Blitz

Energy Harvesting (Photovoltaic) to Power a Patient Tracking Bluetooth Angle-of-Arrival Locator

ELECOMP Capstone Design Project 2023-2024

Sponsoring Company:

Zebra Technologies
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Company Overview:

Zebra empowers those on the front line in retail, healthcare, transportation and logistics, manufacturing and other industries to achieve a performance edge - an edge that translates to delighted customers, good patient outcomes and superior business results.

As the pioneer at the edge of the enterprise, our products, software, services, analytics and solutions are used to intelligently connect your people, assets and data. With decades of industry experience, we design with front-line users and workplaces in mind, giving you the best-action guidance needed to optimize in-motion operations and make business-critical decisions.

With over 10,000 partners across 100 countries, we are committed to delivering industry-tailored solutions that help our customers capture their edge.

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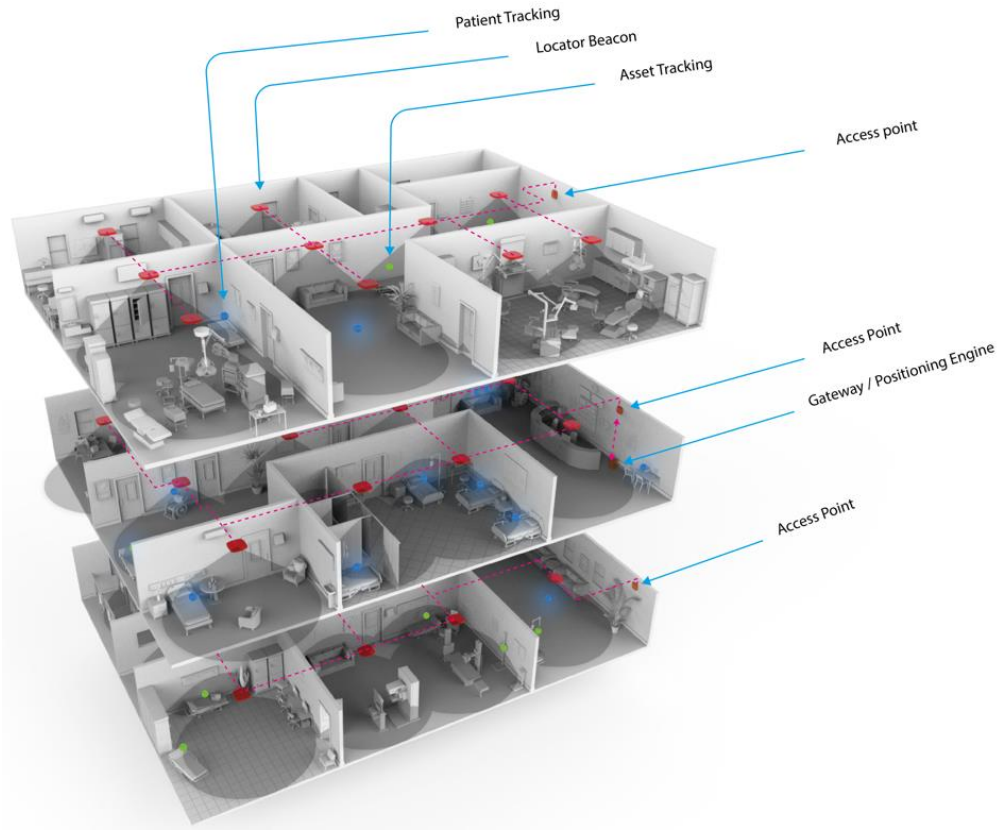
Project Motivation:

The high-level objective of the Blitz POC is to automatically track patients in hospitals, clinics, rehabilitations centers, nursing homes and doctor's offices. A Bluetooth beacon module will be attached to a traditional wristband that has been printed in a Zebra printer. This might look like:

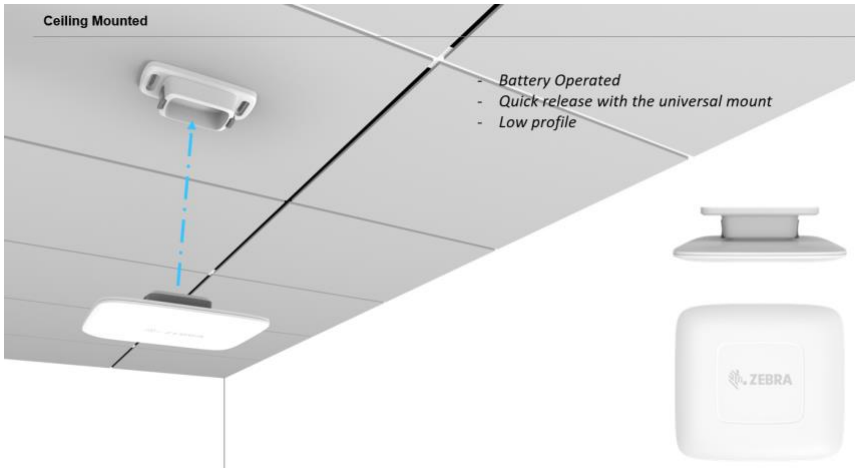
Once attached to a patient's wrist, the Beacon would continuously broadcast advertising packets with AoA CTE data every 1 to 2 seconds. The battery would be sized to last at least 14 days. There are no switches or LEDs on the wristband PCBA. The desire is to know with an accuracy of 99% which room the patient is in.

The current plan is to use Bluetooth LE Angle-of-Arrival (AoA) to meet the 99% room accuracy requirement. An array of AoA Locators would be mounted on the ceilings throughout the facility. The Locators would monitor the local area for Beacons using an antenna array and can calculate the angle of arrival of the RF signal from the beacon. The Locators will push the angles (azimuth and elevation) to a Positioning Engine (using Wi-Fi) which can calculate the X-Y coordinates of the beacon. With enough Locators spaced correctly, positioning accuracy can be sub-1 meter, as low as 30 cm (12 inches).

A typical hospital installation might look like this:

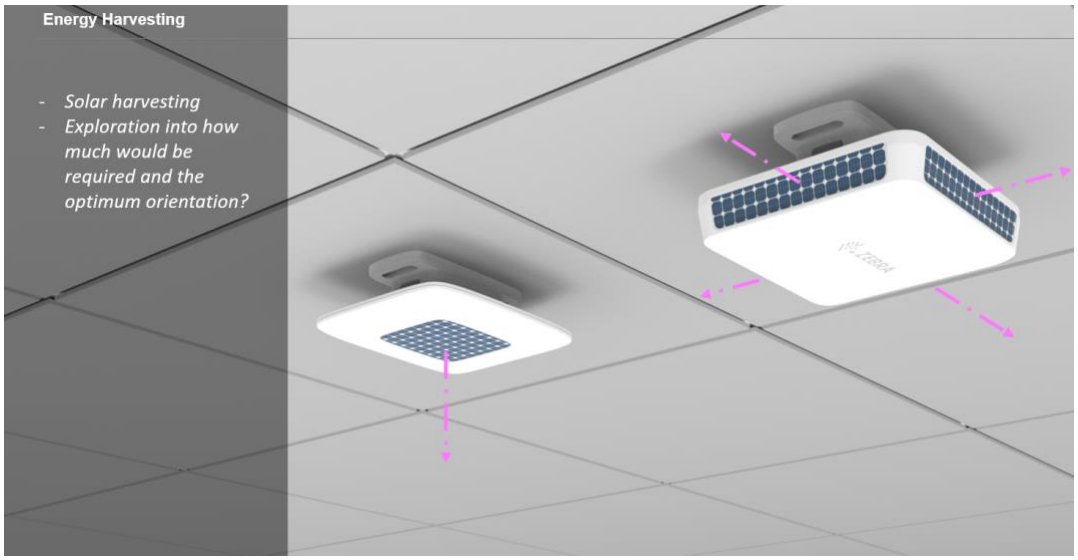


Locators will mount to the ceiling (or wall) using a quick connect/disconnect base for easy installation/removal:



Product management has set an installation goal of 2 minutes or less for the Locators. This pretty

much eliminates all “wired” power options, so we are focusing on a battery-based design with supplemental power being harvested from ambient light. Some Industrial Design concepts:



The main objective of this project (for the URI students): research, identify, procure, and test the latest products in Photovoltaic technology - suitable for indoor, low light conditions.

Anticipated Best Outcome:

The performance of all (selected) PV cells has been characterized in various lighting conditions, lighting sources, orientations, size/surface area, and the top two contenders have been identified. Pricing of the PV cells in our form factor has been obtained, and coordination with Zebra Commodities has started if the contenders are not already approved suppliers to Zebra.

Project Details:

This is a “from scratch” R&D technology research project. No supplier has been selected, and there are no test jigs, test plans, or anything set in stone. There are a few theories and educated guesses, but no data exists to support those. The following is a list of generic tasks that need to be considered on the project – others will likely be added, and some might get removed. That’s the nature of R&D: in the beginning, you know very little, but as work progresses and knowledge is gained, you must be prepared to make changes…

- Research low light energy harvesting technology.
- Compile a list of supplier candidates, listing their pros & cons.
- Create a short list of the most suitable suppliers.
- Prepare a test plan (including the design of a test fixture). Don't forget about obtaining light sources or at least be able to go where the light source is.
- At this point, it would be helpful to measure light levels vs source in an office environment. If we can actually get into a hospital to take measurements, that would be ideal. This brings up the topic of light meters. We have one from Amazon (https://www.amazon.com/gp/product/B005A0ETXY), but there are many out there, so do some research and make a suggestion. Ambient Photonics had a few suggestions also.
- Design the test fixture. It would be very nice for this to be somewhat automated in the data gathering process. This is where a Software/Firmware skill set could be used.
    - Obtain product and/or evaluation kit samples. Keep in mind the form factor of the Blitz Locator when ordering samples. Some suppliers we know of:
        - Ambient Photonics: https://ambientphotonics.com/
        - Their evaluation kit (we have one): https://ambientphotonics.com/video_posts/energy-harvesting-product-design-tools-application-development-kit
        - Epishine: https://www.epishine.com/
        - Their evaluation kit (we have one): https://www.newark.com/epishine/ek01leh3-6/eval-kit-light-energy-harvesting/dp/60AJ3760
        - PowerFilm Solar: https://www.powerfilmsolar.com/
        - They have several evaluation kits: https://www.powerfilmsolar.com/products/development-kits
        - There are many other suppliers…
- Perform testing with variations in:
    - Light levels (intensity) – i.e., LUX.
    - Light sources: LED, incandescent, fluorescent, sun, others?
    - PV cell orientation.
    - PV cell size/surface area.
    - Environmental specs: temperature, humidity, etc.
    - Bend radius (if PV cell can be bent when installed).
    - Other conditions?
- Provide comprehensive report with graphs, etc.
- Make supplier/product suggestions based on test results.
- Find out if suggested supplier is on the Zebra approved vendor list (AVL), and if not start working with Zebra Commodities group.

Composition of Team:

1-2 Electrical (ELE) Engineers & 1 Computer/Software/Firmware Engineers

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

Having a patient tracking system that requires minimal effort to install will put Zebra at a competitive advantage in the market, and this market is very new. If we can develop a Locator that installs in less than 2 minutes and requires no wires at all, it will be a huge differentiator from any other system out there today. The key to accomplishing that is the PV cell research and testing that will be performed by the URI team.