DRAFT V2

The Case for Battery Life in High Density Wireless Deployments for the IoT

A.K.A. Preventing the Battery Life Catastrophe in the IoT

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Might the Internet of Things be held up due to unpredictable battery life? If that is the case, wireless reliability may be key. Don't think so? Spearix put it to the test.

During independent third-party trials conducted in an industrial production environment, performance was tested on 10 distinct wireless links running a IEEE802.15.4 physical layer protocol optimized for 10yrs of battery life. For example, Bluetooth, Zigbee and Thread use this type of wireless in 2.4GHz open spectrum. The goal of the trials was to measure baseline performance and compare it with Spearix patented RADiS™ multi-core wireless. RADiS proved to improve packet error rate error substantially across several of the links, especially those in harsher conditions. And some links in less harsh environments showed slight improvement.

The links were tested in the presence of RF aggressors such as WiFi interference, welding equipment interference, metal obstructions, non-line-of sight conditions and some line-of-sight conditions. We noticed a distribution of performance as you would expect in an indsutrial environment. And we noticed that RADiS distribution of performance was much tighter, achieving 99 percent or at least high 90s in all cases.

Note that RADiS upgrades were added to the gateway side, not on the devices.

Then we looked at estimated battery life on each link. When a link is weak or has high packet errors, it tends to rely on retransmissions. A weak link may also require higher power to reach allowable performance. The combination of retransmissions and higher power means weak links consume more energy, limiting battery life.

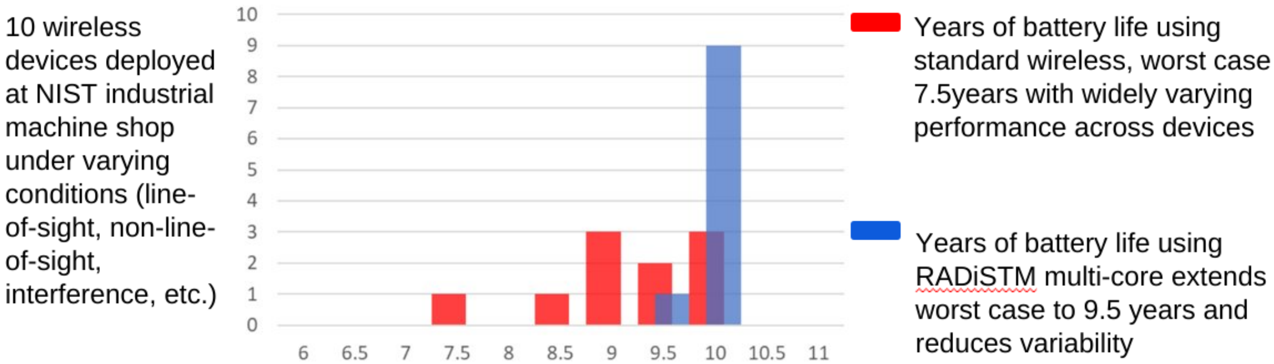
In some protocols such as LoRaWAN, additional processing helps weak links boost packet success rate. But again, these methods, for example spreading, result in longer time on air and also increase energy per packet. As most engineers will accept, there is no free lunch.

That said, we saw a clear benefit using RADiS for two reasons.

First, the increased reliability extends battery life towards the original intended duration. In this case, most of the links achieve 10 years battery life.

Secondly, it reduces the distribution or variance of the battery life across all devices. Since RADiS improves reliability under more sever conditions, there are fewer devices at the low end of the battery range.

Since RADiS is applied only on the gateway side, additional RADiS horsepower necessary to overcome a weak link does not cost battery life on the device side. To the device, it is free lunch. The limit to this free lunch is unknown.

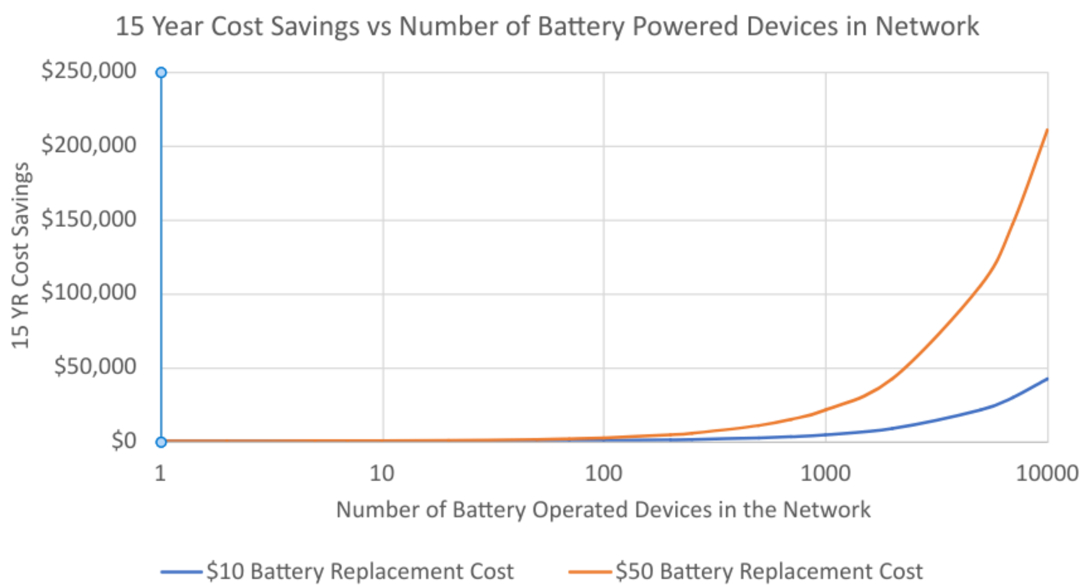


Operationally, the worst-case link determines battery life since most businesses will replace all the batteries when the first low battery occurs.

The above chart shows battery life improvement using RADiS multi-core. The data shows a worst case of 7.5 years improved to 9.5 years, an enhancement of around 30% across all the devices since they are all benchmarked by the weakest link. In many instances where the environment becomes harsher, we have measured beyond 75%.

High variability increases total cost of ownership. As the network scales to hundreds, thousands or tens of thousands of devices variability will grow as well. The weakest outlier will destroy the return on investment of the entire network.

The chart below models total cost savings of a network applying RADiS multi-core on the gateway side modeled to improve battery life 30% as above. The additional cost of the gateways may total a few thousand dollars or even tens of thousands of dollars. There is a clear return as the network scales to 1,000 or 10,000 devices.



Modeling the cost of battery replacement may be a challenge. The chart above expresses total 15-year cost savings using battery replacement costs of $10 and $50 per device. Keep in mind battery replacement costs may skyrocket depending on the type of device and location. Additionally, battery life savings may skyrocket beyond 26% modeled above since some environments may be far worse.

Regardless of the battery life replacement costs, the total cost of ownership of a battery dominated network cannot be determined unless battery life across the network is deterministic, well behaved and can reduce or eliminate outlier weak links.

Battery life should always be a part of the equation and dominates total cost of ownership as scale and density increase. Given enough devices, whether the battery replacement cost is $10 or $50 or more, battery life drives the ROI as the network scales. If the goal is to deploy a hundred devices, battery life may not be a challenge. However, when deploying 1,000 or 10,000 devices or more, battery maintenance becomes limiting if outlier weak links cannot be rehabilitated.

How do you design such a network? You place as much investment as necessary on the gateway infrastructure such that your weakest link achieves the battery life objective. Since RADiS adapts to the environment, all links will remain consistently strong and conserve ROI over time.

Recent news from Imagotag and Wal-Mart is a good example. Wal-Mart has decided to upgrade 500 of their stores with electronic shelf tags (ESL) using a recently approved BLE ESL protocol. Wal-Mart plans to deploy 60 million tags. The challenge becomes battery life performance. Due to battery life variability, a smart rail system delivering connectivity and energy has been designed into shelfs. Read about it here.

What does this mean for the IoT? What do you do when a smart rail system cannot be integrated in a certain location.

Industries desiring to adopt continuous monitoring at scale have limited options. These applications include logistics, retail, warehousing, shipping. Key emerging standards such as the FDA Food Safety Modernization Act (FSMA 204) will also be limited. Battery-less solutions like barcodes and RFID or wired solutions like smart rails seem to be the only option.

Scaling a battery powered continuous monitoring network requires predictable battery life.

Wireless can achieve predictable battery life by rehabilitating weak links. RADiS multi-core provides a step change in reliability enabling emerging active battery powered applications.