



Ekahau White Paper: The ROI of Real-Time Location Systems and Active RFID in Healthcare

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1. Executive Summary

With the Real-Time Location Systems (RTLS) market estimated to reach \$4 billion by 2022¹, healthcare facilities will continue to invest in active RFID (Radiofrequency Identification) technology in order to improve patient experience and care outcomes. While there are many technology options on the market, it is important to understand the most impactful use cases, the formula for achievable ROI based on a whole-hospital approach to RTLS, and the business intelligence afforded by location visibility.

This white paper identifies and explains how RTLS technologies impact healthcare organizations and how to determine ROI of employing these technologies.



Optimize patient queuing with RTLS and put an end to the waiting room.

¹ Real Time Location System (RTLS) Market – Global Industry Size, Share, Trends, Analysis and Forecast 2012-2022 [2011]. Available at <http://www.transparencymarketresearch.com/real-time-location-system-market.html>

2. What is RTLS?

Real-Time Location Systems, RFID and GPS solutions belong to a family of technologies referred to as location-based services (LBS). Location-based services are leveraged in many industries --social media, manufacturing, oil and gas, retail and healthcare. Most users are familiar with GPS-based smartphones applications which offer an outdoor locating platform. Indoor location tracking is provided by RTLS solutions, using radiofrequency identification (RFID) technology and existing Wi-Fi networks in enterprise buildings.

What is a Real-Time Location System (RTLS)?

Commonly, real-time locating solution (RTLS) and radiofrequency identification (RFID) are used interchangeably. However, RFID is only one possible component or technology representing an overall RTLS implementation used to identify, locate, and track an institution's assets and resources. RTLS is not limited to radiofrequency and can include infrared (IR), global positioning system (GPS) and barcode components [passive RFID]²."

There are two types of RFID technology. The first is *passive* RFID, which typically requires a scanner or reader and shows an object's location at 'a point in time' when a tag is close to a reader. The other type is *active* RFID, which shows an object's location in real-time without reliance on readers. Passive RFID solutions are generally a cost-effective solution for tracking common, lower-cost items in manufacturing and retail settings.

An RTLS solution is a positioning system that pinpoints the location of an object or person indoors and outdoors; the most widely adopted RTLS solutions use active RFID technology to pinpoint location. Active RFID over a hospital's existing Wi-Fi network makes a whole-hospital RTLS adoption more affordable -- and therefore commonplace. No longer seen as a luxury, RTLS solutions are proving to be the only means of measuring and seeing 'what's really going on' operationally, without increasing staffing levels in clinical settings.

Some RTLS solutions use algorithms based on Received Signal Strength Indicated (RSSI, a measure of radiofrequency power) to read the data from sensors, tags and badges and translate this information into mapped locations. Since tracking 'things' only provides partial benefits, the newest and most advanced RTLS solutions take location data and combine it with the status or condition of a person, asset or workflow to reveal business intelligence derived from raw or mapped location data.

A few Real-time Location Systems (RTLS) vendors use an existing Wi-Fi network to communicate location in real-time while others require proprietary, hard-wired networks just to assure real-time location tracking. Real-Time Location Systems may re-purpose Wi-Fi (802.11 protocol) networks, or use non-RFID means of calculating location such as Ultrasound, ZigBee or Infrared technologies. Systems that re-use existing infrastructure provide equivalent performance to those using dedicated infrastructure for the majority of clinical use cases for RTLS; this impacts the cost side of the ROI equation.

² Frisch, Paul H & Booth, Paul and Saul Miodownik [2010]. Beyond Inventory Control: Understanding RFID and its Applications. IT Horizons, AAMI. 39-48. Available at https://www.aami.org/publications/ITHorizons/2010/39-48_Behind%20the%20Technology_Frisch.pdf

3. Today's RTLS is more affordable and offers more applications than ever before

Today, the most popular and widespread use cases for RTLS go beyond basic asset tracking and search/find map features. An emerging breed of cost-effective and advanced RTLS solutions are being used to improve staff safety, meet regulatory documentation requirements, drive caregiver productivity, automate workflows, ensure security and prevent loss and improve patient experience tied to reimbursements.

In addition, many of the savings and productivity gains outlined in this whitepaper require a whole-hospital RTLS network to deliver ROI. Many dedicated, non-Wi-Fi systems provide a high degree of location accuracy for niche applications. These systems are rarely deployed hospital-wide as they are cost-prohibitive due to the cabling requirements; therefore, much of the value of location-based business intelligence, workflow savings and automation is lost to facilities considering these solutions.

4. Leveraging RTLS in Healthcare Settings

Healthcare organizations are moving away from partial RTLS deployments that focus on super-fine shelf-level accuracy (primarily used in pharmacy tracking applications) and are instead concentrating on whole-hospital adoption of RTLS in order to improve operations and patient experience. Trends indicate that hospitals want to do more with less and that their RTLS investment is no exception to this philosophy. Enterprise-wide RTLS adoption reduces the cost of care by tracking a broad variety of workflows related to caregivers and common care tasks, automating workflows where possible to remove manual efforts and improving patient safety along with experience.

Big data and cloud computing are the most significant trends driving the need for whole-hospital RTLS adoption beyond basic asset tracking. By leveraging the right RTLS solution, hospitals can take location data and analyze trends that transform operations ---RTLS provides a means of revealing business intelligence otherwise unseen and untapped. A premium is now placed on usability, ease of integration to third-party applications and RTLS solutions that consume little management time and expense.

Each RTLS provider offers benefits and deficiencies, depending on a facility's use cases. This section will outline the general benefits of RTLS adoption for asset tracking, patient tracking and advanced applications such as staff and patient safety, workflow optimization and environmental monitoring and reporting.

5. Reducing Hospital OPEX (Operational Expenditures)

By leveraging RTLS solutions, healthcare facilities can eliminate costly manual processes and reduce the time that employees spend on administrative tasks while preventing capital equipment losses, theft and under-utilization resulting in over-ordering.

5.1 Improving Workflows with Location-Aware Messaging

Routine workflows and administrative tasks often require process changes and managerial oversight and take time to implement hospital-wide. In other words, change is a challenge. For example, adopting a best practice such as hourly nurse rounding can significantly improve patient satisfaction scores but it requires enforcement and monitoring by Chief Nursing Officers (CNOs)³. This effort could be minimized with an automated, timed reminder system to monitor patient activity -- or inactivity -- with RTLS.

In many healthcare facilities, nurses must multi-task a variety of responsibilities or must peer into patient rooms and use their best judgment before rounding, reducing the likelihood of rounding efficiency. Improving caregiver-patient interaction can be as simple as a button push on an RFID tag. Rounding is simplified and improved with RTLS monitoring and reminder text communications based on patient activity or nurse call button pushes.

Caregivers can communicate using location-aware messaging that sends notifications to an individual patient or groups of patients based on their status or location, direct from RTLS tags or badges. Patients in waiting rooms can be queued using a RTLS badge with a text feature. The text feature can tell them where to go based on timing or location, eliminating unnecessary waiting. These systems can also send an alarm to an ED manager if a patient has exceeded wait time benchmarks, impacting Joint Commission compliance. With the healthcare industry's continued adoption of RTLS for patient queuing, waiting rooms could become obsolete.

In long-term care facilities, caregivers can send RTLS pre-program medication reminders that appear on resident wristbands or buzz residents. These automated reminders can be customized so that residents receive the message any time their location changes, (e.g., as they're leaving their room). Residents (or possibly even caregivers) can also press a tag button after medicine is administered to record the time when medication when administered for integration into a patient's record. RFID badges with a text feature offer many possible workflow adaptations to create strong hospital ROI.

5.2 Patient Monitoring Simplified

Monitoring patients is labor-intensive. Caregivers need to be available to help those with the most needs but also keep watch over all patients. Real-Time Location Systems with messaging capabilities allow patients to use RTLS badges or wristbands as a nurse call buttons on-the-go. Patients can stay ambulatory and caregivers can remotely monitor their patient at all times. By empowering more capable patients and allowing them to pick-up their own X-rays and perform other basic tasks, caregivers have more time to serve those most in need, making the best use of existing staff.

Some new RTLS tags are built with motion detectors. These solutions offer location-based 'geo-fencing', to alert caregivers when a patient wanders nearby a stairwell or restricted areas. Badges with LEDs and buzzers can trigger an alarm --customizable for silent or auditory -- telling the patient to avoid entry into a dangerous zone. In addition, caregivers can receive geo-fence alarm notifications showing the patient's location, a faster way to identify and respond to a patient safety issue than coordinating with security teams or scanning video surveillance systems to find the patient's location.

³ Hunsicker, Jason. "NRCM gets results, satisfaction." Kirksville Daily Express 2 May 2013. Available at <http://www.kirksvilledailyexpress.com/article/20130502/NEWS/130509759/1001/NEWS>

5.3 Automating Temperature Monitoring and Documentation for Compliance

Temperature and humidity play a key role in infection control. The average hospital owns and maintains hundreds of food, blood, bone, tissue and medication refrigeration units. The storage of pharmaceuticals, tissues, organs and other items in refrigeration units are critical to hospital workflows and patient safety from infection. Also, humidity is an important factor to minimize infection. For example, ORs should not have a relative humidity (RH) below 40% because the risk of infection can increase above this point, potentially impacting surgical procedures and patient safety. If temperature and/or humidity levels are compromised, a hospital can violate Joint Commission recommendations and increase risk to patients.

Today, most hospitals use manual logs, also known as the 'clip board' method, to track temperature or humidity. This manual tracking requires professional staff to complete the repetitive yet important task of ensuring temperature and humidity compliance. But manual temperature logs are also susceptible to human error; allowing professional staff to concentrate on less administrative tasks would optimize this record-keeping.

RTLS solutions can automatically and wirelessly detect temperature and humidity breaches. Some solutions even proactively alarm via on-badge texts and alarms as temperature or humidity come closer to breach thresholds and trigger an audible buzz in the sensor itself so that those near the refrigerator can act before a breach occurs.

Temperature or humidity RFID sensors are often battery-powered, eliminating the need for hard-wiring. Some solutions offer optional escalation alarms until the alert is acknowledged or work is confirmed; this helps prevent spoilage and loss before they occur. Hospitals can even use automated temperature monitoring to determine which refrigerators are beginning to fail and maintain units differently based on analysis of temperature trends.

Ultimately, RTLS solutions can automate temperature and humidity monitoring and minimize risk by removing the labor costs associated with maintaining manual logs. For example, a hospital with just 60 refrigerators, with each unit taking five (5) minutes to properly check, will require 300 minutes of monitoring work a day. If a Biomedical Engineer is doing that work, it would cost a hospital \$70,194 a year (assuming \$0.64/minute labor costs). This example highlights the savings that can accumulate through RTLS implementation.

5.4 Breadcrumb Trails and Forensics

Ensuring fire safety is one of the most frequently cited deficiencies documented by the Joint Commission⁴. That is why some RTLS software programs offer post-event analysis such as a 'breadcrumb trail'. This feature allows hospital administrators and first responders to replay recorded event movements that show where people and assets moved over a period of time. Real-time forensics allows healthcare facilities to establish emergency plans, tag staff and then run simulations that determine emergency response effectiveness. Viewing real-time movement histories also allows managers to calculate the time spent on tasks and compare areas of the facility with the most- and least-efficient emergency response times to create future improvements.

⁴ McLaughlin, Susan B (January 2012). Avoiding frequent Joint Commission deficiencies. Healthcare Facilities Management. Available at: http://www.hfmmagazine.com/hfmmagazine/jsp/articledisplay.jsp?dcrpath=HFMMAGAZINE/Article/data/01JAN2012/0112HFM_FEA_CodesStandards

6. Lowering CAPEX and Saving \$4,000 per Bed Each Year

Advanced RTLS software can help hospitals lower equipment capital expenditures and rentals. With real-time visibility, managers can track equipment, prevent loss or theft, monitor par levels and utilization (dwell times vs. time in use), optimize equipment availability and improve patient throughput and healthcare operations.

6.1 Equipment Tracking Savings

The average hospital invests approximately \$200,000 in equipment (acquisition value) for each staffed bed and \$3,000 in equipment per patient discharge⁵. Second only to staffing costs, hospitals spend a significant portion of their capital budgets on vital medical equipment⁶. The average hospital owns or rents a total of approximately 35,000 SKUs of equipment at any given point; it makes sense that supply chain costs consume as much as 40% of total operating budgets. Inventory optimization can account for 10% of overall savings. With such a large amount of the hospital's budget spent on medical equipment, hospitals cannot afford the cost of poor asset management expenditures. Without an effective asset tracking solution, asset and equipment management becomes a guessing game.

Most hospitals re-order missing -- or misplaced – equipment. Missing rental equipment must be replaced for hospital use; in addition the lessor also must be reimbursed for the missing equipment. Ineffective equipment management means that the hospital will end up paying for one piece of equipment three times. Beyond the loss of assets, the impact of lost hospital productivity due to lost and missing equipment is substantial and can delay basic processes such as hospital discharges, admissions and transports.

Advanced RTLS solutions allow caregivers to find staff assets quickly and essentially 'see through walls', saving the time it takes to look in every closet and room for a wheelchair, wound vacuum, IV pump and other equipment. Caregivers simply log into the RTLS software and search by using a web browser on a campus-wide map to find what they need. Caregivers can view assets on real-time floor plans and search for a particular asset, a group of assets such as "all IV pumps," or use a combined search such as "IV pumps located in the third floor OR" without having to waste time walking around to find equipment.

Using location-based intelligence, hospital administrators can focus on their problem areas to prevent the estimated \$4,000 of equipment per bed that is lost or stolen in the average hospital annually. This means that a 300 bed hospital could be losing \$1.2 million dollars of equipment each year⁷. Yet even with the significant equipment losses occurring each year, most hospitals continue to live with the inefficiencies of an un-monitored, manual equipment tracking system. Some caregivers may hoard equipment to ensure their patients receive quality care. This is a systematic response to ineffective asset management that can be avoided by employing RTLS. Many hospitals find that assets can be accidentally dumped in laundry chutes, lost or removed from campus altogether. RTLS can help prevent these losses by sending an alert if equipment accidentally or illegally leaves the premises. Alerts can be sent based on entry into pre-programmed restricted 'geo-fenced zones' (e.g., entryways/exits) and an alarm automatically sent to security teams via text, email or page to prevent equipment losses before they occur.

⁵ Wang, B.; Eliason, R.W.; Richards, S.M.; Hertzler, L.W.; Moorey, R., "Financial impact of medical technology," Engineering in Medicine and Biology Magazine, IEEE, vol.27, no.4, pp.80,85, July-Aug. 2008

⁶ Darling, Michael & Sandy Wise (April 2010). Not Your Father's Supply Chain. Materials Management in Health Care. Available at <http://connection.ebscohost.com/c/articles/50137080/not-your-fathers-supply-chain>

⁷ Darling Michael and Sandy Wise (April 2010). Not Your Father's Supply Chain. Materials Management in Healthcare. vol. 19 no. 4. Available at: <http://ehis.ebscohost.com/ehost/detail?sid=3d1e5a57-bdfd-4c63-a740-9c0d8f3fa1f9%40sessionmgr13&vid=1&hid=15&bdata=JnNpdGU9ZWhvc3QtOGl2ZQ%3d%3d#db=f5h&AN=50137080>

6.2 Automated Maintenance and Equipment Utilization Rates

The newest breed of RTLS solutions automate work order management and work confirmation via tag button press. By automating equipment related workflows, equipment utilization rates increase over time and common tasks such as sterilizations and cleaning, repairs and scheduled preventative maintenance are optimized.

If equipment requires immediate attention (e.g., cleaning), caregivers can trigger a service request by pressing an asset tag's button. And if equipment leaves pre-programmed zones (e.g., restricted departments/floors) or moves closer to exits, alerts can be sent to prevent theft and loss before equipment leaves the premises.

Automated alerting based on location-awareness streamlines workflows. For example, some RTLS software allows managers to monitor and receive an alarm when equipment levels are under par (especially in critical areas such as an Emergency Department (ED)). When equipment par levels are low, in certain locations based on equipment dwell times and presence detected in rooms, RTLS software can send alerts to pagers, email addresses, badges and mobile devices so that administrators can prevent over-ordering, reduce inventory. Administrators can even improve speed of cleaning by increasing staffing levels on certain days, but not on others based on the par level business intelligence.

7. Increasing Patient Throughput and Revenues

Real-Time Location Systems can drive healthcare revenues in a number of ways such as categorizing patient queuing to reduce wait times, improving bed management and shortening the time it takes to complete basic processes like a transport or discharge.

7.1 Automation and Work flow Optimization

Hospital workflows are comprised of repetitive tasks and procedures such as admissions, discharges, nurse rounding and equipment maintenance. These tasks are important for hospital operations, patient safety and patient satisfaction. However, if basic tasks are executed inefficiently, these processes can become time-consuming, driving up the costs of healthcare.

To improve routine workflows, performance metrics should be obtained and reviewed. Today, hospital administrators have to manually track a variety of processes to benchmark them against performance to analyze workflow metrics which creates additional work for managers. Automating common hospital workflows such as equipment searches, routine equipment cleaning, transport requests and patient documentation tasks improves patient throughput because caregivers have more time to spend on care.

Ideally, hospitals want to automate and analyze workflows in order to identify bottlenecks and then eliminate them. For example, by tracking the time it takes to call and secure patient transport to and from a building, managers can improve management tactics and productivity for those tasks. The location-based business intelligence that RTLS software provides reveals workflow bottlenecks and helps managers make better decisions for their departments, without consultants or additional paperwork.

7.2 Optimized Patient Queuing

One specific example of RTLS task automation is patient queuing. Patients wear an RTLS badge that also acts as a pager or nurse call on-the-go. Some RTLS solutions providers offer a two-way text feature on their badge so that text instructions can be sent to patients or families who are in waiting rooms. For example, a patient's family may be paged or "buzzed" with updates or patients may be told to go to X-ray on the Third Floor in five minutes. Badges can tell patients where to go next and provide on-badge directions to help them navigate.

With RTLS-based patient monitoring and queuing, patients are ambulatory and untethered to a bed. With a simple button press, patients can request help at any time or help from only those who are close by and see the page on their badges. Patients are visible on real-time maps accessed by nurses.

Ultimately, location-aware patient tracking solutions can free up caregiver time without compromising patient flow or quality of care.

7.3 Patient Satisfaction

By improving workflows and reducing patient wait times, RTLS solutions can result in higher patient satisfaction scores (as graded by Hospital Consumer Assessment of Healthcare Providers and Systems -- HCAHPS). These HCAHPS scores will affect Medicaid reimbursements which are becoming more important because Medicare will cover more than 20 million new patients over the next few years⁸. Therefore patient satisfaction surveys will drive a larger portion of a hospital's revenues.

8. Improving Productivity and Safety

Real-Time Location Systems can improve productivity and lower the cost of ensuring safety while improving safety overall. Ultimately, RTLS is not just about tracking things; it is about creating a positive effect on productivity and generating measurable results.

8.1 Staff Safety

Every day, more than 5 million hospital workers in the United States are exposed to violence or the threat of violence at work. According to one study, nine out of 10 ED managers said that patient violence is the number one threat faced by caregivers⁹. The threat of violence is so great that the term "staff duress" was coined in order to characterize the phenomenon.

Workplace safety not only impacts a hospital's risk profile, it also directly correlates to caregiver satisfaction. Threats of violence directly impact hospital staff retention and recruitment efforts along with a facility's long-term reputation in the community it serves.

⁸ Seidman, William and Rick Grbavac (March 7, 2013). Creating a Culture of Patient Safety. Hospitals and Healthcare Networks. Available at: <http://www.hhnmag.com/hhn-mag/HHNDaily/HHNDailyDisplay.dhtml?id=3110007162>

⁹ Collings, Russell and Tony York (October 2009). Hospital and Healthcare Security. Burlington: Butterworth-Heinemann.

Knowing the exact time and location of an emergency can reduce response times and with it, the likelihood of injury or death, creating a safer environment for staff. In fact, the use of a panic button/silent alarms is associated with lower rates of physical violence¹⁰. Many silent alarm systems and voice dialing systems lack location visibility and rely on the caller to give their location, which is not feasible in many cases. Real-Time Location Systems can offer emergency location visibility along with proximity-based text alerts to emails and mobile phones so that the staff members close by are those that are called on to help. Some solutions even offer receipt acknowledgement, mass communications and man-down alerts based on timed motion detection, built into RTLS tags and badges. With location-aware alerting, caregivers, visitors and other staff on large campuses have peace of mind because they know help is nearby.

9. Return on Investment (ROI)

Typical RTLS hospital ROI is achieved in six to 12 months, when asset tracking is used in tandem with other applications. The two use case examples below illustrate typical ROI derived through the use of Ekahau RTLS for hospital asset tracking.

9.1 A Reduction in the Number of Capital Assets (Inventory)

A mid-size U.S. hospital considered buying 180 ICU-grade ventilators for daily operation, yet their RTLS solution indicated that ICU utilization rates were 55%, meaning that only 100 units were used on average, at any given point in time.

By leveraging an Ekahau RTLS to better understand real-world utilization rates (55%), the hospital limited its purchase to 50 extra ventilators instead of 80, to ensure on-time availability accounting for maintenance down-time, loss, theft, and day-to-day misplacement. The reduction in the number of excess ventilators from 80 to 50 units resulted in a \$325,000 CAPEX reduction for the hospital without impacting caregivers and patients.

Additional savings were achieved over time through reduction of maintenance programs (OPEX) and short-term equipment rentals, as well as lost equipment previously unaccounted for throughout the year.

9.2 Improved Productivity Resulting from Shorter Search Times

On any given day, equipment searches and paperwork related to patients and work orders for equipment translate into delays for patient procedures and lost hours of productivity. It is estimated that 30% of nurses on average report spending at least one hour per shift searching for equipment, potentially delaying discharge, admissions, and transports in the hospital, among other standard procedures. Assuming a \$66,690 average salary¹¹, an estimated \$4,167 dollars is lost per year, per nurse on searches. Conservatively assuming there are 353 nurses for a 300-500 bed facility, equipment searches alone could result in over \$1.4M in lost productivity every year.

When a hospital considers other processes that result in lost productivity that RTLS can help improve, the savings continue to add up. A study 14 hospitals and 27 units' data reported that a reduction of 4,901 call lights per month, for all units doing one-hour rounding, meant that nurses had 326 more hours per month for other aspects of patient care¹².

¹⁰ Emergency Department Violence Surveillance Study [August 2010]. Available at: <http://www.ena.org/IENR/Documents/ENAEDVSRReportAugust2010.pdf>

¹¹ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2012-13 Edition, Registered Nurses. Available at <http://www.bls.gov/ooh/healthcare/registered-nurses.htm>

¹² Meade, CM (Spring 2007). Round bounty. One-hour positively influences patients and nursing staff members. Studer Alliance for Health Care Research. Available at <http://www.ncbi.nlm.nih.gov/pubmed/17396681>

9.3 OPEX Savings from a Reduction in Staffing

The Joint Commission recommends temperature monitoring and recording as a part of its standards to ensure patient safety and quality healthcare. However, many healthcare facilities use the 'clip board' method, which requires that a staff member manually measure then record a refrigerator or freezer's temperature.

Not only is the manual method of temperature or humidity monitoring error-prone, it is also costly. Assuming that it requires a paid professional spend five minutes per refrigerator to measure and record temperature, to monitor just 60 units, at \$64/minute in labor, manual temperature monitoring consumes \$70,194 per year in unnecessary labor expenses.

10. Conclusion

RTLS offers many benefits when deployed hospital-wide, including increasing revenues and operational productivity while reducing OPEX, CAPEX, and other expenditures. RTLS can drive an increase in revenue through workflow optimization, patient queuing and patient satisfaction. Operational Productivity rises due to RTLS's capabilities for creating a safer environment for staff and producing great ROI. OPEX can decrease due to improved workflows, patient monitoring, automated temperature and humidity monitoring and forensic replay. CAPEX also decreases due to the efficiency of RTLS for equipment tracking, automating maintenance and equipment utilization rates through business intelligence software. This white paper highlights the most popular use cases that provide significant ROI; the complete list of possible for RTLS use cases is far more extensive. Many RTLS adopters are working with RTLS providers to create customized and innovative new uses for RTLS technology that provide the hospital with significant ROI. Not all hospitals are alike and customized solutions are a great way a hospital can support their own special needs using RTLS technological solutions.



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