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Real Time Location: RFID, W-Lan, Wi-Fi and Ultrasound

Author

Tosh Sheshabalaya,

Hospital managers face increased pressures from cost containment and other policy reforms, a relentless level of technological change and ever-newer product and solution choices, coupled to shortages of qualified staff. Meanwhile, there has been no let up in the need for improved efficiency and quality assurance to give patients the best medical care. Real-time location systems (RTLS) are a major area of attention in such contexts. Though much of the focus has so far been on radio frequency identification (RFID) systems, new alternatives are emerging – some of which have been designed with hospitals in mind.

RFID: Still Key to 'Automating Everything' ?

Seen some time ago as an indispensable technology for a host of sectors, RFID has been on a roller coaster ride in recent years. The high point for RFID was a January 2004 story in the prestigious Scientific American magazine, which labelled it, unabashedly, as the "Key to Automating Everything".

Since then, in spite of a steady growth in use and a fall in unit costs, interest in the potential of RFID real-time location systems (RTLS) as a killer, paradigm-shift technology has tempered somewhat.

Reflecting this, a survey by Illinois, US-based industry group CompTIA (Computing Technology Industry Association) reported in August that the number of IT companies who "will or might offer RFID products and services in the next three years" fell by 14% from 2006.

From Retail to Hospitals

Nevertheless, CompTIA also found 75% of IT companies still planning to provide RFID solutions, and the technology has acquired considerable traction as a means to monitor closedloop applications. This is especially true in discrete, smaller scale environments – from the automotive industry (a field where it took birth in its modern form) to transportation, warehousing and logistics. One of the major movers in the latter areas is the US Department of Defense, which has begun requiring suppliers to apply passive RFID tags on shipments.

Although the retail sector was considered to be the must-have domain for RFID, the technology seems to have found fertile soil for planting its roots in other fields – not least hospitals. According to a recent study by Menlo Park, California-based Spyglass Consulting, the use of RFID at hospitals has tripled over the past three years.

The Klinikum Saarbrücken Pilot

In April 2005, RFID was launched in Europe's first major hospital trial at the Klinikum Saarbrücken in Germany. This pilot project, aimed at improving administration and reducing clinical errors, provided RFID-tagged wristbands for 1,000 patients. The tags carried a unique code corresponding to encrypted patient records, and provided data on drugs and dosages required by the patients. Hospital staff were equipped with PDAs and tablet PCs to connect to the RFID data by means of a WLAN. Patients too were provided with terminals to scan their wristbands.

Such a technological architecture, indeed, remains the mainstay of RFID use in hospitals across Europe and the US. So do the objectives – to provide positive identification of patients, track and locate patients and medical staff, and thereby enhance administrative/operational efficiency and reduce clinical errors.

New Value Points = New Opportunities

More recently, several additional value points have begun to be exploited, such as automatic alerts/alarms on staff tags which permits location of a surgeon or nurse to colleagues. There also have been reports of tagging mothers to newborns, to prevent mismatching – an issue of

considerable concern in large hospitals.

In the long term, increased RFID use is not unlikely to dovetail into hospital-wide process improvement and quality assurance programs.

Of 30 Million RFID Syringes

On the more generic applications side, hospitals have begun using RFID to track medical equipment and pharmaceuticals. Indeed, one of the largest RFID applications so far has been in the healthcare sector, when Anglo-Swedish pharmaceutical giant AstraZeneca tagged 30 million syringes of the anaesthetic Diprivan. The initiative was also the first to use high-volume chipless RFID tags beyond a few millimeters range.

Fight Counterfeiting – US and Europe

In spite of continuing debates about standards, it seems likely that the pharmaceutical industry becomes a major player in the RFID area if the US Food and Drug Administration (FDA) mandates tagging of drugs to fight counterfeiting. As in many other emerging medical technology areas, the US seems to be setting the pace in RFID. While its Federal Register Notice (FDA-2008-N-0121) in March 2008 seeks explicit comment about RFID, the EU's 'Public Consultation in Preparation of a Legal Proposal to Combat Counterfeit Medicines for Human

Use' – also released the same month – only mentions "various tamper-proof technologies ... under discussion by the industry (e.g. datamatrix/2D barcoding)."

Hospitals: New Issues on RFID

Unlike the pharmaceutical sector, the debate on increased RFID use in hospitals has been charged – with regard to electromagnetic interference by active, long-range tags with vital, life-support medical electronic devices.

In June 2008, the Journal of the American Medical Association published the findings from a study by Amsterdam University's Academic Medical Center (AMC). This warned that RFID may disrupt the operation of sensitive medical equipment and occasionally induce "potentially hazardous incidents."

The study, which investigated the electromagnetic effects of RFID on 41 medical devices (including defibrillators, infusion pumps and pacemakers), reported a total of 34 incidents of reproducible electromagnetic interference, 22 of which were classified hazardous and another 2 as significant.

A Charged Debate

The debate on RFID is expected to remain charged for some time to come.

One month after the Amsterdam study, US researchers at Indiana University Purdue University Indianapolis (IUPUI) reported that RFID systems did not result in interference with medical equipment.

The difference however lies in the details. While the Amsterdam study used two RFID systems—one passive (868 MHz tag and interrogator) and one active (124 kHz battery-powered tag and reader) – the US study used only a passive ultra high frequency (902-928 MHz) system.

Another critical difference is that while the former studied RFID systems at very close distance (within centimeters) of medical devices, the US tests never placed them closer than 30 centimeters — a more real-world scenario. On the other hand, the Amsterdam investigators did extend their tests to as much as 6 meters.

Experts believe that such concerns will dampen enthusiasm about RFID, at least until there is more conclusive evidence to rule out its purported risks. In the interim, it is likely that hospitals are advised to test the impact of specific RFID systems on their medical electronic equipment before deployment.

Alternatives Emerge: Wi-Fi RTLS

In recent years, there has also been considerable promise in a different technology. So-called Wi-Fi-enabled location systems serve many of the same purposes of RFID – at least in an indoor hospital setting. These include the location, status and movement of both people and devices.

Wi-Fi-enabled location systems use positioning algorithms, based on calibration of Wi-Fi signal strength. The systems are capable of locating Wi-Fi tags, VoWLAN handsets, PDAs and tablet PCs, barcode scanners and other Wi-Fi enabled devices. Operating as Wi-Fi network-connected devices (in some cases, with sensors plugged and played on standard electric sockets), the system integrates directly with a Wi-Fi network, at most requiring the installation of extra APs (access points). It avoids interference with existing Wi-Fi connectivity, voice telephony, data, messaging etc., but provides an option to create various levels of secure access within a user's facility.

Resonance with Healthcare Managers and Vendors

Philosophically, Wi-Fi RTLS systems have struck a strong chord of resonance with healthcare IT managers, as well as with vendors.

For IT managers and hospital administrators, a distinct advantage is that Wi-Fi-enabled location systems capitalise on the existing wireless infrastructure in a hospital. In addition, they do not produce any electromagnetic interference, a strong argument in light of the above concerns about RFID.

For vendors, on the other hand, Wi-Fi location systems address a specific challenge posed by hospitals, where every department has specialised needs and working practices – as do the different users (nurse, physician, pathologist or administrator). In such an environment, the over-arching need for any IT system is to use or build a multi-purpose backbone infrastructure that integrates different departments and users. This has clearly been met by Wi-Fi, which has decimated proprietary offerings, ranging from Voice-over-WLAN, to mobile access systems and more.

Europe Takes a Lead

Wi-Fi RTLS systems first made their presence felt in the US, with major deployments, among others, by the US military. The highest profile healthcare application so far is the Carolinas HealthCare System (CHS), the third-largest public hospital system in the US, with 15 hospitals and medical centers and facilities of about 500,000 square meters.

Europe has, nevertheless, also been quick to adopt Wi-Fi RTLS, especially in a healthcare setting. Some sources claim that the world's first Wi-Fi system used for patient location and tracking was in 2004 at Heartlands Hospital in the British Midlands. Europe has also taken the lead in other areas. In 2007, Belgium's Gent University Hospital was reported as the world's first to use RTLS to track not only where, but also how patients were. The hospital has integrated RTLS tags with medical monitoring equipment to despatch patient health data (blood pressure, oxygen levels and ECG images) as well as emergency alerts to nurses equipped with wireless VoIP phones.

The use of Wi-Fi RTLS in Europe intensified in 2008, with implementations from Scandinavia to Spain. Leading vendors of such systems have partnered with local resellers, to build future sales channels.

And Now, Ultrasound RTLS

The latest approach to RTLS is ultrasound. USID (ultrasound identification) was pioneered in Scandinavia, and uses a barcoded wrist band with a small, disposable battery-powered ultrasound tag. Receivers use proprietary DSP (digital signal processing) algorithms to acquire and transmit signals via a user's LAN/Wi-Fi network to a database with information about the tag's location and the time of reception.

Unlike RFID (or Wi-Fi RTLS systems), USID is better for room level tracking since ultrasound does not penetrate walls or floors. This helps in precisely pinpointing assets (equipment or staff) within a room, and also avoids problems in areas such as a junction of rooms. So far, addressing such challenges have included relatively expensive solutions, such as hybrids of RFID and infra-red (IR) to enhance precision where required.

On the other hand, USID is similar to Wi-Fi location systems by capitalising on the existing wireless infrastructure and not producing electromagnetic interference. USID systems are also quickly scalable.

Enabling Technologies and Operational Efficiency

The continuous development of new enabling RTLS technologies is likely to continue.

On the horizon are new RTLS healthcare applications to improve reporting, compliance and workflow. Overall, RTLS may eventually also have relevance for quality assurance and process improvement programs in hospitals.

RTLS: Taking a Lead

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