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George Morley didn't have to sell his hospital staff on a radio frequency identification (RFID) equipment tracking system. The system sold itself.

Morley, director of biomedical engineering at PinnacleHealth, was nearly finished installing a tracking system at one of his company's two hospitals in Harrisburg, Pennsylvania, when he got a call from the cardiac care department about two missing defibrillators. This was before everyone in the company, which has 800 beds combined, had access to the new system. The department already had confronted likely culprits with no success. Luckily, the devices had been tagged, and the system located one defibrillator on a shelf and the other in a utility room in the intensive care unit. Word got around, and Morley was deluged with calls to tag more and more items.

"People have been frustrated for years because they buy something—particularly small items—and it never stays where it's supposed to," Morley says. Staff members spend hours looking and often end up ordering new items because the old ones can't be found.

Morley started examining positioning systems five years ago. He considered infrared and Wi-Fi vendors and tested various systems on a small scale. Subsequently, in early 2005, PinnacleHealth adopted a patient

BY CHRISTOPHER M. WRIGHT

“Where's My DEFIBRILLATOR

More effectively tracking hospital assets



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tracking system from Lawrence, Massachusetts-based Radianse Inc.

In December of that year, Morley began installing Radianse's equipment tracking component at room and zone levels. The accuracy of Radianse's positioning system is virtually 100 percent, as documented by a 2003 double-blind, peer-reviewed study at Massachusetts General Hospital funded in part by the National Institutes of Health.

Morley initially ordered 4,000 equipment tags and has ordered 4,000 more. Additional thousands will be needed for the program. PinnacleHealth leaders intend to roll out at their second hospital in 2007. Equipment moves from one facility to the other, and Morley will be able to track it between hospitals when the system is completed.

Relatively few hospitals have RFID equipment tracking today, but the technology is on the cusp of widespread adoption, many observers say. Radianse installed its first system in 2003 and had systems in 20 hospitals by November 2006.

Paul Mathans, manager of emerging technology and RFID

solutions for the consulting firm BearingPoint Inc., also sees interest picking up. "RFID can be used to address the core issues of hospital management," he says, noting that locationing solutions have impli-

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cations for equipment, patients, pharmaceuticals, and workflow procedures.

The need for tracking is growing because hospital employees are shuttling more pieces of increasingly expensive equipment among patient rooms. New hospitals have larger rooms to accommodate the trend. Hospital administrators are tracking infusion (drug-delivering)

pumps, cardiac monitors, ventilators, portable imaging devices, wheelchairs, and more. "When you need something, the current approach [in most hospitals] is you send folks scurrying up and down hallways looking for the equipment. This wastes staff time and delays treatment," Mathans says.

Real-time equipment location helps in "making sure you have the right equipment in the right place at the right time," says John Pantano, Radianse's vice president of marketing. The benefits are many and include reducing equipment search time, minimizing surgery delays, improving patient response time, providing visibility into equipment purchasing, facilitating recalls and preventive maintenance, and preventing theft and hoarding. Morley likes the results already.

The basics

The Radianse indoor positioning system (IPS) consists of tags, receivers, software, and Web-based displays. As RFID technology has matured, interference problems with other wireless networks and medical devices have become a thing of the past, Pantano and Mathans say.

The IPS system uses an assortment of active (battery-powered) 433-megahertz tags attachable to equipment, patient bracelets, and staff identification badges. Equipment tags cost roughly \$30 each, while disposable patient tags run about \$7 or \$8. The batteries typically last 2 years at a 10-second update rate and 6 years if they signal every 30 seconds. Some vendors put their tags to sleep to prolong battery life, Pantano says, but this sacrifices the quality of the system. He advises users to program a 10-second rate for the items about which they are most concerned. Lanyards or adhesive discs that remain behind if the tag is removed send tamper alerts to the system when they are cut or broken.

The tags speak to receivers, small RFID readers that hang on the wall, which become local area network

Sponge 54, Where Are You?

Besides equipment tracking, wireless and bar code technologies are finding a wide variety of uses in hospitals, including

- tracking surgical trays and instruments, patient charts, hazardous materials, and specimens
- tracking and replenishing supplies in nursing stations, supply carts, and shelves
- sending vital sign data, such as heart rate and blood pressure, from wearable sensors to the network
- matching babies to their mothers and patients to the correct blood transfusions, medications, or surgical implants
- tracking staff members and clinicians who are needed for emergencies with voice-activated identification badges
- tracking surgical sponges, which is not a trivial issue. Some 3,000 to 5,000 are left inside surgery patients in the United States every year. Serious and sometimes fatal infections result, with the overall price tag estimated at \$500 to \$750 million annually in liability settlements and other costs.

appliances or Wi-Fi clients. Morley is still fine-tuning the calibration of his receivers to improve accuracy, having experienced a bit of bleed-through, whereby the system mistakenly says an item is on another floor.

The signals are sent to a Windows-based server where a structured query language database updates location information. Locationing is achieved through multilateration, not signal speed triangulation. Instead, multilateration uses relative signal strength to calculate position. Thinking of each receiver as the center of a bull's-eye, the system puts the item in one of several bands around the center, achieving zone-level accuracy with a single receiver. Overlapping bands from multiple receivers pinpoint items with room-level accuracy.

Accessing the information is “like using a search engine on the Web but, instead of finding Web pages, you find real things,” Pantano says. The location is displayed in map or text form on full-size screens. Morley says his staff members find the text lists more helpful. While text results will display on cell phones, pagers, and personal digital assistants, he anticipates Radianse will improve its small-screen interface in the near future.

The great debate

The relative merits and demerits of 433 megahertz RFID systems versus 802.11 Wi-Fi systems have been the subject of some considerable debate. Radianse and other vendors tout the superiority of 433 technology for room-level accuracy.

“Several competing RFID platforms have solid performance,” Mathans says, noting that both Wi-Fi and 433 are finding their place in the market. The 433 systems have the edge at the moment for room-level accuracy, but that could change, he says. He likes the Radianse system but says it is theoretically possible to achieve room-level accuracy with Wi-Fi.

It does matter whether 433 or Wi-Fi is used. Some hospital administrators have concluded that the most

cost-effective solution is to piggyback a tracking solution on top of their existing Wi-Fi network. That may or may not be the case, as Mathans and others have noted. Achieving acceptable accuracy may require installing more antennas than are currently

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available on an existing Wi-Fi network. A site survey is required to ferret out coverage problems, such as the lead walls that line X-ray departments, Mathans says. If existing Wi-Fi antennas every 100 yards don't meet desired performance, or if an access point needs to be installed in every room to achieve room-level accuracy, administrators may not end up saving money.

There are other problems to consider. Adding too many Wi-Fi antennas can cause interference *within* a Wi-Fi network, PinnacleHealth's Morley says. In his case, he chose 433 over Wi-Fi because he already was encountering interference problems stemming from the previous addition of access points to handle mobile computers. Also, heavy metal objects affect radio signals, which is primarily a Wi-Fi problem, he says.

As a 433 vendor, Radianse leaders unsurprisingly are quick to point out further problems with Wi-Fi. It can only place an object somewhere within a 30-foot sphere, Pantano says. This means that a Wi-Fi-based system could report a device as being

in room 302 when it actually is in room 202. Second, some hospitals have bought equipment tracking solutions only to find they could not use the solutions for patient tracking later. (Where in the hospital is Carmen Sandiego?) “At some point, you will want to track patients, whether or not you believe that today. It's absolutely where all this is going,” Pantano says. Finally, “Wi-Fi standards are very power hungry, so they chew through the batteries fairly quickly,” he says, raising total cost of ownership issues.

Where's the payoff?

Radianse systems typically cost \$1,200 to \$1,600 per licensed bed, Pantano says. The price includes tags, receivers, software, implementation, and training.

While some administrators narrowly focus on the price of the tags, Morley takes a total cost of ownership approach. When he initially did his analysis, he found Wi-Fi vendors had lower infrastructure costs, but much higher software maintenance (debugging) costs. In addition, shorter battery life for thousands of tags and the fee for adding tags to the system made Morley choose Radianse over competing systems. “You can't only look at what it costs for the hardware or only for the tag, you have to look at every component,” he says.

Morley has no strict formula for calculating return on investment (ROI), but figures his system will pay for itself in less than two years based on the following three factors: equipment purchases, rentals, and theft.

Statistical analysis will tell Morley how often the hospital's equipment—for example, an infusion pump—is in use, giving him visibility into whether pleas for additional equipment are justified.

The same type of analysis will tell Morley how often the need for bariatric beds and other rental items exceeds the number on hand. “Before we had locating systems in place, typically the rental compa-



A Radianse radio frequency identification tag.

nies were called right away,” Morley says. He expects to save hundreds of thousands of dollars a year in rental equipment alone.

Lastly, four expensive ultrasound probes were stolen from the hospital a year ago, Morley believes, and the insurance company denied the claim because the hospital could not prove

the items were stolen. The insurance company representatives suggested the items instead could be lost. In future incidents, Morley will be able to pin down the time the system sent an out-of-bounds alert, pull video footage from the camera system, and document the theft to the insurance company’s satisfaction.

BearingPoint’s Mathans agrees that theft prevention is an important part of the ROI case. “[With] the amount of high-value assets that disappear out of hospitals, the ROI there is very favorable,” he says.

Radianse executives report their systems pay for themselves within 12 to 24 months. A pilot project of 100 beds in two units at Boston’s Brigham & Women’s Hospital paid off in 15 months. The system is being adopted throughout the hospital as a result, Pantano says. Also, he reports executives there have seen equip-

ment usage rates increase and overtime costs decrease at other Radianse installations.

Where would we be?

Hospital RFID equipment tracking is moving beyond “nice to have.” “People are starting to realize it’s a must,” Pantano says, noting there are never enough nurses or dollars in the capital budget to go around. Locationing can ease the trade-offs hospitals must make between replacing lost equipment and staying on top of new-to-the-market devices.

As for all the functions of the system, Morley says, “I think there [are] a lot of things that we haven’t even thought of yet.” ❏

Christopher M. Wright is a freelance writer specializing in investment and technology topics. He may be contacted at cwdirect@sinewaveinvestor.com.