Colden

tracks is under a pile of laundry, there's no way to tell it's there and that it needs cleaning unless it's connected to a network. The thousands of GPS-enabled cellphones used in the Mobile Millennium Project must be turned on in order to send the positioning information needed to play a role in generating real-time traffic data.

This network must be tailored to fit the particular environment. Seeonic chose to transmit updates on TM Apparel's garments to its back-end relational database over a cellphone uplink rather than the Web or a T1 line. The cellphone link was seen as more flexible than the store's data network and less prone to downtime, says Bill James, a VP at Seeonic.

Often, no additions to network infrastructure are required to gather and process instrumented data. Instead of new hardware or software, the real issue, says Tom Nolle, president of CIMI, a consulting firm that specializes in networking products and services, "is how to manage the plethora of data an RFID solution would produce."

### **Practical Insight**

The point at which this Internet of Things yields insight that people can act on varies with the application.

Say you're a U.S. blue jeans designer tracking a shipment of jeans as it leaves a factory in China, 20 pair to an RFID-tagged box, says Bernie Meyerson, VP and chief technologist at [IBM Corp.](#) (NYSE: IBM)'s Systems and Technology Group. Someone in China scans each box using a handheld scanner with a valid IP address and fingerprint recognition to verify its use is legitimate. When the jeans reach their next destination -- the port of Hong Kong, for example -- the boxes are scanned again. At this point, you know that some of the jeans are to be routed to a Paris retailer and some to a store in New York, with which you have agreements to have them there within a week. But then you get a rush order from a rock star in London, so you look up the tracking number on one of the Hong Kong cases containing your celebrity client's size, intercept that case, and have it routed on an overnight flight to Heathrow.

### **REASONS TO BE WARY**

**When it comes to the Internet of Things, there are reasons to be cautious. Even among close partners, the joint generation of value can be difficult to achieve, says Tim Payne, supply chain management research director at [Gartner Inc.](#)**

**Partners may not want to share all data all the time, he says. Retailers, for example, might be willing to share overall sales figures with suppliers but not want to tell them the specific prices of items sold.**

**Tom Nolle, president of consulting firm CIMI, cites concerns about privacy threats as RFID tags get attached to more things and readers find their way into unscrupulous users' hands.**

**RFID offers a potential risk to our privacy that "dwarfs anything else we have ever talked about in technology," Nolle says. "We're nuts to even be thinking about it without stringent protection measures in place."**

**A tag that remains embedded in a pair of jeans or sneakers unbeknownst to the consumer would let anyone with a scanner track that person's every move, Nolle says.**

**"Every reader of RFID tags should be licensed, and the use of a RFID reader in an unlicensed way should be a crime," Nolle says.**

**In the case of Ford Motor's Tool Link -- an RFID-based system that monitors the presence of tools in a truck to prevent them from being inadvertently left behind at work sites -- its developer, ThingMagic, considered that thieves equipped with an RFID reader might cruise around looking for trucks with valuable tools inside. As a result, the system is designed to only work at very close range. Someone using a reader can't tell that you have any tools in the truck "until they're close enough to look into the bed," says ThingMagic co-founder Ravikanth Pappu. And even if a potential thief were to get close enough to scan the tags on the tools, they'd just get a bunch of numbers, with no usable information.**

**Then there's also the fact that systems for supply chain monitoring and asset tracking aren't invincible. Scanner abuse is possible, says Bernie Meyerson, VP and chief technologist at IBM's Systems and Technology Group. An opportunist, he says, might "forget" to wave a reader at every fifth box in a long line of boxes being loaded onto a cargo ship, and position himself to skim a few garments every few minutes.**

This sort of data sharing and intelligence generation is being used across a variety of industries with an eye toward yielding new layers of information.

The orthopedic unit of the Greenville Hospital System University Medical Center in Greenville, S.C., for instance, is working with Integrated Business Systems and Services, which makes security management tools, to bring an RFID-based patient-tracking system online. When a patient arrives for surgery, an RFID active tag containing a unique ID number is clipped to his or her hospital gown at check-in. Data is collected from this tag every time the patient moves through the hospital by readers positioned in all rooms that patients occupy. That data is sent to the patient's hospital record, letting administrators track the person's progress and also measure the efficiency of the services delivered, says George Mendenhall, IBSS's president and CEO. Families can track the progress of the patient, from pre-op to the operating table to recovery, by checking the patient's identifying number on monitors around the hospital.

Greenville's system stays within HIPAA privacy rules by never revealing patient names, Mendenhall says. Only the ID number is used to track patients. In addition to the RFID tag clipped to their gowns, patients wear standard plastic hospital wristbands with personal identification information.

Golden State Medical Supply, a contract manufacturer, wholesaler, and distributor of pharmaceuticals whose clients include the U.S. Department of Veterans Affairs, is developing a



tracking solution that aims to curb drug counterfeiting. RFID tags embedded in plastic pill bottles indicate where the contents were made, lot number, its National Drug Code, and other information. They're read at every stop the pill bottle makes from the time it's manufactured to the point it arrives full of pills at a pharmacy. Of course, for this to work, pharmacies will have to install their own RFID readers.

Consumers and pharmacists would be the ultimate beneficiaries of all the intelligence gathered along the way, says Jim Stroud, president and CEO at Golden State. They'll be able to put a bottle under an in-store scanner, and "know who exactly possessed that bottle from the time it was manufactured."

## **Share the Data**

The Internet of Things' very existence is predicated on the notion that information can and should be shared by connected online organizations with a vested interest in keeping tabs on the things they're charged with tracking, be they screwdrivers, blue jeans, or hospital patients.

One of the biggest hurdles to creating such networks is that all organizations that handle a product have to be willing to share information, says the Information Technology Research Institute's Hardgrave. "It's one of those things where you have to have a level of faith that your partners are going to do the right thing and reciprocate with you by sharing it," he says.

Data sharing happens in any number of ways, including using Web portals and extranets to provide information to approved partners.

Coke is doing that with data generated by its Freestyle drink dispensers. Fast-food outlets leasing the machines will be able to view graphical drink consumption reports -- such as ones that rank drinks sold during specific time periods -- on an e-business portal Coke has set up. The system also keeps track of flavor cartridge capacity and alerts outlets when to order more.



Coke's new drink dispensers are data dispensers, too

Seonic makes the data about TM Apparel's clothing available on a Web portal. The manufacturer can view inventory at each store, taking steps to replenish or reroute incoming garments. The whole goal "is to be able to predict and analyze," says Seonic's James.

Seonic also works with manufacturers to improve the success of promotions. Its software can be used to track the course of a product as it moves (or doesn't move) through a retail store. A manufacturer in the middle of a major product promotion can monitor this data to see if retailers are moving product displays to store floors at the correct time in the promotion schedule. They



also can check whether shelves are being restocked as products are sold, and that retailers have sufficient stock to meet future demand.

In more complex situations, tracking and monitoring systems are collecting massive amounts of raw data to actually operate machines and processes. In these cases, IBM's Meyerson says "stream processing" can be used to run data from thousands of sources through a set of decision trees to best direct a storm drain, beer keg, or other object to behave in a certain way or to be routed in a certain direction. With this kind of computing power at our disposal, response times end up being measured in seconds rather than days, weeks, or months, he says.

### **The Final Answer**

Getting things connected and generating data via the Internet of Things is more than just a technology challenge, Meyerson says. It requires imagination and planning, But if an organization has the business goals clear and the data-sharing issues resolved, Meyerson says that concerns about technology shouldn't hold it back.

The challenges come in choosing the appropriate tools from all that's available, deciding what to connect, and devising a means of drawing meaningful conclusions from that data. It's still an emerging business technology strategy, one that a whole cadre of vendors, systems integrators, and others are trying to build the right business systems around for collecting, managing, and distributing information -- from Texas Instruments' array of RFID tags to Seeonic's SaaS version of its asset-tracking product.

Ultimately, as Gartner's Payne points out, the best way to decide if a company needs to build its own Internet of Things is to decide if it answers vexing questions that are holding back the business, such as: "I now know my shipment is delayed by two days. Should I panic, or should I say, no big deal? The data will only tell you it's two days late," Payne says. "It won't tell you how big a problem that is." Start pulling in information about the shipment's size, its intended destination, the relative importance of that customer, the expected profit, and other factors, and a much more valuable answer is more likely to emerge, Payne says.

Your own Internet of Things, implemented well, could help pull more of that disparate information together.

*As seen here: [http://www.internetevolution.com/document.asp?doc\\_id=181268&page\\_number=1](http://www.internetevolution.com/document.asp?doc_id=181268&page_number=1)  
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