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RFID FOR DUMMIES®

by Patrick J. Sweeney II

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About the Author

As you may have guessed by the dangling participles and misused gerunds, this is the first book by **Patrick J. Sweeney II** (despite Amazon's link to books on gynecology by an author of the same name). When not negotiating with his editor to push back book deadlines, he leads ODIN technologies as President and CEO.

ODIN technologies is a global RFID software and services company focusing on RFID infrastructure. Mr. Sweeney is well recognized as a visionary in the RFID industry with several RFID patents in various stages of approval. He has appeared in such publications as *CIO Magazine, The Washington Post, Fortune* magazine, *Internet Week,* and many others. He has been interviewed by ABC news and CNN, among others, and is a frequent speaker worldwide on all topics relating to RFID. He is also an active member of several standards bodies and regulatory groups helping to shape the evolution of the RFID industry.

Mr. Sweeney is a second-generation IT professional; his father was one of the first employees at Electronic Data Systems (EDS), where "Pops" entertained him and his brother on weekends by teaching them to read punch cards and other useful skills. Mr. Sweeney took that genetic proclivity toward data centers and started a successful, secure managed hosting company in the late 1990s, which he later sold. His brother took that same early training and started XS Speed Choppers, making custom motorcycles — go figure.

Mr. Sweeney finished second in the 1996 Olympic trials in the single scull, is an avid outdoorsman, enjoys helping other entrepreneurs, and is passionate about various Irish causes. He is a board member of Trinity College business school in Dublin, Ireland, and an Alumni Board member at the Darden School of Business at the University of Virginia. He graduated from Darden and received a Bachelor of Science degree from the University of New Hampshire. He is blessed with a great family—wife Christen, daughter Shannon, son P.J., and three dogs. They live in Middleburg, Virginia, in a house full of useless RFID gadgets.

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Dedication

This book is dedicated to everyone who makes the dream of entrepreneurship and innovation possible, from the brave men and women defending our freedom in the armed forces, police, and fire departments to college professors, mentors, and angel investors.

Topping the list of people who make entrepreneurship (and crazy book projects) possible are loving, understanding, and helpful spouses like mine. This book is especially dedicated to my beautiful wife Christen, who helps and supports me as I build companies, write books, and travel around the world chasing birds and the Red Sox.

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Earl Cox
Scianta Intelligence
www.scianta.com
www.autoidlabsus.org

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Daniel Engels, Ph.D.
Robert Goodman
Yankee Group
www.yankee.com

Pat King, Ph.D.
Bob Brescia
Michelin US
www.michelin.com

Sharyn Leaver
Forrester
www.forrester.com

Chris Fennig
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Acquisitions Editor: Melody Layne

Copy Editor: Andy Hollandbeck

Technical Editor: Christopher Bratten

Editorial Manager: Leah P. Cameron

Media Development Manager: Laura VanWinkle

Media Development Supervisor: Richard Graves

Editorial Assistant: Amanda Foxworth

Cartoons: Rich Tennant, www.the5thwave.com

Composition Services

Project Coordinators: Adrienne Martinez, Emily Wichlinski

Layout and Graphics: Carl Byers, Andrea Dahl, Lauren Goddard, Denny Hager, Joyce Haughey, Lynsey Osborn, Melanee Prendergast

Proofreaders: Laura Albert, Leeann Harney, Jessica Kramer, Linda Morris, Carl William Pierce

Indexer: TECHBOOKS Production Services

Special Help: Kim Darosett, Teresa Artman

Publishing and Editorial for Technology Dummies

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Andy Cummings, Vice President and Publisher

Mary Bednarek, Executive Acquisitions Director

Mary C. Corder, Editorial Director

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The reader not only generates the signal that goes out through the antenna into space, but also *listens* for a response from the tag. The RFID reader is like a high-tech Morse code machine, but instead of the dots and dashes the Lone Ranger might have listened in on, the RFID reader transmits and receives analog waves and then turns them into a string of zeros and ones, bits of digital information.

Each reader is connected to one or more antennas. The three components, the reader, and the antenna are shown in Figure 1-1 and Figure 1-2. Figure 1-1 shows an Alien reader with Alien Class 1 tags (more on tag classes in Chapter 2) and Figure 1-2 shows a Matrics/Symbol reader with antenna and Class 0 tags. To put their size in perspective, the grid is made up of 12-x-12-inch squares. The antennas are a science all their own (see Chapters 4 and 5 for more details), but the important thing to know is that the reader creates the electromagnetic signal and the antenna broadcasts it into a specific interrogation zone. The interrogation zone is a radio frequency field that can be thought of as a giant bubble coming off of the antenna.

The tag

If the reader transmits a signal out into space (and space can be the distance from one side of a dock door to the other), what is out there transmitting back? The answer of course is the tag.

An RFID tag is made up of two basic parts: the chip, or integrated circuit, and the antenna. The chip is a tiny computer that stores a series of numbers unique to that chip. The chip also has the logic to tell itself what to do when it is in front of a reader. The antenna enables the chip to receive power and communicate, enabling the RFID tag to exchange data with the reader.

Some tags are *active tags* because a battery powers their communication. Most of the tags produced today are *passive tags.* This means that the only time they communicate is when they are in the close presence of a reader. Being in the presence of a reader means that they are sitting in an electromagnetic field. When a passive tag enters an electric or magnetic field, the tag draws enough energy from that field to power itself and broadcast its information.

The type of communication that allows this exchange to happen is called *backscatter.* The reader sends out an electromagnetic wave at one specific frequency. That wave hits the RFID tag, and the tag then "scatters back" a wave at a different frequency with the chip's information encoded in those backscatter waves. I explain how tags work with readers in more detail in Chapter 5.

Frequency

Both the tags and the readers operate over a specific frequency. Think of them as what they really are: radios that have their own very specific stations on which they can talk and listen. So in a way, the tags are tuned into the readers, just as your car radio is tuned into that hip-hop station.

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Here are some tips for creating configuration files:

- Store the reader configuration file in a secured database that has limited access.
- Develop the configuration file in a program that can interoperate with any open database connectivity (ODBC) database because many monitoring, management, and middleware programs may end up accessing the configuration files.
- Make sure you fully back up your configuration files to tape or disc once a month, and do incremental back-ups at least weekly, but preferably daily. Daily incremental back-ups are particularly important as you build out your network and as things change daily.

Getting the Digits

One of the biggest benefits of RFID over bar codes is the capability to uniquely number every item. Typically, you encode this number into each tag just before applying the tags to objects.

Most of the deployments I have set up so far encode tags with an RFID label printer. Zebra, Printronix, and Paxar bar code printers can have an RFID module embedded in them that allows them to work as both an RFID label printer and also as traditional bar code printer. The module broadcasts a special command with a discrete number (usually an EPC number) through the transmit (Tx) antenna, and that number is "written" onto the tag. Some of the deployments have used the readers to directly commission (write to) the tags. The operation is always controlled by some form of software — see Chapter 11 for more about the issues surrounding middleware features. Whether you use an RFID label printer or write to the tags directly through the readers, the technical aspect of sending a specific RF signal out the antenna with a write command is always the same.

Unique item identification has tremendous benefits, but assigning and managing unique item-level identification can be burdensome and difficult if not done properly. Having a numbering structure and a system for assigning numbers can simplify the allocation and management of unique numbers. The following sections explain proven methods for managing numbers.

A simple hierarchy for assigning numbers

All numbering schemes in use — whether for open RFID systems, such as the ones that enable retailers and suppliers to share information, or for closed systems, like the ones libraries use — rely on some sort of numbering hierarchy. All you need to do is understand the hierarchy so that you can use it to your advantage in assigning unique identifiers to all your items.

The general identifier of the electronic product code (EPC) is a good example: The general identifier EPC comprises three numbers whose combination uniquely identifies an item. Those three numbers are the manufacturer number, the product number, and the serial number. EPCglobal, the manager of the general identifier EPC, assigns a unique manufacturer number (also called an EPC Manager Number) to each of its member organizations. Each member organization is free to assign a product number (also called an Object Class) to each of that member's products. Similarly, each member is free to assign a serial number to each item manufactured by that member. Here's how you might take advantage of this hierarchy to uniquely identify an item:

- **Assign the same product number to all products with the same properties.** Thus, all 16-ounce blue bottles of Fabulous Fiber are assigned the same product number. All 24-ounce bottles are allocated a different product number. This is the basic approach used today by most product manufacturers.
- **Assign each item in a product line a unique serial number.** In this way, you can distinguish one 16-ounce blue bottle of Fabulous Fiber from another bottle just like it.

Serial numbers are new to the fast-moving consumer goods market, but they have been in wide use in the electronics, automotive, and aerospace industries, among others, for a very long time.

Allocating unique numbers across many lines and locations

Because all products of the same type receive the same product number, the serial numbers must be maintained in order to enable unique item identification. When a product is manufactured on exactly one production line at exactly one location, assigning unique serial numbers to every item manufactured is straightforward. A central numbering allocation authority may be used. Difficulties arise when multiple lines, potentially at multiple locations, are used to manufacture the same product.

When multiple manufacturing lines are used to manufacture the same product, a centralized numbering authority is more difficult to manage. The centralized authority must be consulted every time an item is produced, requiring that it be accessible over the network whenever production runs are in process. A centralized authority that is always reachable and is able to assign numbers at production speeds can efficiently use the numbering space. Additionally, careful details must also be maintained about which line an item was produced on.

An always-accessible central numbering authority isn't practical for many companies. These companies can use an intelligent hierarchy imposed on the serial number allocation to decentralize and make feasible the allocation of unique serial numbers across all manufacturing lines.

Here's a simple example of a decentralized, hierarchical approach to allocating serial numbers. A range of serial numbers for each product is allocated to each manufacturing facility. Within a facility, a range of numbers from those allocated to the facility is allocated to each line producing a particular product. In this way, the serial number is effectively subdivided into a facility number, line number, and subserial number, in which the allocation hierarchy is maintained between facility number and line number.

Remember to assign a line number for hand-applied tags that replace damaged or nonfunctioning tags. You need to look at your business processes to determine the best way to incorporate this.

Applying Tags to Objects

Eventually, all tags will be placed on products automatically, either on the packaging prior to receiving it or on-line within your facility. Until then, tags need to be manually placed on items.

When you apply tags to objects (or train staff to do so), you need to keep two important factors in mind:

- **Be sure you handle tags in a way that doesn't put stress on the tag's connections and parts.** Broken tags don't communicate well (if at all) and thus make your system less effective. See the sidebar, "Armor-plated tags," for details on emerging solutions to these vulnerabilities.
- **Place the tag in the optimal spot on the object.** During your testing (see Part III), you determine where the tag antenna can best couple (communicate) with the reader antenna. Some of the early adopters have already started printing tag outlines on their case boxes so that workers applying them know exactly where the tag goes and what the correct orientation is.

The following sections explain how you can work around these two factors as you apply the tags.

Applying tags without breaking them

Manually manipulating tags always has the potential hazard of physically damaging them. You can minimize the physical stress placed upon the tags by always following these steps when applying tags by hand:

1. **Place the label face down on a flat surface with the backing paper face up; the face of the label is therefore down on the table or flat surface.**
2. **Peel the backing paper away from the label while keeping the label flat on the surface.**

SML Exhibit 1013