Chapter 1

Taking the Mystery out of RFID

In This Chapter

- Discovering RFID
- Getting a handle on the technology
- Figuring out what you need to know
- Knowing what to expect in the future

With all the recent hype over radio frequency identification (RFID) and the requirements to implement it, you might think that RFID can turn water into wine, transform lead into gold, and cure the world's diseases. You might also be worried that RFID will enable Big Brother to track your movements to within a foot of your location from a satellite five hundred miles up in space. The truth is, RFID can do none of these things.

In this chapter, you find out the basics of what RFID is, what forces are driving RFID as a replacement for the bar code in the marketplace, and what benefits RFID can offer.

If you are responsible for complying with high-profile mandates from one of your suppliers or customers, this chapter also offers a framework to help you begin setting up a system and making it work within your existing business process. The bad news is that an RFID implementation is a daunting project even at a minimal compliance level, sometimes referred to as *slap and ship* or, more appropriately, *tag and ship.* The good news is that the benefits to the business are substantial, particularly if your trading partners are involved. RFID technology is here to stay, so the sooner you understand it, the quicker you can make key strategic decisions for your company.

What Is RFID?

RFID is a very valuable business and technology tool. It holds the promise of replacing existing identification technologies like the bar code. RFID offers strategic advantages for businesses because it can track inventory in the supply chain more efficiently, provide real-time in-transit visibility (ITV), and monitor general enterprise assets. The more RFID is in the news, the more

creative people are about its potential applications. For example, I recently heard from someone who wanted to use RFID to track fishing nets in the North Sea.

The origins of RFID in inventory tracking

Wal-Mart has spent millions of dollars since the late 1990s researching the efficacy of RFID systems to replace bar codes (which have been in use since the days of *The Brady Bunch* and *Gilligan's Island* — that's the early 1970s, for those of you with all your hair left).

In 1999, with the help of scientists at the Massachusetts Institute of Technology (MIT), a consortium of companies formed the Auto-ID Center — a center for continued research into the nature and use of radio frequency identification. The consortium had a new idea about how organizations could identify and track their assets. The vision underlying automatic identification (or Auto-ID) is the creation of an "Internet of Objects." In such a highly connected network, devices dispersed through an enterprise can talk to each other — providing real-time information about the location, contents, destination, and ambient conditions of assets. This communication allows much-sought-after machine-to-machine communication and decision-making, rendering humans unnecessary and mistakes a thing of the past.

Today, Auto-ID can track not only enterprise assets, but also the movement of products, containers, vehicles, and other assets across vast geographic areas. For more about the Auto-ID Center and the current organizations involved in developing RFID technology, see Chapter 2.

Tracking goods with EPC codes

RFID is actually nothing new. Just as goods today have bar codes, goods in RFID systems have codes that enable systems to share information. Because the mandated RFID systems require businesses to share information with each other, the different systems need to use the same code — the electronic product code (EPC). The EPC is the individual number associated with an RFID tag or chip.

The EPC was developed at MIT's Auto-ID Center in 2000 and is a modern-day replacement for the Universal Product Code (UPC). A tag's embedded EPC number is unique to that tag. However, the EPC *protocol* is universal to all EPC-compliant systems and serves two specific functions:

- Telling how data is to be segregated and stored on the tag, or what is also known as the *numbering scheme*.
- Determining how the tags and readers communicate (also called the *air interface protocol*).

Wal-Mart, like other large retailers, had more pragmatic issues at hand when they established an RFID requirement for their suppliers. Under Wal-Mart's mandate, each supplier is required to identify their products not by bar codes and waybills, but through EPCs that are automatically broadcast by RFID tags as new products arrive at the retailer's warehouse, distribution center, or store. In Chapter 2, I explain how EPC works in more detail.

Sizing Up the Benefits of RFID

Capturing inventory as it arrives from the supplier is the first step in a company-wide tracking system that "knows" where every item is throughout its lifetime in the store. This tracking offers retailers tremendous insight into their inventory, which enables those retailers to control costs and reduce investment on inventory, which means lower prices and better competition for consumers.

Having better information about inventory offers retailers all sorts of potential benefits. The retailers know how much inventory is still on pallets in the warehouse, how much is on its way to distribution centers and stores, and how much is currently on the shelves in each of its stores. With this knowledge, retailers have the foundation for measuring product consumption, seeing buying patterns, and controlling inventory more efficiently. Through this process, a retailer ensures that its shelves are stocked and that customers can buy high-volume products (such as razor blades, diapers, and toilet paper) when they need them and in the quantity they need.

Of course, businesses don't spend money unless they expect to make money off that investment. Major retailers believe that a comprehensive RFID program — tying suppliers to inventories to retail outlet shelf stock — will generate savings of around 10 to 16 percent, based simply on inventory cost reduction in each of their distribution centers (DCs). This translates into billions of dollars in savings each year — a pretty impressive result by any measure. The benefits can extend to other applications beyond retailers: Third-party logistics companies can speed up their billing cycle and create a new revenue stream with RFID; government agencies can reduce loss and increase security; museums can reduce cost to conduct inventory; sports teams can increase sales at games — the applications are limitless.

In an RFID system that uses an electronic product code (EPC) or similar numbering scheme, the following RFID attributes lead to those kinds of savings:

- **Serialized data:** Every object in the supply chain has a unique identifying number.
- **Reduced human intervention:** RFID allows tracking automatically without needing people to count or capture data or scan bar codes, which means reduced labor costs and fewer errors.

- **Higher throughput supply chains:** RFID allows many items to be counted simultaneously.
- **Real-time information flow:** As soon as an item changes state (off the shelf, out of a truck, sold to customer), the information can be updated across the supply chain.
- **Increased item security:** Tagging items allows them to be tracked inside a confined facility or space.

In the following sections, I explain each of these benefits in more detail. In Chapter 2, I compare RFID to other auto-identification technologies, like the bar code, and offer tips for developing an overall Auto-ID strategy so that you see how you might apply RFID's benefits to your own business.

Obviously, there is a genuine reason for the excitement surrounding RFID and the EPC. People are anxious to implement the technology so they can track supplies from the factory to the foxhole, or from the grower to the grocer. Much like the excitement surrounding the Internet, RFID carries the promise of a very disruptive technology with substantial future rewards. The excitement (dare I say *hype?*) needs to be tempered by the real-world limitations of the technology and the laws of physics. Adding to the practical limitations of today's RFID technology is a deluge of misinformation and broken promises. Today's marketplace dynamic is the cause of much of this RFID heartache. I introduce a well-balanced approach to RFID in "Finding Success with Four Ps in a Pod," later in this chapter, to make sure that you stay on an even keel and take a pragmatic, process-driven approach to the technology.

Tracking individual items with serialized data

Serialized data means that each item has its own unique identifier or serial number. This helps an enterprise

- **Keep very accurate account of each item in the supply chain or property list.** Instead of knowing that there are 1,000 boxes of Cap'n Crunch (get it? *serialized* data) in the back room, a grocer knows which box has been sold and which one has been sitting there for a long time.
- **Know which item was produced where, in companies that produce the same item at multiple plants.** This is critical for tracking total quality, aiding in recalls, verifying warranties, and so on.
- **Prevent counterfeiting and diversion.** Serialized data allows items such as high-cost drugs to travel through a supply chain while recording every stop they make.

The benefit of serialized data is better inventory control, reduced loss, reduced carrying cost, and improved customer satisfaction (customers at every level, not just walk-in-off-the-street Joe Brown). Each of these advantages over the existing system has a benefit of reducing cost and improving productivity (another way of saying the same thing!).

RFID tracks individual items by associating the unique EPC number to a secure database. This concept is often likened to license plates. Just like the DMV knows who owns a car by looking up the license plate number on a central server, an RFID system can pull up a limitless amount of information about a tag based on its unique identifier.

In some instances, particularly with active tags, the RFID tag allows all the critical information to be stored directly to the tag. No need to look to a database — all the info is right on the tag. This technology can be very useful in instances such as the shipment of military supplies to overseas theaters, where accessing a central database is nearly impossible.

Reducing human intervention

Thousands of applications require humans to scan an object with a bar code scanner or read information on a label. When you check out at the supermarket, the checker has to pass each item in your cart over the lasers that scan the bar codes. RFID technology has the potential to eliminate this human intervention. If all your groceries had RFID tags, you could walk straight out the door and have all the items in your basket read automatically as you passed by a portal, with no need to take things out and scan them.

Think about cases of items coming off of a tractor trailer into a distribution center. Today, someone scans each box one at a time with a bar code scanner and often sticks a label on the box as it leaves the truck. From a logistics perspective, RFID can automatically verify a shipment, optimize cross-docking and flow of goods, and automate much of the pick-and-stow functions. With RFID, things can move off the truck by the pallet-load. Hundreds of items can be read simultaneously, and the data can immediately hit the inventory system as being on-site, identifying what it is, where it came from, where it's going, and so on.

The benefit of having fewer human hands involved is reduced errors, which produces reduced costs, faster throughput, and reduced damage and returns. The overall implication of reduced human intervention, given the high cost of salaries, benefits, and the cost of management associated with crews of human workers, is a dramatic reduction in operating costs.

Automated toll systems are a prime example of how the lack of human intervention saves both time and money. Remember how long the lines at highway tollbooths used to be? This was especially annoying if your daily commute

was on a toll road. With automated toll systems (made possible by RFID), no longer does a car have to stop to hand cash to an exhaust-inhaling person stuffed in a 2-x-3-foot box all day. Zoom by and smile. Less traffic, lower cost, elimination of a hazardous job. Thank you RFID!

Moving more goods through the supply chain

Supply chains that can move more goods (also called *higher throughput supply chains*) reduce processing time, which leads to reduced costs, higher turnaround for billing customers, improved cash flow, a better bottom line, and, of course, reduced error rates, which also contribute to improved customer service. This leads to better customer retention, higher sales, and an increase in profitability and throughput performance.

Before RFID systems became a viable Auto-ID technology, systems with high-volume throughput (airline luggage handling, package delivery, road race participants) all had to be read one item at a time because a bar code scanner can read only one bar code at a time. Whenever only one item is read at a time (manually or with a bar code), the maximum throughput is — you guessed it — one.

Entire systems were designed around processing *one* as quickly as possible. Fred Smith, the CEO of FedEx, spent millions trying to figure out how to collect one package at a time and read it in the shortest amount of time as it goes down a very high-speed conveyor. That was the design goal of systems that required optimization of a one-at-a-time bottleneck.

RFID changes all that by allowing a whole bundle of packages, a trailer of luggage, or tens of runners to be read all at once, greatly increasing throughput. With RFID, you can read hundreds of objects all nearly simultaneously. No longer will systems be designed to optimize the speed of *one;* rather, they will be designed using the laws of physics to maximize the number of simultaneous reads.

Capturing information in real time

Real-time information can help you reduce costs, improve sales, increase cash flow, allow for specialized servicing and manufacturing for top customers, and thus capture a larger market share and improve overall capitalization per client and per employee. Because you know, in real time, where everything is, you can deliver on promises, reduce errors, increase customer loyalty, reduce waste, optimize materials use, and directly impact the tactical (departmental) and strategic (corporate and division-level) bottom line.

If time is money, information is insurance. What is on a store shelf, off the shelves, selling well, about to spoil, running low in back, and missing is all critical information to a retailer, producer, or supplier.

An RFID system can also allow machine-to-machine communication and automated decision-making. Automated decision-making is based on two principles of RFID: lack of human intervention and real-time information flows. In real time, a conveyor can close a gate and route a package at 600 feet per minute from one line to another line all because it reads the data off an RFID tag and retrieves a command specific to that individual item (it's that serialized data benefit again).

Increasing security

RFID's increased security means improved delivery and control and increased anti-counterfeit measures, as well as theft reduction, which leads to a significant reduction in costs.

If you are responsible for the tracking and accounting of property items, or if shrinkage to you is more than what happens when you jump into that frigid Cape Cod Bay, RFID is a dream come true. (*Shrinkage* in an inventory sense is the loss or theft of items in the supply chain.) The ability to permanently affix a tag to every item of value in a location and know exactly where that item is at all times as it passes through various doorways is something no other technology can offer. From a security perspective, RFID's ability to track and trace property can help everything from the war on terrorism to anti-fraud and anti-counterfeit measures. Here are some examples:

- The pharmaceutical industry not only deals with fake drugs being passed off as the real deal, but is fighting a multibillion-dollar issue of *diversion*. Drugs have different price scales for different buyers. Distributors know who pays less for drugs — like hospitals and nursing homes — and some less-than-upstanding distributors take advantage of these price differences to illegally turn a profit. See Chapter 6 for more details.
- *Gray market* items (items that are made in the same plants or with the same markings as a real product but sold much cheaper on the black market) are another problem easily solved with RFID: Embed a chip in every Fendi bag and you'll be able to tell the fake ones sold on the street from the real ones sold at Neiman Marcus without waiting for the faux leather to fade.
- The federal government just wishes they had tagged the assets at Los Alamos and other sensitive facilities. You can track assets with RFID by, for example, triggering an alarm to sound and a camera to take a picture when tagged assets pass through a doorway. RFID allows all these things and more to happen automatically.

Mandates, Womendates, Blind Dates — Forcing Efficiency

In June of 2003, when Linda Dillman, Chief Information Officer (CIO) for Wal-Mart, announced to the world that Wal-Mart would require all suppliers to put RFID tags on every case and pallet that entered a Wal-Mart distribution center or store, the technology world as we knew it changed forever. This was the first of several high-profile mandates that rocked the retail and technology world and catapulted a new industry to be coined "the next big thing."

What are the major mandates?

This section gives you a rundown of the major mandates that are driving RFID implementation.

Wal-Mart

The Wal-Mart mandate detailed a plan for its top 100 suppliers to ship certain RFID-tagged items to distribution centers and stores in and around Sanger, Texas, by January 2005. Wal-Mart encouraged and engaged many other suppliers to participate — 137 in all. From that portentous announcement in June 2003, the press, the privacy advocates, and the competition began to emerge. The analysts quickly began to claim that RFID will be much bigger than Y2K and that Wal-Mart will become Big Brother and track everything everywhere. Sensationalism in the press took every angle from market size to predictions of failure. But no matter what angle they took, it was clear that the first stone was cast.

The U.S. Department of Defense

In the late summer of 2003, rumors of high-level U.S. Department of Defense (DoD) personnel making regular trips to Bentonville, Arkansas, began circulating in the RFID community. Rumors turned to rumblings when the DoD's Office of Automatic Identification Technology (AIT) began meetings with the various branches looking for information about existing RFID programs, the use of contact memory buttons, and where bar codes might be replaced and optimized by passive RFID tags. Although DoD was also an early member of the Auto-ID Center, the DoD was clearly going to use Wal-Mart's research and development efforts and early momentum to bring its own mandate to the world.

The DoD has always been a technology innovator through such groups as the Defense Advanced Research Projects Agency (DARPA) and others, but the technology impact has been mostly within its own secluded world. Demanding an RFID mandate of their 40,000 suppliers seemed like an unprecedented

move — a move which had the potential to dwarf the impact of Wal-Mart's announcement in the technology and supplier world and guarantee the future of a fledgling RFID industry.

That announcement came in October of 2003, when Michael Wynne, Acting Under Secretary of Defense for Acquisition, Technology, and Logistics, released a policy paper spelling out a passive RFID program for all 40,000 DoD suppliers. When details were finally released in July of 2004, the policy turned out to be a near carbon copy of Wal-Mart's mandate. Cases and pallets going into two DoD distribution facilities — Susquehanna, Pennsylvania, and San Joaquin, California — are required to have passive UHF RFID tags with an EPC number or specific military number embedded on the tag.

Target

At about the same time the DoD announcement came out, another one of the most successful retailers in the United States, Target Corporation, announced its plans to keep up with Wal-Mart and require its suppliers to adopt RFID as well. Details of Target's mandate came out in August 2004, when the company called many of its suppliers to a meeting in the Minneapolis headquarters. The company took an intelligent approach to dealing with suppliers by making its mandate specific to a distribution center in Tyler, Texas. Target was also looking for suppliers that were already underway with Wal-Mart to participate in its early pilot, scheduled for a handful of suppliers in January 2005. The top suppliers to Target have until June 2005 to become compliant, allowing Target to stay a close follower to Wal-Mart, while learning from many of Wal-Mart's early mistakes.

Other mandates

Other mandates came along from the grocery store chain Albertsons, European companies Metro AG and Tesco, and (in a significant validation for the consumer products world) electronics superstore Best Buy. With many common suppliers in every industry deploying RFID, it is only a matter of time before other industry powerhouses like Home Depot, Lowes, Staples, and others follow suit.

Responding to the mandates

Mandates are similar to blind dates for many suppliers: The retailers say that RFID could be the perfect match, and that they're committed to seeing it through, but most of the suppliers haven't a clue what the outcome will be. As I write this book, suppliers have shown a range of responses:

- **Love at first site:** Some suppliers are already planning to adopt RFID deeply into their enterprise. Many industry pioneers have taken this approach. Gillette, Kimberly Clark, Procter & Gamble, Orco Construction

Supply, GTSI, and others have moved aggressively to gain a competitive advantage by incorporating RFID fully into their systems. These are the folks who are going to get an early — and potentially insurmountable — strategic advantage from the technology, in much the same way as FedEx crushed the U.S. Postal Service in overnight delivery by incorporating supply-chain optimization and technology into a delivery service. The Postal Service has never recovered. The companies investing heavily and working through the learning curve quickly have the potential to leave their competitors in the dust.

- **The cautious approach:** These suppliers are doing the minimal amount to get by until they discover more about the technology. This is a risk-aversion approach that doesn't lead to a big strategic advantage, but it also enables these companies to learn about the technology a bite at a time and not make any big mistakes in implementation — lower risk and lower reward.
- **The naysayers:** A small percentage of suppliers are doing nothing and will accept whatever penalties companies like Wal-Mart assess to noncompliant suppliers. These are the folks who, if they are in a competitive industry, are most at risk. Remember Eastern Airlines, and Digital Equipment Company? All once-successful companies that died because they failed to innovate. RFID represents a classic case of innovation advantage for early adopters and margin-eroding competitive pressure for naysayers.

Many folks may see a mandate as a powerful customer forcing new technology on a powerless client, and in some cases that is certainly the truth. The DoD, however, is a notable exception. According to analysts within the DoD's AIT group, the average payment cycle for a DoD supplier is 45 days from DoD receiving a shipment to a check being sent out to the supplier. With RFID-enabled shipments, DoD is committed to getting the payment down to 72 *hours.* The $60,000 question is when that efficiency will be in the system. My guess is that payment cycles will approach less than a week within four years.

Calling All Physicists! Calling All Physicists!

Over the past ten years, enough graduates have matriculated with a degree in physics to fill a few sets of New York City subway cars. Compare this with the number who have graduated with degrees in Engineering or Business Administration, which could fill up the entire island of Manhattan.

Why should you care about what Junior decided to study once he was out of high school? After all, the tuition is the same for basket weaving or applied physics, right? You need to know this because a jungle full of 800-pound

gorillas in blue, monogrammed, smiley-face-adorned smocks are insisting that you need to use a technology you hadn't even heard of a year ago. The bottom line is that you're going to need help. You need a physicist.

Finding a physics expert

The marketplace dynamics of RFID are starkly different from the Internet, the word processor, the telephone, and other disruptive technologies of recent memory. In most other instances, invention, understanding, experimentation, and eventually adoption flowed naturally. Not so with RFID. Tens of thousands of enterprises are being forced to go from oblivion to adoption. This accelerated implementation creates a tremendous opportunity for the handful of folks out there who understand and can work with radio frequency technology. However, much like the carpetbagging that went on after the Civil War, it has opened the door for opportunists to try for a quick buck. And without many RFID experts in the world, you need the ability to distinguish the true experts from those who claim to be.

When you look for an expert to help with an RFID deployment, you can easily vet out the technology charlatans by having a little bit of knowledge and knowing the right questions to ask.

Because you're smarter than the average bear and bought *RFID For Dummies,* you'll at least know what you're in for and will eventually be able to choose a partner who can provide you accurate information and accurate help. Alternatively, brave warrior of RFID, I arm you with enough information to take on this mighty task yourself. Either way, to get you started, you need to understand something about the physics yourself.

The basic physics of RFID

In essence, an RFID system is just a reader and a tag communicating over the air at a certain frequency, like any other radio communication. The readers, antennas, tags, and frequency make up the basics of an RFID system, and the following sections give you an overview of how they work. Understanding some of the nuances behind the system as your company wades into the choppy waters of RFID can be the difference between making a multimillion-dollar mistake and being the CEO's new golfing buddy.

RFID readers

An RFID reader is really a radio, just like the one you have in your car, except that an RFID reader picks up analog signals, not hip-hop. The reader produces electricity that runs down a cable at a particular rate. That electricity eventually hits a piece of metal on the antenna, which radiates the same signal rate out in space at a certain frequency and wavelength.

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.

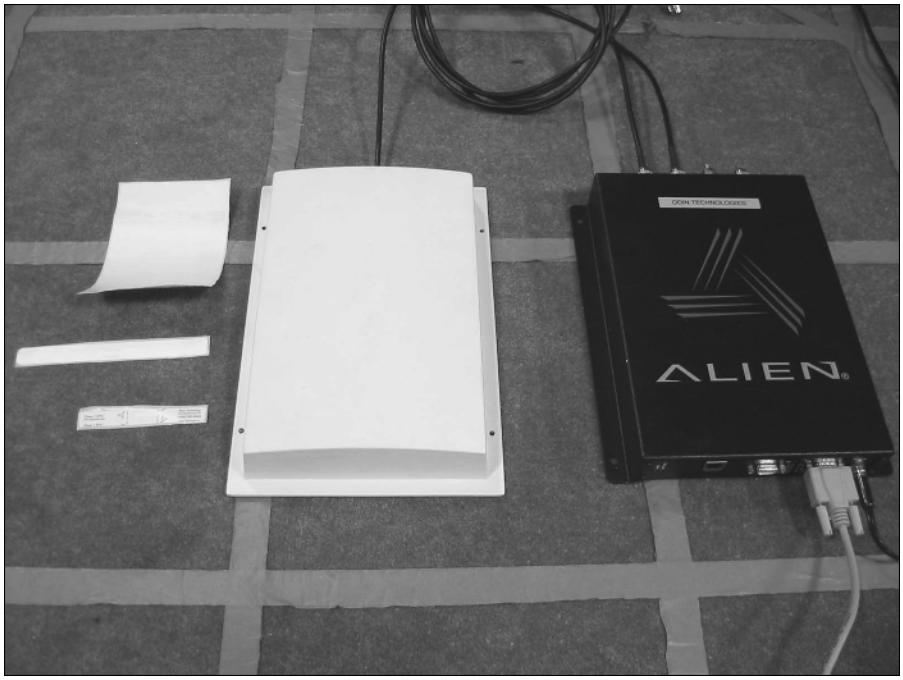

Figure 1-1: An Alien reader, a single antenna, and three types of Alien Class 1 tags.

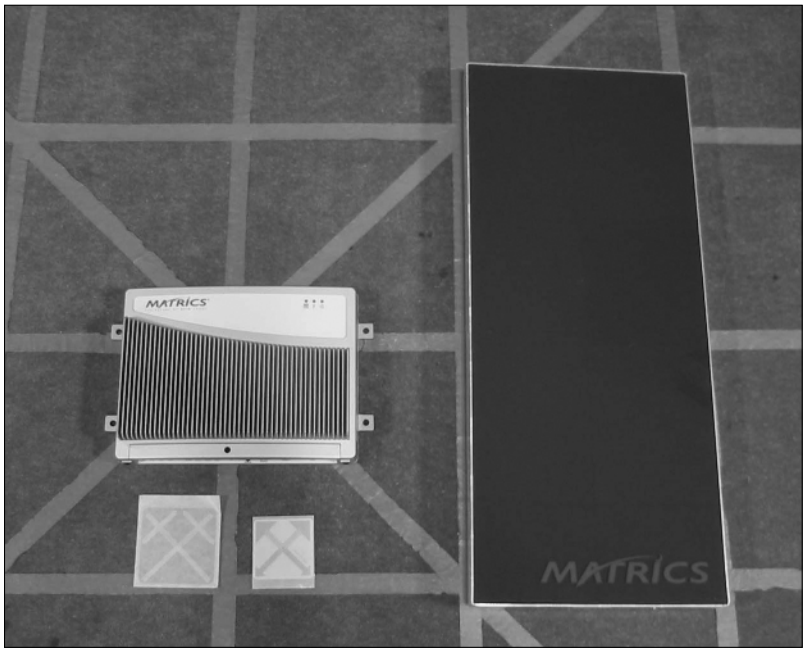

Figure 1-2: A Matrics/Symbol reader, a single antenna, and two types of Matrics Class 0 tags.

When will tag cost please the boss?

As I write this book, tags cost anywhere from $.22 to $1.20 each for passive tags, depending on volume, manufacturer, and special design functions for hard-to-tag items like metal or liquid products. Many people in the consumer packaged goods (CPG) industry have said that the "magic price" for tags is under $.05 each.

Many highly innovative companies are addressing this cost problem by pioneering production systems, experimenting with low-cost adhesives, and using conductive ink for antennas. Given the volume of potential applications (12 billion items in the pharmaceutical industry alone) and accelerating innovation, I advise clients who will buy in significant volumes that they should plan for a $.05–.075 tag by the end of 2007. Look for some large Asian manufacturers to bring tags to market in 2005 and 2006, adding to the increase in competition and fueling price pressure for that cheaper tag.

The majority of RFID being used in the supply chain world uses the ultrahigh-frequency band, or UHF. In the United States, this is referred to as the 915 megahertz (MHz) band. Although it is actually the 902–928 MHz range, 915 just happens to be the center. In Europe and Asia, this range is slightly different. Some applications, such as pharmaceuticals and asset tracking, use high frequency, or HF, which is at 13.56 MHz. Chapter 3 explains frequencies in more detail.

Finding Success with Four Ps in a Pod

I can enlighten you on all you need to know for an RFID deployment with the Four Ps. By the Four Ps, I don't mean that intoxicating Irish pub in Washington, D.C. I mean the four principal stages of an RFID deployment: Planning, Physics, Pilot, and Production.

The Four Ps encompass the key stages of an RFID network deployment. Figure 1-3 shows how they tie together in an evolutionary process of assessment, deployment, and scalability. The following sections explain the importance of each P in more detail.

Planning

Planning is the most important step in any complex undertaking. An RFID system is no different than a military operation; only the stakes are different. If you're playing the role of Captain RFID in your organization, the best thing you can do is plan properly.

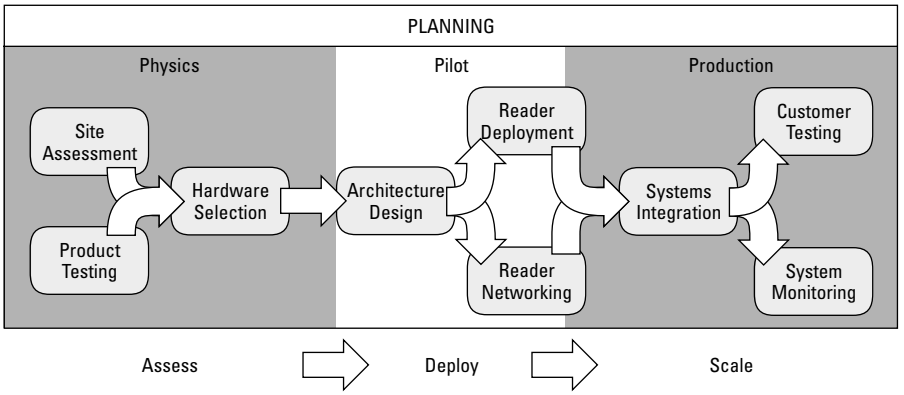

Figure 1-3: The Four Ps of an RFID Network Deployment.

The Planning stage ideally takes place over several months to make sure your organization has considered all the potential areas of impact, had time to get up to speed on the technology, and appropriately budgeted for the future. If you are being forced to comply by the government or a by large retailer, you do not have that luxury. If you do not have the time to do a full-blown planning session, use the following guidelines as must-haves for moving forward successfully. If you do have the time, use Chapters 3 and 16 as the foundation for your long-term planning cycle.

The critical planning steps for your RFID deployment are

1. **Create a global RFID policy.**

   Creating the global RFID policy requires a lot of research so that you understand all the available options in technology, business processes, and costs. This policy step addresses how to roll out the plan throughout your organization, what frequencies to use, data synchronization methods, and so on. If you are under a mandate, you might have many of these issues decided for you by someone else. Essentially, your global RFID policy will set the basis for how you need to move forward and help everyone in your organization understand what is about to happen with RFID.

   Spend as much time as necessary in setting the RFID policy. If you don't nail down your RFID policy well, you won't be overly successful with the steps that follow. Remember what Roger Staubach, a former Navy midshipman, once said: "Spectacular achievements are always preceded by unspectacular preparation."

2. **Execute an application analysis.**

   An application analysis covers the rationale and reasons for the RFID deployment and how RFID will be used. This includes very specific understanding of how RFID fits within your business processes. See Chapter 3 for more about assessing business processes.

3. **Develop a cost/benefit breakdown.**

   You need to examine the tangible and intangible ROI (return on investment). Chapter 17 gives a quick and dirty example of how to do that.

4. **Develop an implementation model (timeline).**

   With a new war chest of knowledge, you need to put together a project timeline (working back from any mandates you might be under) and investigate RFID vendors and consultants.

   Keep in mind that most RFID hardware vendors are not ramped up for high-volume production. This means order lead times can be anywhere from three to six weeks. Many people fail to consider this and end up being delayed several weeks. Make sure you incorporate equipment order timing into project planning timelines to stay on schedule. Chapter 12 offers more details on project planning.

5. **Design a deployment plan.**

   Basically, this step involves going through each step in the implementation model and assigning roles and responsibilities, seeing what parts are dependent on successful completion of other parts, and understanding the scope of the entire project. Having a timeline and some outside expertise on board will help you move toward a comprehensive, straightforward pilot that will serve as the foundation for a widely-deployed RFID network. See Chapter 17 for details on how the RFID plan fits in with your strategic plan.

6. **Manage the change and potential impact on the enterprise.**

   Finally, as with all good projects and consistent with the popular tenets of Six Sigma management principles, you need to audit the result by seeing how your deployment of the technology compared with what was being used before (usually bar codes) and ensure the survivability of the change by making sure the organization has mechanisms to prevent workers from avoiding or faking the use of the technology.

Physics

The second P is the Physics component. Certain laws of physics — no matter whom you know in the RF Police — just can't be bypassed. Those laws of physics are important because they affect the products you tag and the facilities where you set up readers. The three areas in which physics most come into play are

- **Full Faraday Cycle Analysis to understand the environment:** The Full Faraday Cycle Analysis, named after the famous physicist of the 1800s, Michael Faraday, is made up of two primary components. First is a

time-based analysis of ambient electromagnetic noise (AEN), and second is RF path loss contour mapping (PLCM). You can find out how to execute both of these functions in Chapter 7. The goal is to see all the invisible electronic, magnetic, and radio waves that flow throughout a location and then properly design an RFID network to live within that environment.

- **Product or SKU testing for tag selection and placement:** This step involves properly testing your products for an RF signature. Many people refer to this as *SKU testing for RFID compatibility.* In a vacuum, the reader and its antenna combine to make a perfectly shaped RF field. Put an object, like a case of SPAM, in the middle of that field and that perfectly shaped RF field becomes distorted beyond recognition. Why? Because RF waves, like light waves, can be reflected and absorbed. Metal reflects RF waves, and liquids absorb them. Knowing this, you can imagine how an RF calamity might ensue in an interrogation zone if you try to tag a case of SPAM, a highly liquid foodstuff in a metallic can. To avoid this calamity, see Chapter 8, which goes over a sound scientific methodology to find the right tag and placement for your products.

- **Selection of the RFID hardware based on scientific testing:** Buying an "RFID in a box" or a "slap and ship portal" is a big mistake. Although these solutions look attractive on the surface, they can turn into a maintenance and support nightmare, and often end up being completely written off as organizations move to a full RFID network. The physics and planning should be done with the end in mind — where do you expect or want your RFID network to be in three to five years? If you are planning for ten dock doors, design for that and source a solution *now* that is optimal for the long term, even if you're setting up only one dock door today.

  To design with the end in mind, you need to do scientific testing. After you understand how your products behave in an RF field and what the specific requirements of your environment are, you can set up a lab to help you discover what the best readers and antennas are. Colvin Ryan, the world-famous steeplechase jockey, is famous for saying, "No matter what place the horse is in over the first two fences, the only thing that matters in the end is who gets the girl." That is a prime example of working with the end in mind.

I remember one client whose software vendor sold them a print-and-apply solution and readers before any of the physics testing was done. The client then discovered that the tags read 10–15 percent of the time at most and that the readers didn't have the communication capabilities to fit well into the existing infrastructure. Then they went through the proper testing and hardware selection and are now at a 100-percent read rate. But they're left with several thousand dollars' worth of high-tech paperweights.

Pilot

If you've been following the RFID buzz for the past year or two, you might think you were on the set of the movie *Top Gun* with the number of times you've heard the word *pilot* bantered about. The truth is, there is so much to learn about RFID that companies are trying to get away with as little initial impact as possible. Many are limiting the commotion by starting out with a one- or two-location pilot, or a trial system.

The bad news is that pilot costs can range from $50,000 to $1,000,000 depending on the scope and requirements. The good news is that, when done correctly, a pilot program can save you hundreds of thousands of dollars as your company moves toward full deployment. And you *will* eventually be deploying an RFID network. Think of the pilot as an initial deposit in a high-yield 401(k) — the earlier you start it, the more benefit you get out of it in the long run. (Sorry, I know this isn't *Financial Planning For Dummies,* but that recessive MBA gene flexes its helix every now and again.)

In essence, the pilot provides a solid road map for production but has a more limited scope. Following the Four Ps process, the Pilot stage becomes a pragmatic step toward true understanding of RFID.

The pilot is about deploying and testing the RFID network in your environment. To get a better sense of what a pilot involves, see Table 1-1, which outlines the basic phases of an RFID pilot.

Table 1-1 Phases of an RFID Pilot

Phase	*Percent of Total Pilot Timeframe*	*Key Tasks*
Planning	40 percent	Designing a single RFID interrogation zone to work in concert with business processes and systems Testing for proper hardware choice; the better the planning, the fewer the changes after deployment
Setup and installation	30 percent	Putting together the hardware, configuring it, integrating it with existing systems, and then training users
Testing and redesign	30 percent	Evaluating the performance of the design and process and making modifications to increase performance

Think of the pilot deployment as the first node in an overall system architecture that may take years to develop completely. Pilots provide a road map for production, but have more limited scope and a longer redesign process. After the system is up and actually collecting data, you can expect several reiterations of design and modifications to the process. That redesign process allows you to expand the system as you're ready; it also helps you understand that the RFID network is a living thing, evolving as business processes change and become optimized. As shown in Figure 1-3, the pilot logically morphs into the Production phase and scaling up the network.

Production

The first three Ps might seem like a sprint to get yourself ready with this new technology, but the last P, Production, is the methodical scaling up of a well-designed system. It's the steady pace of a marathoner who knows exactly what his splits should be at every mile to get to the finish line.

The key difference between the pilot and the production systems is that the network grows exponentially in complexity as readers are added and more data is captured. As scary as this might sound, if the Planning and Pilot stages were done with the end goal in mind, growth should come smoothly and relatively painlessly. Scaling up an RFID network is similar to the pilot process; you add nodes to a previously designed network and focus on small design modifications to manage any unplanned events.

In addition, when you reach the Production phase, you're ready to add the following tasks into the mix of your RFID network:

- **Managing the health and performance of the network:** This is the most complex challenge of production and involves making sure that the readers are performing optimally and stay correctly configured. Detecting anomalous behavior before it leads to catastrophic failure is the key. Only a couple of options today address this need, and they are covered in Chapter 14. One thing is very clear, however: Traditional network management systems like Tivoli, Unicenter, and OpenView are poorly suited for management and monitoring of a complex RFID network because they can't understand the multifaceted physics components that are at the root of an RFID network's performance.
- **Integrating your RFID data into existing systems:** This is the timeliest issue. An RFID network will produce much more data in real time than your current system (because items are serialized). This is very different from what most core business applications are used to. Many are designed to deal with bar code data coming in at regular intervals in a batched mode. Fortunately, the major enterprise resource planning (ERP), warehouse management (WMS), and inventory software vendors are designing and building new additions to their existing applications

specifically for RFID. This will ease the integration burden and help enterprises leverage the intelligence gleaned from real-time serialized data. Already, companies like SAP, Manugistics, Oracle, and others have built RFID middleware and modules that their existing clients will be able to benefit from. See Chapter 10 for more details.

- **Testing your system with outside partners:** Just like the force of an army's battalion is made up of many individual soldiers, the power of RFID is unleashed when a multiplicity of single nodes are bonded together sharing real-time, specific data. After you have data populating your critical business applications and are confident your RFID network and infrastructure are performing well, you can start to test with selected suppliers and customers. The value of this information is stunning:
  - *For companies concerned with inventory management,* incorporating both upstream and downstream partners provides a level of in-transit visibility that allows radical changes in your inventory management process and, most importantly, reduces necessary capital tied up in the inventory cycle.
  - *For companies focused on asset tracking and security,* incorporating the new RFID data with back-end applications allows chain-of-custody or pedigree information and specific association with people, plants, and distributors that has never been available.
- **Educating the users:** Training is critical to ensure front-line adoption and proper usage of the systems. The complexity of performance and the invisible nature of RF make for a unique combination for the worker in the field. Warehouse and system staff need to understand what affects the success of a reader network and how to recognize some of the basic issues. Behaviors they may not think twice about today may need to be modified. For instance, if a worker decides to unplug a reader to use the outlet, he needs to know that the custom configuration on most of today's readers will be lost, and when that reader is plugged back in, that the configuration is set back to the factory default. Or if a forklift is parked in a reader's interrogation zone, users need to know that the success of tag reads is likely to be altered. Performance and business process issues can be designed into the network to a certain extent with visible light or sound queues, but many of the relevant issues will need to be addressed with specific training. Chapters 14 and 15 discuss training for your pilot and production deployments in more detail.

A Ride in the Time Machine

This book was written in 2004 and released in early 2005. So what will things look like five or ten years from now? As I mentioned earlier, the $.05 tag will be a reality, but more importantly, RFID technology and a global protocol will

enable a world we couldn't even have imagined at the turn of this century. In less than five years, we will witness a $25 RFID reader and all the technology and digital signal processing on a single chip. RFID readers will come in two flavors: (1) cheap, dumb readers that only read tags and send the data up to a central collection point, which filters and smoothes the data for analysis; and (2) more expensive, higher-processing, smart RFID readers that can perform intelligent operations beyond simple communication.

The cheap and small readers will enable a convergence of parallel technologies you may have already heard of:

- **Mesh networks:** Items that communicate and self-configure every time a new node is recognized or removed.
- **Grid computing:** The ability to co-opt computing power like a utility when an application needs more horsepower.
- **Dust motes:** Tiny sensor networks that can do everything from predict disasters like tsunamis to recognize chemical warfare, and can be deployed by dropping them from a plane by the thousands, like crop dusters.
- **Sensors:** To monitor everything from temperature to vibration to nuclear levels attached to this networked world.

Many people's vision of an internet of smart objects will be realized as all of these technologies unite in a manner that is pure machine-to-machine communication. An object embedded with an RFID tag or some derivative will enter the presence of other objects that are similarly enabled and be instantly recognized. Each object will have enough data to configure itself into the geographical network in which it resides. Information about everything from temperature and movement to cost and ownership will be distributed in these complex systems. Most importantly, it will all happen wirelessly, with a limited number of data standards, such as the EPC protocol, ISO standards, and unlicensed bandwidth.

This intelligent, wireless, machine-to-machine communication will grow at a cost of strict regulatory compliance related to our privacy and freedom if we let one seed germinate that has already been planted — ignorance. Without clearly understanding the impact and application of disruptive technologies like RFID, some people will have a knee-jerk reaction that our privacy is at stake. In today's world, and the world a decade from now, education and understanding will be the best protection against overbearing federal regulations and alarmist articles in popular press. See Chapter 2 for more about privacy concerns.

George Jetson never had it as good as we will a decade from now: When you wake up in the morning, your armoire will notify you of your perfect wardrobe based not only on fashion coordination, but also on what's on your calendar

for the day. Then you'll get in your car and head back to sleep because it will use sensors and GPS to drive you to the office. If a tire gets low on air, it will route the car to the service station for a quick fix and get you back on your way. If the interstate is backed up, your car will route you to a different path and get you there on time. Then, when you stop at the store on the way home, you'll simply fill your cart up with items and walk out the front door, and a sign will let you know that you've just purchased $38.76 worth of Pop-Tarts, toothpaste, SPAM, and Cheez Whiz. When you get home, your refrigerator will display a warning light that your arteries are going to be blocked quicker than brushing your Newfoundland in the tub will block your drain if you don't change your diet. If it does get that far, we may want Jane Jetson to stop this crazy thing called technology. But, needless to say, the future could be a very cool place that is wildly efficient, thanks to RFID.