It's in the Tag: The Importance of Considering Power Efficiency when Choosing a Real Time Location System

For a location system to deliver a return-on-investment, a critical mass of assets must be tagged for tracking.

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While more organizations are realizing the value of investing in a real time location system, demonstrating the return-on-investment is critical to garner broad support. One factor to consider when projecting an estimated return on investment is the system's power efficiency, which contributes significantly to operating costs of ownership.

Why is power efficiency important? After interviewing over 60 hospitals to determine their requirements for an effective Real-Time Location System (RTLS), battery life emerged as a top concern for biomedical and clinical engineers. They felt that tags should not require frequent battery changes, as this would be yet another distraction for busy healthcare engineers. A tag is the device which, when attached to an asset, communicates that item's location and status. An RTLS should help improve work flow and shorten the time previously spent on routine processes. A typical medical device has a five year minimum service life, and the tags attached to that device should have an operating lifespan at least equal to that time period.

The sizes and shapes of tags available dictate the types of assets that can be tagged, and ultimately the number of tagged assets possible. A tag's size is largely determined by the size of the power cell inside. If a tag is not efficient, it needs a bigger power cell. Once a critical mass of assets is tagged and visible to the system, the system's value can be proven, as various location-related metrics are gathered to provide a return-on-investment. If less than a critical mass of assets can be tagged, the return-on-investment calculation can quickly be adversely affected.

A Closer Look at Power Consumption

Figure 2. Long lasting tag batteries are critical for real time location systems that also automate temperature monitoring for clinical refrigerators.

An RTLS generally is composed of tags, readers and collectors. As previously discussed, tags are attached to assets and communicate with readers (and, in turn, collectors) to gather, reduce, and present location information. This information may include location, status of equipment (e.g., in use, needs cleaning, is available), environmental conditions and remaining battery life. The many RTLS technologies on the market are differentiated in part by how these components communicate with one another. Most emphatically, not all location systems operate identically; a tag from one system might have to do something entirely different from a tag of another system in order to facilitate a location determining event. This difference is a vitally important fact to understand in any comprehensive analysis of power consumption, and power cell life.

The various processes for determining location are important to note when conducting an analysis of power consumption and subsequently power cell life. All RTLS technologies expend a certain amount of power in each instance of calculating the position of a given object, and different RTLS underpinnings draw more power per location event. For example, using an acoustic transducer type system takes a great deal of energy as it is necessary to move air at amplitudes that can provide useful range. The challenge with an acoustic-media system is the same as that faced by stereo systems; any audiophile knows that for good fidelity, you need a lot of peak power capability.

When using WiFi technology for location, a tag must be listening to the WiFi channel before a transmission takes place to avoid disruption to other WiFi devices. The energy consumed by the receiver has to be counted as part of the power needed for the location event even though the tag receiver itself does not contribute to the location calculation.

In a synchronous multiple input multiple output (MIMO) "smart antenna" system, the medical device tags are autonomous microprocessor-controlled radio transceivers, communicating bi-directionally with readers. By being synchronized, device power consumption is absolutely minimized; by employing MIMO, radio range is maximized for any given power used.

Most RTLS systems use a single three-volt lithium primary cell, as opposed to a battery of cells. There are a number of reasons for this, but it bears noting that calculating the lifespan of the power cell in the application is made easier through the use of a single cell. The increase in the internal resistance of the cell, as it discharges, is easier to evaluate in a single cell than it is in a battery. Therefore, expected service life of a given-size power cell can be accurately modeled when the power consumption is also known.

Research conducted at UC Berkeley between 1999 and 2003 determined that, in any system, a certain amount of power is expended to calculate a position, which is the fundamental function-event of a location system. While most location systems perform additional tasks beyond location, consider location-calculating events alone for a comparative understanding of the concept. The term ‘system' in this instance is defined to mean the entire array of devices employed in the entire location determining process. A qualified vendor of RTLS systems will be able to state and demonstrate the amount of power consumed in a location determination event.

RTLS system elements fall into two broad categories: power-rich, in that they are connected to some kind of constant energy source, and power-poor, or battery-powered elements. In an RTLS system, readers and data collectors are power-rich elements. Therefore a system designed so that the power-poor elements do the least amount of work (when compared with the power-rich elements) will yield a system in which the power cells and, subsequently, tags, have a longer service life. In the case of systems, such as those employing WiFi (where the technology's primary purpose is not to determine location) power-poor system elements will be burdened with the operating requirements of the host system function protocols.

The converse is also demonstrably true; in systems designed expressly or primarily to be location determinant, the balance of power consumption between power-rich and power-poor system elements favor idealized design for the power-poor elements, and thus extend the service period of their power cells.

For example, 802.11-based WiFi systems operate through a technology that was designed with the intention of facilitating data communications and that are already supporting file sharing, web browsing, voice and video transmission, and more. The addition of RTLS tags will consequently consume large amounts of battery power because they will be burdened by WiFi LAN protocols even as they are competing with data already circulating the network when transmitting information.

Determining the Technology that Best Fits an Organization

Organizations considering adopting an RTLS system will find a widely varying range of technologies and products, each with notable pros and cons for consideration. Some vendors exhort the potential user into believing that existing infrastructure, such as a WiFi network, can be re-purposed to provide locations services. However, the supposed advantages of this method fade quickly when organizations factor in the cost of installing additional hardware (access points) and ongoing calibration, along with diminished tag battery life. Moreover, the potential impairement of data on 802.11n networks when forced to simultaneously support legacy 802.11b/g tag devices adds further challenges when determining accurate real-time location using this technology.

At a fundamental level, otherwise disparate systems can be objectively evaluated based on their root-level design. This can be done by examining whether the architectural underpinnings of the location system are optimized for permitting a wide array of assets to be tracked. If the installation process is disruptive and invasive or if the system cannot be quickly and easily scaled, it will be difficult to realize a speedy return on investment. Also, consider the amount of power consumed for each location-calculating event as the system tracks those assets. Tags in a system designed for the hospital environment should use a relatively small power cell, have service lives measured in years, and should be available in a variety of form-factors and custom packages.

Conclusion

For a location system to deliver a return-on-investment, a critical mass of assets must be tagged for tracking. If the tags are too large due to a large power cell size or require frequent power cell changes or charging, the number of assets that can practically be tagged is significantly reduced. Tags that are part of power efficient RTLS technologies can be made smaller and therefore applicable to a larger variety of devices. Choosing a system optimized for efficient power consumption will therefore fulfill the true goal of most adopters: getting the critical mass of tracked devices on-line in a cost effective manner. In so doing, the potential customer can be satisfied that their investment will have a safe and rapid return of value, and a long operational lifespan.

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