

6 Major Problems with Wi-Fi RTLS That Cannot Be Ignored

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Despite the seductive presentation that a real-time location system (RTLS) can be piggybacked onto an existing Wi-Fi infrastructure, the truth is Wi-Fi system capabilities are inadequate for an RTLS in hospital asset and patient tracking applications.

Problem 1: Poor Location Determination

Problem 2: Wi-Fi Access Points Can't Triangulate — Anything

Problem 3: Noise, Noise and More Noise

Problem 4: Access Points – Not Enough and in All the Wrong Places

Problem 5: Access Points are Not All the Same

Problem 6: The 802.11 Standard

Wi-Fi's use in location-based applications threatens to damage the reputation of RTLS technology as a viable tracking solution. Hospitals considering the implementation of a tracking technology should look beyond any perceived savings they hope to gain by using an existing Wi-Fi system and select an RTLS technology developed specifically for the purposes of tracking the locations and status of equipment and patients.

Wi-Fi (802.11)-based tracking technology is currently riding a wave of popularity dependent upon the seductive presentation that a real-time location system (RTLS) can be piggybacked onto an existing Wi-Fi infrastructure, saving customers time and money. Wi-Fi system capabilities, however, are inadequate for an RTLS in hospital asset and patient tracking applications. The unrealistic expectations will be short lived once end users realize Wi-Fi was developed and deployed to be a wireless Ethernet replacement — not for location tracking. In fact, Wi-Fi RTLS is less accurate and ultimately more expensive than an RTLS installation designed specifically for monitoring the location and status of equipment and people. Wi-Fi RTLS implementations fall far short of delivering the accuracy and bottom-line benefits that non-Wi-Fi RTLS can provide.

The Wi-Fi hype is perhaps most damaging and costly in the health care industry which stands to gain significant advantages from applications of real-time tracking technology. The ability of hospital staff to instantly locate a vital piece of equipment and determine its status can provide a substantial return on investment (ROI) measured in terms of time, money and patient care.

Faced with tight budgets, some hospitals have fallen prey to the Wi-Fi sales pitch that promises lower implementation and operating costs if they leverage previously installed wireless networks as RTLS backbones. As a tracking system, these Wi-Fi implementations do not deliver clinically-significant location information, device status or environmental data thereby making a reasonable ROI difficult to achieve.

This paper describes the six major problems inherent in Wi-Fi RTLS which simply cannot be ignored

Problem 1: Poor Location Determination

The primary goal of RTLS is to accurately determine the precise location of an object or person. Wi-Fi is not able to perform this function very well. This problem relates to the relatively short 2.4 GHz wavelength used for Wi-Fi data transmission and its susceptibility to signal loss. In a Wi-Fi tracking application, a tag affixed to a piece of equipment or a patient communicates with an access point (AP) via a radio frequency (RF) transmission. The system estimates the location of the tagged asset by using the signal strength, or RSSI (received signal strength indication), to calculate the distance between the fixed AP and the tag. The accuracy of the location calculation depends on the continuity of the RF signal.

Unfortunately, the 2.4 GHz Wi-Fi RF signal is easily interrupted by moving assets (carts, beds, equipment) and especially human bodies that obstruct the path between tags and APs. In the dynamic environment of a hospital, the result is consistently unpredictable signal loss, making meaningful and accurate determination of location impossible.

In fact, Cisco, the largest supplier of Wi-Fi networks in health care, produces a Design Guide for Enterprise Mobility 3.0. Within this guide, specific location accuracy / location precision metrics are represented, which clearly confirm the poor performance of Wi-Fi-based RTLS systems:

“When properly deployed, the accuracy and precision in indoor deployments is represented in two ways, as follows:

- ***Accuracy of less than or equal to 10 meters, with 90 percent precision***
- ***Accuracy of less than or equal to 5 meters, with 50 percent precision***

For applications that require better performance than an accuracy of 10 meters with 90 percent precision, the solution can deliver accuracy of 5 meters but with 50 percent precision. Or stated another way, in 50 percent of all reporting instances, it can be reasonably expected that the error distance between the reported and the actual location will exceed 5 meters.”

Problem 2: Wi-Fi Access Point Can't Triangulate — Anything

Wi-Fi-based tracking system promoters incorrectly use “triangulate” to describe how multiple APs determine the location of an asset tag. This misuse of terminology vastly overstates the accuracy and precision of Wi-Fi.

Triangulation is the location of an unknown point by the formation of a triangle consisting of the unknown point, such as the asset tag, and two known points in a triangle. The two known location APs must also be able to measure the azimuth, or angle within a reference plane, to the tag in order to make a triangle. Since Wi-Fi APs have no notion of azimuth or even that all three locations are in the same plane, how can APs triangulate anything? The fact of the matter is they can't.

This can create potentially dangerous problems for a hospital. Hospitals expect their Wi-Fi tracking system to locate patients and equipment with clinically significant accuracy — the exact room or hallway. Wi-Fi cannot reliably accomplish this function. Imagine a nurse searching from room to room looking for an infusion pump the Wi-Fi RTLS says is nearby, when it actually cannot indicate the location to within 50 or 60 feet, and it could also be on another floor.

Some proprietary Wi-Fi-like systems can perform Cartesian coordinate estimations or other calculations such as time-of-flight analysis, but these custom-engineered solutions are very expensive and the accuracy varies.

Problem 3: Noise, Noise and More Noise

Not only is Wi-Fi poor at locating assets, hospitals will also discover that its wireless communications performance degrades. Immediacy and mobility are major goals for Wi-Fi in health care. Wi-Fi networks are providing clinical staff unprecedented access to medical data, imaging and test results, and more. However, with the continuing advancement of Wi-Fi enabled devices and applications comes an enormous requirement for ever more bandwidth. CIOs and IT administrators must prepare for the increased load these will introduce to their networks. And, we're not talking the distant future – significant load increases are expected over the next two years.

The problem is that RTLS requires thousands of chirping Wi-Fi asset tags, each generating “noise” on the communications network. Excess RF noise reduces the effective range of every AP by up to 30%, interfering with and jamming communications.

Hospitals also use a variety of specialized equipment and monitors capable of generating RF noise that can interfere with communications between tags and APs, further diminishing location capabilities. Self-calibrating Wi-Fi RTLS technology that overcomes this problem is available but requires significant additional costs.

Problem 4: Access Points – Not Enough and in All the Wrong Places

Hospitals may think they are saving money by building their tracking system on top of an existing Wi-Fi network. They are soon faced with considerable expense to upgrade the network.

The placement of APs sufficient for a typical hospital wireless network just isn't dense enough to use for tracking. Hospital IT departments initially install network APs in locations designed for communicating with wireless clients — in nursing stations, offices, and reception areas. The layout and configuration of those APs are incompatible with asset and patient tracking. Location tracking requires a much higher density of APs, often four to six times more (see Figure 1. and 2.), because the accuracy of RSSI measurement is inversely proportional to the distance between the tag and AP.

It is clear that proper placement of access points must be adhered to enable full performance potential of RTLS. Again taken from the Cisco Design Guide: ***“In many existing office wireless LANs, access points are distributed mainly throughout interior spaces providing service to the surrounding work areas. These access point locations have been selected traditionally on the basis of coverage, WLAN bandwidth, channel reuse, cell-to-cell overlap, security, aesthetics, and deployment feasibility. In a location-ready design, it is important to ensure that access points are not solely clustered in the interior and***

toward the center of floors. Rather, perimeter access points should complement access points located within floor interior areas. In addition, access points should be placed in each of the four corners of the floor, and at any other corners that are encountered along the floor perimeter.”

Both wholesale repositioning and additional access points play a vital role in ensuring good location fidelity for Wi-Fi-based RTLS (requiring additional hardware costs, and disruptive and costly mechanical installation.)

Figure 1
Typical configuration for Wi-Fi APs for communication purposes. NOT RECOMMENDED for RTLS applications

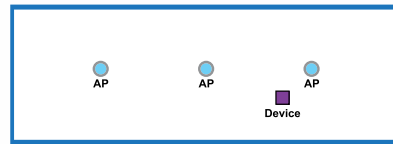
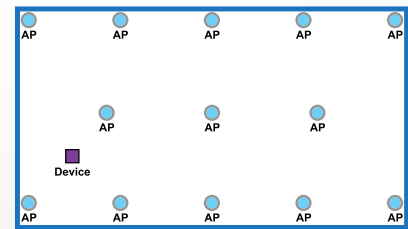


Figure 2
AP configuration and density needed for RTLS. Wholesale reposition and additional APs required.



Problem 5: Access Points are Not All the Same

A single Wi-Fi network may contain several different types of APs with different capability and functionality, and some do not collect the data needed to derive location information. APs that do collect the right kind of data may not be compatible with the RTLS location engine used in a particular implementation.

Some APs are equipped with radio chips that only show RF signal levels in coarse steps, but many location systems require signals measured in a more granular manner. The only way to ensure an existing Wi-Fi network has APs that are compatible with the selected RTLS engine is to conduct an inventory of radio chips in each AP.

Problem 6: The 802.11 Standard

The Institute of Electrical and Electronics Engineers (IEEE) standards govern the operation of Wi-Fi devices and systems, referred to as 802.11. IEEE standards are constantly updated to accommodate changes in technology. The Wi-Fi standard was recently enhanced by the new 802.11n specifications. Hospitals with existing Wi-Fi networks will likely eventually upgrade APs to the higher bandwidth 802.11n devices. When this happens, the thousands of 802.11b asset tags installed for tracking will compromise the newly available bandwidth.

At the very least, the presence of thousands of 802.11b asset tags and other legacy devices will force a notable capacity slowdown of the 802.11n wireless communications network.

Alternatives for RTLS Tracking

Fortunately, RTLS technologies developed specifically for tracking are cost-effective and highly accurate. Among the most notable are Infrared (IR) based systems. The low cost, ease of install and separation from Wi-Fi that make a IR-based location system attractive relate directly to its underlying simplicity. A purpose-built IR network uses an array of strategically placed beacons to pinpoint the locations of tagged assets and people, determine their current status and relay that information to a centralized server.

Most important, an IR network, used as an RTLS, can provide clinically significant accuracy. IR-based location in hospitals is well known and well suited for high density tracking needs, including bed level location accuracy (room, semi-private room, open bay) plus defined area locating (nurse stations, dirty pump zone, clean/dirty equipment, linen closets, laundry chutes, ingress/egress points, etc.) IR-based systems provide location exactness not only between rooms, but can differentiate beds in semi-private rooms or open treatment bays, and even distinguish specific areas within a room.

Conclusion

Wi-Fi networks perform poorly in RTLS applications because they were not designed for use in tracking. Their use in location-based applications threatens to damage the reputation of RTLS technology as a viable tracking solution. Hospitals considering the implementation of a tracking technology should look beyond any perceived savings they hope to gain by using an existing Wi-Fi system and select an RTLS technology developed specifically for the purposes of tracking the locations and status of equipment and patients.

About TeleTracking

For over two decades, TeleTracking Technologies has applied innovative, industry-leading logistics principles to hospitals and health systems to enhance patient flow, improve patient care, increase financial performance and gain competitive advantage. Along with its Avanti Patient Flow and Business Analytics divisions, TeleTracking designs and delivers an enterprise-wide platform that reduces overcrowding, cuts costs, generates revenue, fights the spread of infection, manages assets, accelerates patient transfers and provides business analytics for continual operational improvement and business development. The result is an end-to-end system that connects patient flow to patient care for better outcomes.

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Corbley Communications

In the past 18 years, CCI has represented organizations spanning the complete spectrum of Geospatial technologies, including GIS, Remote Sensing, Location-Based Services, GPS and Online Mapping and has gained extensive experience in the Energy, Defense/Intelligence, Public Safety, Environmental, and Cartographic industries. Kevin P. Corbley is the founder and owner of Corbley Communications and brings a unique combination of professional communications experience, scientific understanding, and business knowledge to every engagement. Mr. Corbley graduated from the University of Notre Dame with a Bachelors of Science Degree in Earth Science. He spent four years as a Journalist in Washington, D.C., covering the energy and aerospace industries before joining the Public Affairs Office at EOSAT, a geospatial firm in Lanham, Md.