Location Systems Could Offer Greater Precision, Data

Mike Dempsey

With some hospitals reporting asset shrinkage in the millions of dollars, real-time indoor location systems deserve a closer examination. Companies have been working on indoor location systems (ILS) for tracking assets and patients for 10 years, but the industry is in still in its infancy.

In early attempts, this technology provided too slow an update rate to accurately locate moving assets or people. These were often modified systems that were originally utilized to track goods in warehouses. Other systems in the past were unreliable or came with infrastructure costs that were too prohibitive to justify a reasonable rate of return.

Today, the outlook has improved because of technological advancements and a better understanding by producers of the real-life implications of the complex environments in hospitals. Producers are recognizing that people sometimes hoard, steal, and abuse equipment and other assets. As a result, robust systems are being developed that can survive the tough environment within the hospital setting. This article will address location technologies with an emphasis on real-time location systems, and the varying need for data rates and location precision.

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Methods Used for Location Systems

There are 3 major approaches used in locating assets and people in hospitals today. The first of these is portal management. Retailers often use these systems for theft detection. The systems only let users know when something or someone is in the portal (doorway), but once they are through, there is no location information.

The second concept is contact systems. These systems require that a tag be in contact with a reader, such as a barcode reader. The problem with these systems is that you must first know where something is before you make contact with the reader.

The third concept is real-time location systems. All real-time locating systems include some sort of a tag that is attached to a person or object. There are 3 competing technologies utilized in today's tags: radio frequency identification (RFID), infrared (IR), and radios (RF). These tags are active in that they broadcast unique information associated with the tag. These systems can provide a vast amount of information on asset utilization and can give insights on patient and process flows.

Competing Technologies for Real-time Location Systems

RFID: RFID can provide either long-range or short-range tracking. These tags can be either active (broadcast) or passive. Active, long-range RFID tags are similar to radio transmission tags addressed shortly. Passive, short-range tags can have a range from 2 inches to 2 meters. Passive tags have no battery. They simply pick up a signal from a radio and add their data to the signal and reradiate the signal back to the antenna. Typically, these tags are only used with portal technology and are therefore of limited value in real-time location systems.

Infrared: Infrared tags use light to send information. Since light cannot travel through walls, an asset must be on the same side of the wall as the receiver. Sensors are connected to information collectors through a high-speed serial connection. Collectors are then connected to concentrators and information is then passed to com-

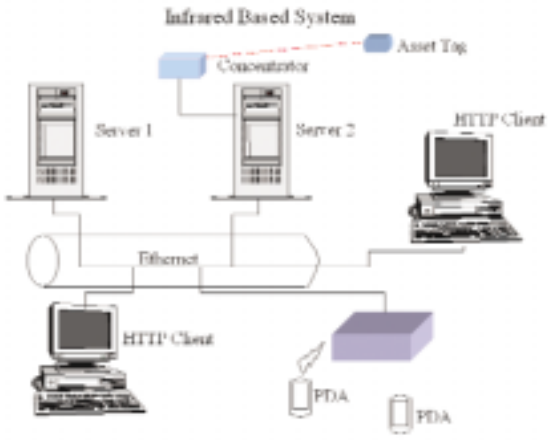

Figure 1. *Infrared based system.*

puters. The major problem with these systems is that when a tag is covered the light it emits is blocked and the signal is lost. So if we want to locate an ambulating patient and the patient has put on a bathrobe over the tag clipped to their hospital gown, information on the patient's location is no longer broadcast. Similarly, if a sheet hangs too far over a "tagged" gurney, its tag may be covered up and you will not be able to find the gurney without conducting a physical search.

Radio Technology: Typically, radio technology real-time location systems use triangulation to fix the location of an RF tag on a person or piece of equipment. These systems can be as accurate as a few centimeters and like IR systems, there are data collectors (antennas) that are then connected to concentrators. These concentrators are then connected to a personal computer for data storage. Typically, the antenna systems use coaxial or special cable, which is expensive to install and re-configure, to provide the needed synchronization these RF systems require. The cost of running these special cables or even parallel Ethernet cables can increase the price of an indoor location system by 50 to 100 percent. Some systems use 2.4 GHz Industrial Scientific and Medical (ISM) band radios and can interfere with other wireless systems using that band or they can be subject to interference from BlueTooth and other ISM devices. Other systems comply with part 15 of Federal Communication Commission regulations for location systems. These systems do not interfere with other wireless systems in the hospital. In general, these systems tend to be more expensive than IR systems.

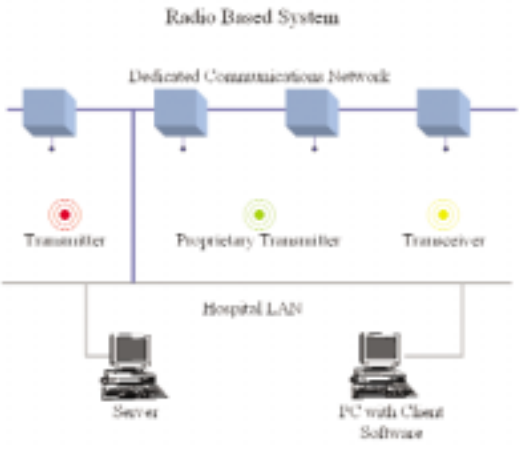

Figure 2. *Radio based system.*

Hybrid Technology: A hybrid tag that combines infrared for location with a radio could serve as an effective solution to these challenges as long as the infrastructure and implementation costs are kept low. Because radios use less power than IR emitters, these hybrid systems use RF to provide high-rate data for quickly moving items, such as staff. IR, used wisely, can help increase accuracy and speed of location. The information from these tags is sent to easy-to-install-and-maintain IR/RF combined receivers that are hooked directly into the hospital's existing wired or wireless Local Area Network (LAN). Using the hospital's existing LAN can radically decrease cost of installation by reducing material and labor. Data is once again collected centrally using a PC with a database. However, it is important that both the IR and the RF signal be used for location. Systems that

Figure 3. *Hybrid (radio and IR) based system.*

use the RF only to tell you that the IR is covered up provide little real benefit.

Location Systems in Use Today

Because of the high cost and questionable accuracy of these systems, there are few systems utilized in hospitals today. Some real-time location systems are closely associated with nurse-call systems. The system uses a series of lights mounted outside the patient's room to indicate if a nurse is present. Another color light is used to signal when a nurse manager is in the room. While this provides value in managing staff, it hard to justify the cost of these limited capability systems.

Other systems are used to improve the quality of hospital services provided to patients. Here, response times to nurse calls or requests to staff for food and beverages are measured to drive down response times.

Clinical engineers and biomedical equipment technicians can use asset-locating systems to prevent assets from being stolen. In addition, when it is time to conduct preventive maintenance, they can print out a report of the location of all devices. The system can also be used to measure asset utilization to prevent hospitals from over or under buying devices, preventing underutilized assets, and reducing the need to rent equipment.

One major project is taking place at Partners Healthcare in Boston. Partners Healthcare has created an operating room of the future (ORF). The objective is to bring in new surgical therapies (less invasive), innovations in patient and clinician process flows, and new concepts in supply and materials chain management.

At Partners, a hybrid RF/IR tag-based location system is being tested to track asset utilization and location, staff location, the time people and things are in one spot, and the association of assets and people. This last item provides information on the association of who is in the room at one time such as a patient, a nurse and a doctor, and what equipment is around the patient.

The key here is time. Knowing the amount of time a doctor spends with a patient for a particular procedure can lead to changes in workflows, which can in turn lead to process reengineering. In later phases of the study, the

"association" concept will be tested. The goal is to provide information not only about the locations of assets but also what other assets or people are around them.

Planning for the Future

To determine your budget, you'll need to decide the number of people and items you'll want to locate. You should also understand how many assets are lost by the hospital on an annual basis for conducting a valid return-on-investment. You can estimate the amount of lost assets by reviewing past capital budgets and looking for items that show up on subsequent capital budgets well before obsolescence or expansion would justify the purchase of these items.

- RF tags cost around $40 each. The infrastructure for these systems costs about $70,000 for 20 rooms.
- Infrared tags cost between $50 and $100. The infrastructure costs for 20 rooms is about $40,000.
- Hybrid tags cost between $30 and $50. The infrastructure costs for 20 rooms is $20,000.

It is time for the biomedical community to look into real-time locating systems. You should look for a system that is easy to install and maintain. You will want a system that can tie into existing infrastructure to keep these costs low. Be cautious of a system that only tracks one particular manufacturer's equipment.

Just as "open systems" are becoming popular with software, the successful indoor location system must also be open to multiple vendors and users. Make sure your vendor of choice has experience in operating in the complex medical environment. Look also for a system that is expandable and will grow with your need. The system should be sensitive to the privacy needs of staff during break times. It should also provide location data including the time a tag is in a particular location such as the bedside or in an equipment closet.

Lastly, the data provided by these systems should use standard databases and simple messaging protocols to simplify the integration of these systems into existing asset management databases and information systems. Providing the data to your organization's information systems will help in the goal of increasing throughput.