

Wi-Fi RTLS in Healthcare *Reducing Costs and Improving Patient Care*

WHITE PAPER

The emergence of Wi-Fi RTLS is having a direct impact on operational efficiency, safety and loss prevention in healthcare settings.

This paper examines the benefits of deploying Wi-Fi RTLS in healthcare over other alternative technologies.



Executive Summary

Traditionally, wireless location-based systems have been limited to simple asset tracking, content provisioning and security applications.

With the advent of more capable 802.11 wireless LAN (WLAN) technologies, as well as the convergence of voice and data over these networks, Wi-Fi Real Time Location Services (RTLS) are emerging as a powerful and cost-effective approach for asset management in a wide range of industries and applications areas.

Some of the benefits of Wi-Fi RTLS include:

- The broad availability of Wi-Fi-enabled equipment, which can be tracked and managed by a Wi-Fi RTLS solution;
- The relative low-cost of Wi-Fi tags, compared to competing proprietary RF-based systems;
- Compatibility with existing 802.11 wireless networks, both legacy a/b/g and those based on the more advanced 802.11n standard;
- Proven and standardized security, which can be adapted to fit more demanding security requirements;
- The ability to smoothly integrate with voice, data and other unified communications deployments.

In fact, the market for Wi-Fi RTLS is expected to grow to \$839M by 2012, according to ABI Research.

While there are a variety of applications that can make use of Wi-Fi RTLS, the technology itself can be broken down into four principal and inter-related services:

1. Location Tracking. Using Wi-Fi tags and embedded transmitters to pinpoint the exact location of equipment and people within an organization. In a hospital, this might involve locating the exact whereabouts of expensive, mission-critical medical equipment to eliminate delays in the moment of need.

2. Asset Management. This involves classifying assets and people so that they can be monitored across the organization. This allows more advanced applications than simply finding something. In medical applications, this might involve monitoring the whereabouts of all inventory of a certain asset type e.g. wheelchairs, IV pumps and so on, and continually tracking whether it is in use, idle or requires servicing or calibration. Or, linking inventory management systems with location and asset tracking services to pinpoint the usage of equipment and supplies in a particular department, like the emergency room or radiology. Using RTLS in such applications serves to eliminate equipment theft, misplacement and hoarding, which in turn allows significant reductions in inventory.

Hospitals and healthcare organizations are clearly positioned to benefit the most from the use of wireless RTLS since the technology has a direct and tangible impact on improvements in patient care, reducing costs, improving physical security and limiting liabilities.

3. Location-aware Safety and Security.

Once physical and people assets are tracked and catalogued, and authorization levels assigned, Wi-Fi RTLS can also provide a powerful layer of security by ensuring that tagged equipment is in specific locations and is not moved into unauthorized areas or outside the hospital. Since Wi-Fi RTLS can be as ubiquitous as the Wi-Fi infrastructure that is deployed, RTLS is no longer limited to preventing child abduction from neonatal ICU. It can be used for any "at-risk" patients. For example dementia patients can also be tagged and monitored to make sure they remain in specific locations, and don't wander off!

Location services have an important role to play in augmenting network access security and ensuring HIPAA compliance at all times. Enterprise-wide RTLS makes it possible for hospital IT staff to restrict patient and guest network access to specific areas of each building, as well as totally locking-down network access from outside the building, except for specific clinical staff and select applications such as voice.

4. Location-based Content Delivery. Once medical personnel are tracked and authorization levels assigned, needed content – such as patient records, doctor notes, insurance forms and so on – can be automatically and securely channeled to the right people based on their security credentials and current location. A doctor making hospital rounds, for example, might automatically receive the complete patient records at the bedside of each patient, whereas a nurse in the same location may get only a subset of that information, and a porter or nursing assistant get an even more restricted subset. Location-based content can also be channeled to specific departments on a just-in-time basis, such as in an operating room during a procedure. This not only saves time and money, it also improves the level of patient care and reduces the risk of getting the wrong information for a particular patient.

A Healthy RTLS Outlook for Healthcare

Healthcare is one of the industries expected to make widespread use of Wi-Fi RTLS and take advantage of its asset management and location-aware security capabilities – especially as hospitals continue to look for ways to minimize expenses and improve patient care. Wi-Fi RTLS can also be linked to patient administration, supplies and billing to reduce unnecessary inventory and provide more accurate materials reporting.

Although only about 5% of the 6100 or more hospitals that have deployed basic Wi-Fi networks have expanded those networks or added separate Wi-Fi RTLS architectures, the market potential for wireless asset management is tremendous due to the technology's competitive and financial advantages, reports market researcher Frost & Sullivan.

As more hospitals look to deploy wireless asset management solutions, there will be an increased interest in Wi-Fi RTLS and an appliance approach, since this offers a simpler and more cost-effective approach to effectively manage assets, control costs and deliver a positive ROI without sacrificing patient care.

Introduction: Wi-Fi RTLS a Strategic and Cost-Effective Asset

Real-time location systems (RTLS) used within buildings and across campus-wide settings have traditionally involved the use of both active and passive RFID tags that operated within a variety of short-range wireless communications networks, like Zigbee.

A proprietary active solution, for example, would make use of active tags or transmitting devices that would broadcast the whereabouts of a piece of equipment or person as they pass within range of an active reader. Signals would be transferred via a short-range low-power wireless network, and then channeled back to a central server. The same operation would happen in a passive system, although the radio frequency ID (RFID) tags would remain dormant until activated by a reading device.



The main problems with these types of systems, however, is: they are expensive, which limits the coverage area and number of items that can be monitored within a building or campus; they are mostly incompatible with existing IP-based network and computing architectures, due to their proprietary design; and they may not be reliable, especially in a passive network that depends on a close proximity pass between tags and readers.

In the past few years, however, 802.11 Wi-Fi networks have emerged as a cost-effective and highly viable alternative to proprietary overlay networks of the past for a number of reasons: The improved performance of emerging 802.11n networks, the high level of adoption within companies across most industry segments, and other advances in wireless LAN management and security have resulted in more robust, more scalable, more flexible and more secure technology that positively impacts deployment scope and ROI.

The high security and cost-effectiveness of 802.11 wireless technologies has positioned Wi-Fi-based RTLS as a leading alternative to traditional RFID technologies. Unlike current and emerging technologies (such as Ultra-Wide Band), Wi-Fi is also not dependent on line-of-sight connections, and the cost of remote tags can be more than 30% cheaper than competing RF systems.

Further, because Wi-Fi chips are relatively inexpensive, equipment vendors of all sorts are Wi-Fi enabling virtually everything from LCD projectors used for hospital presentations and education to expensive and critical IV pumps. And this dramatically reduces the cost of tracking such devices, since it is no longer necessary to tag them at all.

Most important, Wi-Fi RTLS leverages the existing Wi-Fi infrastructure without compromising the existing applications, which results in a rapid and clearly-defined ROI. The convergence of voice, data and location-based technologies also promises to take RTLS to the next level and provide even an even greater ROI across a wider swath of applications. In many cases, even deploying only a few simple asset management applications, the ROI is large enough to cover initial installation and deployment costs within a year or so, and sufficiently high to completely

cover the cost of the wireless network itself within 3 years.

The industry sectors that are positioned to benefit most from Wi-Fi-based RTLS include:

Healthcare – Managing material assets and locating people or shared equipment within a healthcare facility or campus. Also used to restrict access to sensitive areas of a hospital, and pinpoint positions of key staff to provide faster patient and medical response.

Education – Tracking the whereabouts of expensive equipment, channeling content and courseware to specific groups based on their location and need, and providing location-aware security services to quickly secure a campus and notify the right personnel in the event of an emergency.

Transportation – Tracking and managing the flow of products arriving and departing a facility, and keeping tabs on materials that may be hazardous or sensitive in nature.

Financial Services – Keeping track on the flow of pre-tagged equipment and supplies from vendors, as well as their use by employees and visitors within an organization.

Manufacturing – Automated tracking of fixed or capital assets, IT assets, reusable containers, and expensive material assets such as forklift trucks or handheld computers.

Retail – Tracking people within warehouses, distribution centers, and retail stores, as well as coordinating people and processes to automate the retail flow.

Other industry segments and applications areas that may see some productivity, efficiency and security improvements by using Wi-Fi-based RTLS include: Libraries, Hospitality (hotels, convention centers, etc.) and Public Safety (especially in establishing temporary wireless networks and RTLS in emergency situations such as e911).

Hospitals at the RTLS Forefront

Hospitals and healthcare organizations are clearly positioned to benefit the most from the use of wireless RTLS since the technology has a direct and tangible impact on improvements in patient care, reducing costs, improving physical security and limiting liabilities due to medical errors and delays in staff response. More than 80% of the hospitals in the U.S. have already begun deploying 802.11 wireless networks. Although coverage is often limited to just a few areas of the campus, and used mainly as a convenience to visitors and patients (by establishing general wireless hotspots), as EMR applications get rolled out, more and more clinicians are embracing their new found mobility with enthusiasm.

Over time, these basic networks – which serve to validate the general utility of Wi-Fi – can be expanded and supplemented with more advanced and reliable 802.11 systems that provide the secure end-to-end coverage required for an effective Wi-Fi RTLS. Hospitals opting for a wide scale deployment of Wi-Fi, can benefit from the location-based and asset tracking capabilities of the system, by adding Wi-Fi RTLS technologies. Since wireless RTLS can be gradually deployed throughout a hospital on a floor-by-floor basis, systems can be designed that easily keep within budget. Smaller deployments can also be positioned as location- and asset-tracking pilot projects, providing important information and feedback for future expansion throughout a healthcare facility. Later, these smaller deployments can be easily expanded to seamlessly work together to provide a complete Wi-Fi RTLS.

The use of wireless RTLS in hospitals can save time in locating staff, patients and hospital equipment; reduce costs by tracking and positioning key pieces of equipment within reach of multiple hospital teams; allow healthcare providers to receive immediate alerts about patient activities and restrict movements within a hospital area; help to automatically assign caregivers to individual patients; and provide valuable feedback in terms of forecasting future equipment and staffing needs.

Point of Patient Care Benefits

Most hospitals cite improvements in patient care, rather than cost containment, as the primary reason for deploying Wi-Fi. In fact, a recent international survey commissioned by Motorola, Inc. revealed that healthcare workers can recover approximately 39 minutes per day through the use of mobile applications within a hospital or across a hospital campus, which can allow more time at the point of patient care.¹ Deploying Wi-Fi RTLS on top of that infrastructure, enables even better patient care, and has direct impact on asset cost reduction as well.

A major hospital network north of Boston, for example, has been using a wireless RTLS (Wi-Fi and proprietary), that uses both active and passive RFID, for more than three years, initially deploying the system to allow doctors and nurses more time with patients and improve response to patient needs. Hospital administrators were also aware of the cost benefits of having a wireless location- and asset-tracking system that could reliably keep tabs on the movement of costly equipment resources and limit the possibility of theft and misplacement.

There are also a number of 'soft' benefits to Wi-Fi RTLS, including improved reporting and inventory, more accurate forecasting, reduced liabilities because supplies can be tracked and traced from storeroom to actual usage, and the positive impact on regulatory compliance through improved accountability of people and assets within a facility.

A growing number of hospitals presently use Wi-Fi-based systems to track and manage resources and personnel. Approximately, 5% of the hospitals in the U.S. have deployed Wi-Fi-based RTLS according to Frost & Sullivan, providing a significant competitive and financial advantage to these early adopters and a substantial growth opportunity for the industry in general.

¹ Motorola Enterprise Mobility Healthcare Barometer, April 2009



A typical 500-bed hospital can expect to save up to \$260K per year by using a wireless RTLS to reduce the misplacement and theft of hospital resources, and limit the time spent searching for missing equipment.

Wi-Fi-Based RTLS on the Healthcare Front-Line

Wi-Fi-based RTLS is designed to provide accurate and precise location tracking of any 802.11 device within the parameters of a dedicated wireless LAN (WLAN). These 802.11-enabled devices include wireless asset tags, embedded wireless transmitters and Wi-Fi phones (Polycom, Ascom) and voice-enabled Wi-Fi badges (Vocera) that can be worn by medical personnel and used as part of a strategic voice over Wi-Fi (VoWi-Fi) network.

In addition, Wi-Fi RTLS systems can be used to track and manage 802.11 voice over IP handsets, handheld computers, tablet PCs and other electronic devices. This means doctors, nurses and support personnel can be instantly located and linked to the people and information necessary to accomplish key tasks. Wi-Fi RTLS can not only be used to monitor and track physical assets within a hospital, but can also be used to manage and coordinate equipment and personnel to create a more effective and responsive network of people and resources.

For example, in the emergency room, Wi-Fi RTLS can be used to quickly broadcast information to the right people about a critical event, and then bring those people and the necessary equipment together for rapid response. This might involve something as simple as locating a wheelchair for a patient, or pinpointing and retrieving a life-saving cardiac 'crash cart'.

RTLS can also be used to 'lock down' certain areas of a hospital and alert administrators or security personnel when someone is in an area without proper authorization (in a nursery or laboratory, for example, or to alert personnel if a dementia patient has left a restricted area without authorization).

As a cost-cutting aid, Wi-Fi RTLS can accurately track hospital inventory and supplies to eliminate shortages or over-supply. The system can also be used to prevent hoarding by nurses and doctors to avoid shortages, since location- and asset tracking is automatic and can generate timely reports and re-order requests. The end result is more control over durable goods inventory for the hospital, and a potential cost savings to patients as well – which improves the competitive position of a healthcare organization.

In terms of the cost benefits, a typical 500-bed hospital can expect to save up to \$260K per year by using a wireless RTLS to reduce the misplacement and theft of hospital resources, and limit the time spent searching for missing equipment.²

The location-aware nature of Wi-Fi RTLS can also be used to automatically and securely channel patient information to the point of need, saving time and potentially saving lives – in the case of an emergency room and arriving EMT services, for example. Doctors and nurses can spend more time aiding a patient and less time chasing records and paperwork. Key personnel can also be called into play since the Wi-Fi network also supports location tracking of people with both voice and data communications.

Keeping Track of Different RTLS Solutions

Not all RTLS systems are alike, however. Some are capable of basic tracking – meaning they can pinpoint tagged equipment or people in proximity to the nearest wireless access point. Others require specialized client devices, or software installed on clients devices, which adds to the initial costs and long term support / maintenance requirements of the system.

The more capable Wi-Fi RTLS alternatives provide a more accurate and auditable profiles of personnel and equipment within a hospital and therefore a richer and more useful view of a hospital environment. The latter types of systems provide:

- More precise and accurate tracking, through the use of software and location algorithms that build upon the basic proximity capabilities of standard 802.11 networks;
- An appliance-based architecture, which simplifies setup and provides industry-standard APIs that support a wide range of leading networking platforms (Cisco, 3Com, Aruba, Nortel and the Trapeze Smart Mobile Platform);
- A lower cost of ownership, due to the compatibility and integration with existing WLAN infrastructures and support for a wider variety of industry-standard readers and sensors;

² Frost & Sullivan, Dec. 2008

- The ability to closely map X and Y coordinates on specific floors of a hospital facility and name these locations (such as 'Operating Room A' or 'Nurse Station B', or even target individual patient rooms and beds);
- The ability to accurately define physical boundaries to isolate and restrict the movement of key equipment within defined "locales", coordinate the activities of medical teams, and automatically channel content to specific people within these defined boundaries for real-time 'point of need' or 'time of need' requirements;
- Centrally-controlled WLAN management, allowing highly accurate control of all access points and Wi-Fi-equipped devices within a specified area, as well as flexible management of security levels and enforcement of hospital network policies.

It is also important to note that not all wireless LANs (WLANs) are alike, and do not necessarily provide the end-to-end reliability and security that is necessary for a effective deployment of Wi-Fi location and asset tracking applications. While 802.11 technology is mature, a number of solutions lack the ability manage and control the flow of traffic and users on the system, or provide the necessary user policy and authorization restrictions to design a secure and multi-functional RTLS.

Reliability is perhaps one of the most important aspects of a mission critical Wi-Fi network, especially in a hospital setting where technology failures and shortcomings have a direct impact on patient safety and hospital liabilities.

Hospital Wi-Fi RTLS in Action

While wireless RTLS can routinely be used to monitor patients, equipment and healthcare providers to track general movement within a hospital, the technology can also be applied to specific departments and aligned with applications that are unique to healthcare facilities. For example, Wi-Fi-based location tracking can be used to provide real-time tracking of patient records in oncology departments, and coordinate the flow of time-sensitive information and services between doctors, patients and laboratories.

Wireless location systems can also be used to track medicine inventory and generate chain-of-custody reports for the use and disbursement of highly-controlled medications. This system can also be tied to patient location and nursing station to coordinate activities and simplify the shift transition process.

In operating and emergency rooms, RTLS can be applied to work area and medical bay to pinpoint the precise location of doctors, nurses and other healthcare personnel, and coordinate activities between pre-OP and recovery operations. Wireless location-based networks can also function as the backbone for time management and prioritization systems to maximize the time spent with patients, provide real-time triage activities, and streamline patient workflow without sacrificing quality of care.

Wi-Fi-based location systems can also be applied to track at-risk patients (Alzheimer, psychiatric, elderly, etc.) within a hospital environment or assisted living facility to monitor and restrict their whereabouts and to trigger alerts in an emergency situation to contact specific medical teams or security personnel.

Most hospitals are using wireless RTLS to track and manage the physical assets within a hospital or healthcare facility because of the strong return on investment (ROI) potential of using the technology to keep tabs on expensive medical equipment. For example, a number of hospitals use wireless RTLS to identify the whereabouts and availability of infusion pumps (each costing \$2.5K or more) to make better use of supplies (and thereby reduce rental costs), as well as to improve delivery times to medical personnel (by pinpointing locations close to points of patient care).



Cost Benefits of Wi-Fi RTLS	Non-Monetary Benefits of Wi-Fi RTLS
Mobile asset location prevents theft/ loss/ misplacement of valuable hospital equipment	Increased productivity and staff efficiency
Reduction in time spent by staff searching for misplaced equipment and resources	Higher bed turnover rates and patient satisfaction
Reduced rental costs since tracked equipment can be more effectively used by hospital staff	Improved monitoring of elderly/ psychiatric patients resulting in increased patient safety and less liability

Source: Frost & Sullivan

Other hospitals rely on wireless RTLS solutions to track the availability of beds and speed bed turns, and monitor wheelchair availability (priced at \$5K or more for specialized versions), thereby reducing annual costs by hundreds of thousands of dollars. Tracking systems can also be used to generate reports on usage trends or resource forecasting and future equipment purchases and rentals.

Other healthcare organizations are taking wireless RTLS a step further by tagging doctors, nurses, patients and equipment and then tracking the interaction of all the players and resources to build a highly-accurate profile of a patient's course of treatment. This information can be used to generate a highly-detailed billing profile, or produce reports that can be used for provider accountability and responsibility.

Taking an Appliance or Server-based Approach to Wi-Fi-based Asset Tracking

As more hospitals look to adapt current 802.11 networks or add dedicated overlay networks to perform location asset tracking, there will be an increased demand for an appliance approach since it offers a simpler and more effective way to deploy and manage these networks. These appliances should be designed to be compatible with a variety of wireless networking architectures and client devices to minimize costs and maximize coverage and manageability over a wide range of industry-standard devices.

Almost any enterprise-grade Wireless LAN provides basic location-based tracking capabilities (able to sense the presence of an 802.11 signal when in range) that are sufficient to locate one device at-a-time on demand. But the scope of advanced real-time location systems is on a wholly different scale. They are designed to provide much higher-positioning accuracy – with 3-5 meter precision, on a massive scale, tracking thousands of devices simultaneously – and with the ability to correlate that information to people and material assets.

These systems provide the tools to visualize asset location on a floorplan. They can also be made to trigger alarms, alerts and more, when specific user defined event occur, for example when more than X units of IV pups are in this 'dirty room', notify someone to come and services them. The more integration with business processes and other business applications, such as patient registration systems, the faster the ROI that is realized.

Wi-Fi RTLS Profile: The Medical Centre Alkmaar (MCA)

- Major hospital located in the Noord-Holland Noord province of The Netherlands, which provides medical services to more than 600,000 residents
- Presently using a Trapeze LA-200E Location Appliance to track over 1,200 users and 200 various wireless devices (laptops, asset tags, PDAs) within the hospital
- System integrates location information from Trapeze LA-200E APIs with existing Electronic Nurse File patient tracking system – ensures each nurse matches up with the assigned patient.

Best of breed Wi-Fi location tracking solutions can also be easily configured to define physical boundaries and to accept 'named locations' (based on X, Y and floor coordinates) to simplify overall system management. They can also be set to overcome 'floor hopping' and employ asset filters, rules engines, real-time floor plan views and alerts to easily locate people and equipment anywhere in a hospital environment.

All of these features combine to create a more intuitive and responsive asset tracking environment that can not only accurately pinpoint physical assets within a hospital or medical campus, but also monitor the movements of patients and medical personnel within a facility.

By providing edge-to-edge asset tracking and coverage, medical teams can track and control high-risk patients, eliminate traffic within restricted areas, and maintain close connections with key medical personnel. Alert capabilities can also be integrated with existing email and VoIP and wireless messaging systems (Polycom, Ascom, etc.)

Since cost is still an important factor from an IT budgeting standpoint, systems that make use of an existing Wi-Fi infrastructure to track and manage assets, and do not require the use of proprietary readers, exciters or chokepoints, or proprietary client software, are a better choice because this can significantly lower deployment cost and improve the return on investment (ROI) metrics.

A Solution for Wi-Fi RTLS: ActiveAsset™

ActiveAsset is a Real-Time Location Services (RTLS) application that empowers enterprises to locate, track, manage, secure and analyze critical mobile assets and personnel for maximum return on investment and efficiency. Together with the Trapeze LA-200E Location Appliance™ and optimal AT-320 Wi-Fi asset tags, ActiveAsset delivers critical, real-time point-of-need and time-of-need information necessary to improve enterprise processes, asset allocation, cost efficiencies and maximize employee productivity.

Improving operational efficiency, safety and loss prevention in healthcare settings are important benefits that real-time asset tracking delivers. And since the incremental deployment cost is so low, return on investment (ROI) within 12 months is typical. Active Asset provides organizations with the ability to access timely location-specific information and services easily and efficiently – beyond the limitations of passive RFID or even hybrid Wi-Fi location systems using passive readers or choke points.



Summary: A Cost-Effective Case for Wireless RTLS

As stated earlier, only about five percent of the Wi-Fi-enabled hospitals in the U.S. presently use Wi-Fi-based RTLS. However, the potential cost savings and impact the technology can have on patient care and improvements in the flow of medical operations are expected to rapidly drive adoption – especially as hospitals look for new ways to control costs and remain competitive.

The ROI benefits of Wi-Fi RTLS are a strong incentive, since the cost of system deployments and operation will ultimately come out of constrained IT budgets. For example, the cost of installing a wireless RTLS in a typical mid-size hospital is approximately \$147,000. But, the yearly cost savings in asset location, labor and equipment rentals can easily approach \$324,000, according to Frost & Sullivan*.

Wireless RTLS can also be seamlessly integrated into current Wi-Fi networks and become a valuable part of an active integrated communications network, combining voice, data, video and location-based applications.

Key benefits of using Wi-Fi-based RTLS over other contained or short-range communications alternatives include:

- Leverage existing wireless infrastructure investment;
- No requirement for proprietary overlay RFID equipment;
- Ability to natively track ALL Wi-Fi-enabled medical devices, Wi-Fi handsets and all types of PDAs, notebook and tablet PCs;
- Improved and flexible levels of security, especially when combined with server-based policy management software;
- Open and standardized operational and applications development platforms;
- More affordable remote tags and 802.11 location devices;

- Real-time sensing and monitoring capabilities, since the 802.11 network and tags are always active as opposed to passive;
- More robust, powerful and compatible radio networks, especially 802.11n (compatible with 802.11 a/b/g technologies);
- The ability to closely relate personnel, applications and content to location to expand the usefulness of wireless RTLS beyond simple tracking and control.

Hospitals can typically use Wi-Fi RTLS tags to track and monitor usage of expensive and critical medical equipment, like IV pumps; coordinate the activities of healthcare professionals and medical teams; relate patients to medical devices, records and medical procedures within a hospital (to provide better control and improve billing), and restrict the activities of the elderly and psychiatric patients without the need for staff intervention or supervision.

While there is a definite cost-savings benefit to using wireless RTLS in a hospital, the real impact can be on improvements in patient care and the time spent by healthcare providers at the point of patient care. That, essentially, is the driving factor behind selection and deployment of wireless RTLS as rising costs, increased demands and pressures to increase patient throughput, put more of a strain on core health services and operations.