WiFi Inadequate as Real-Time Asset and Patient Tracking Solution

WiFi RTLS is less accurate and ultimately more expensive than an RTLS installation designed specifically for monitoring the location and status of equipment and people.

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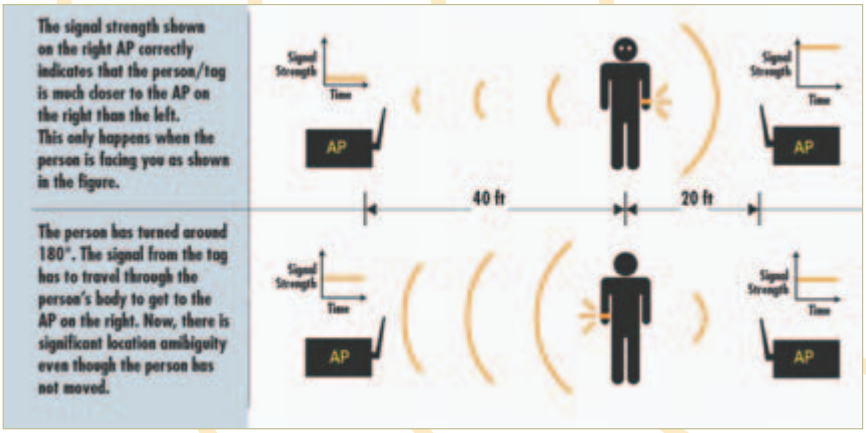
WiFi (802.11)-based tracking technology is currently riding a wave of popularity dependent upon the seductive presentation that a real-time location system (RTLS) can be piggybacked onto an existing WiFi infrastructure, saving customers time and money. WiFi system capabilities, however, are inadequate for an RTLS in hospital asset and patient tracking applications.

The unrealistic expectations will be short lived once end users realize WiFi was developed and deployed to be a wireless Ethernet replacement — not for location tracking. In fact, WiFi RTLS is less accurate and ultimately more expensive than an RTLS installation designed specifically for monitoring the location and status of equipment and people. WiFi RTLS implementations fall far short of delivering the accuracy and bottom-line benefits that non-WiFi RTLS can provide.



Figures 1 and 2. These figures illustrate the signal obstruction at 2.4 GHz that occurs when an object such as a human body comes between an AP and a tag.

The WiFi 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 WiFi sales pitch that promises lower implementation and operating costs if they leverage previously installed wireless networks as RTLS backbones. As a tracking system, these WiFi 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 WiFi RTLS which simply can not be ignored.

▶ *Problem 1:*

Poor Location Determination

The primary goal of RTLS is to accurately determine the precise location of an object or person. WiFi is not able to perform this function very well. This problem relates to the relatively short 2.4 GHz wavelength used for WiFi data transmission and its susceptibility to signal loss.

In a 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 WiFi RF signal is easily interrupted by moving assets (carts, beds, equipment) and especially human bodies that obstruct the path between tags and APs. (See Figures 1 and 2.)

In the dynamic environment of a hospital, the result is consistently unpredictable signal loss, making meaningful and accurate determination of location impossible.

▶ *Problem 2:*

WiFi Access Point Can't Triangulate — Anything

WiFi-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 WiFi.

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 WiFi 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 WiFi tracking system to locate patients and equipment with clinically significant accuracy — the exact room or hallway. WiFi cannot reliably accomplish this function. Imagine a nurse searching from room to room looking for an infusion pump the WiFi 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 WiFi-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 WiFi poor at locating assets, hospitals will also discover that its wireless communications performance degrades. The problem is that RTLS requires thousands of chirping WiFi 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 WiFi 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 WiFi 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

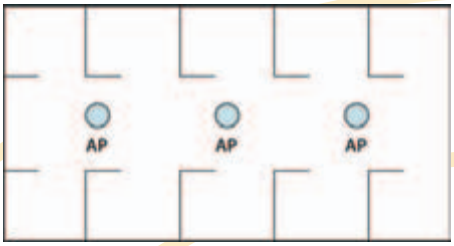


Figure 3A. Typical configuration of WiFi APs for communications purposes.

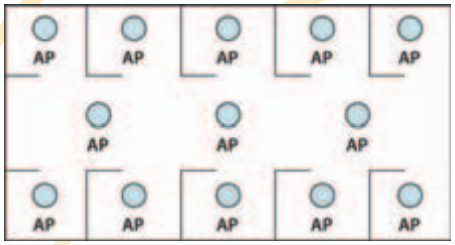


Figure 3B. AP configuration and density needed for RTLS.

asset and patient tracking. Location tracking requires a much higher density of APs, often four to six times more (see Figure 3A. and 3B.), because the accuracy of RSSI measurement is inversely proportional to the distance between the tag and AP. This means location accuracy requires wholesale repositioning and more APs (requiring additional installation costs).

▶ *Problem 5:*

Access Points are Not All the Same

A single WiFi 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 WiFi 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 WiFi devices and systems, referred to as 802.11. IEEE standards are constantly updated to accommodate changes in technology. The WiFi standard was recently enhanced by the new 802.11n specifications. Hospitals with existing WiFi 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 is the Sensor Area Network. The low cost and ease of use that make a Sensor Area Network attractive relate directly to its underlying simplicity. Using the same basic concept for wireless tracking, a Sensor Area Network uses an array of strategically placed sensors (readers) to pinpoint the locations of tagged assets and patients, determine their current status and relay that information to a centralized server. Unlike the WiFi network, the Sensor Area Network is readily scalable to meet the needs of growing hospitals.

Most important, the Sensor Area Network, used as an RTLS, can provide clinically significant accuracy. When the Sensor Area Network determines the location of an available infusion pump to the Fourth Floor East Elevator Lobby, it will be found there. Sensor Area Networks developed for the purpose of RTLS are also inherently simple to use for everyone in a hospital — from the orderly to the surgeon.

Conclusion

WiFi 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 WiFi system and select an RTLS technology developed specifically for the purposes of tracking the locations and status of equipment and patients.

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