

TIU Tracking System



Sponsor

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Introduction



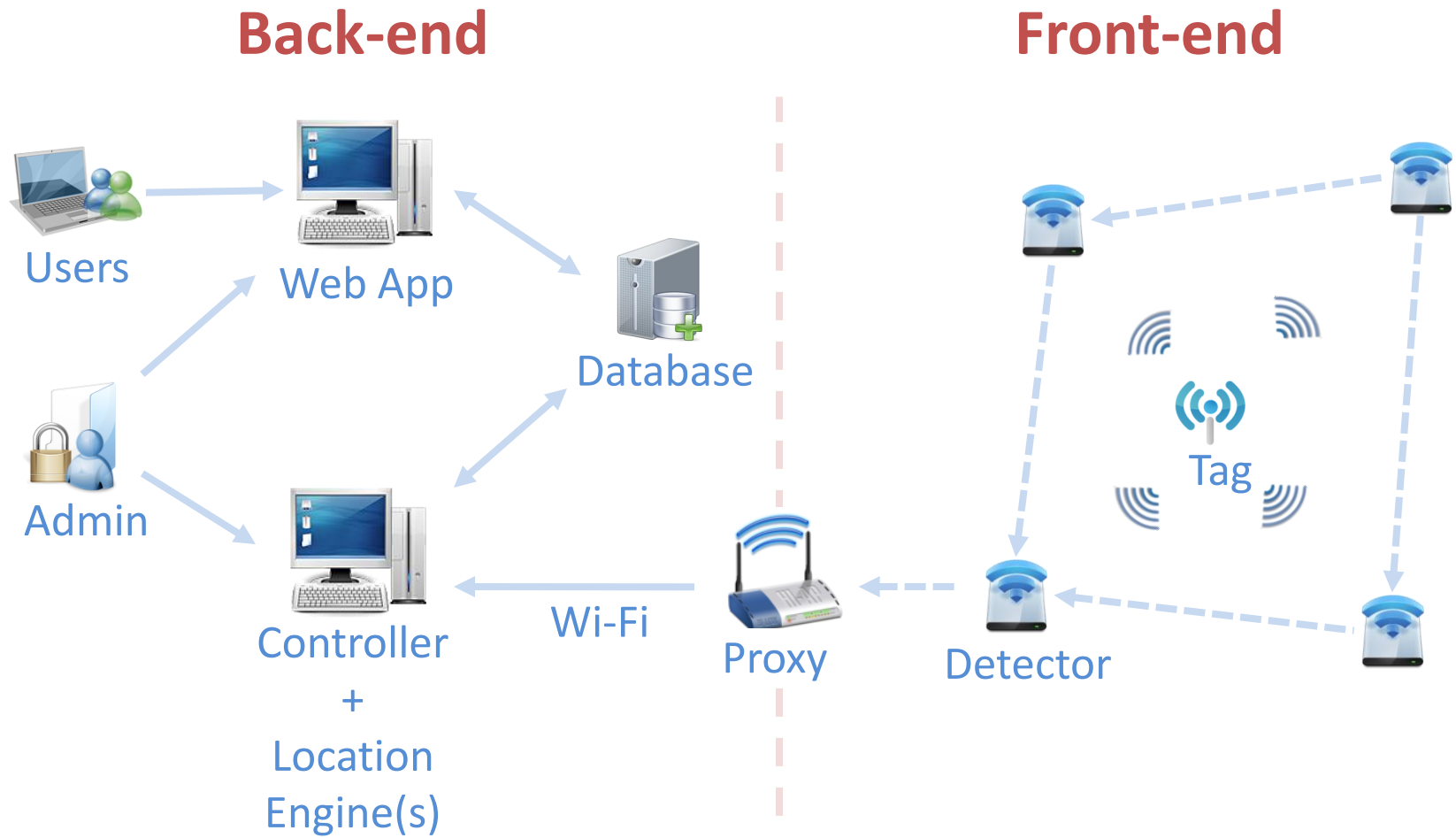
- Problem statement
- Key requirements
 - Size
 - Power
 - Accuracy

Agenda



- **System Overview**
- Hardware
- Firmware
- Software
- Deployment
- Results
- Conclusions

System Overview



Agenda



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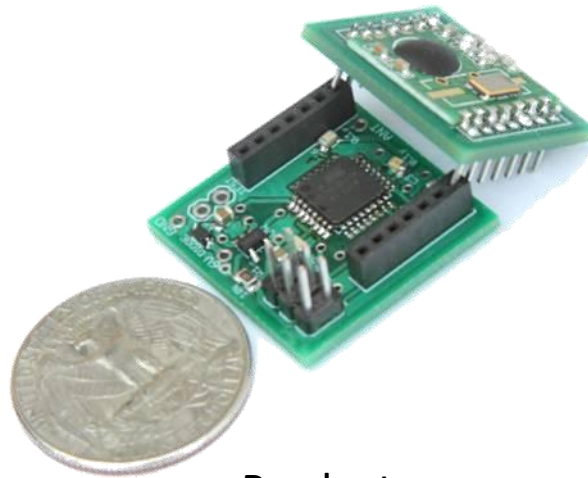
Hardware



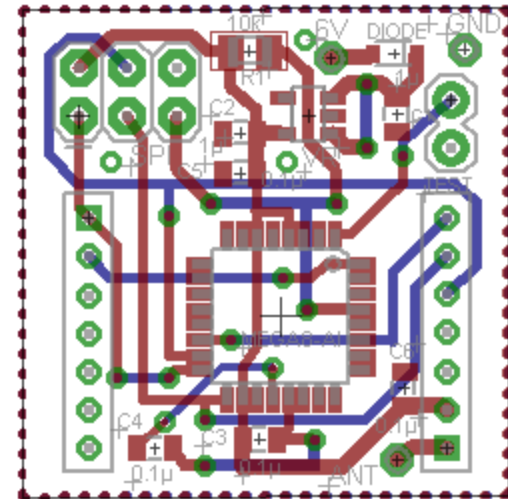
- Devices
 - Tag
 - Detector
 - Proxy
- Components
 - RF12 transceiver
 - ATmega328p MCU
 - WiFly 802.11b/g transceiver
- Schematic and layout by Eagle CAD
- PCB by Sunstone Circuits

Hardware

- Tag
 - RF12 transceiver
 - ATmega328p MCU
 - Size: 1" x 1" x 1"
 - 240mAh coin cell battery



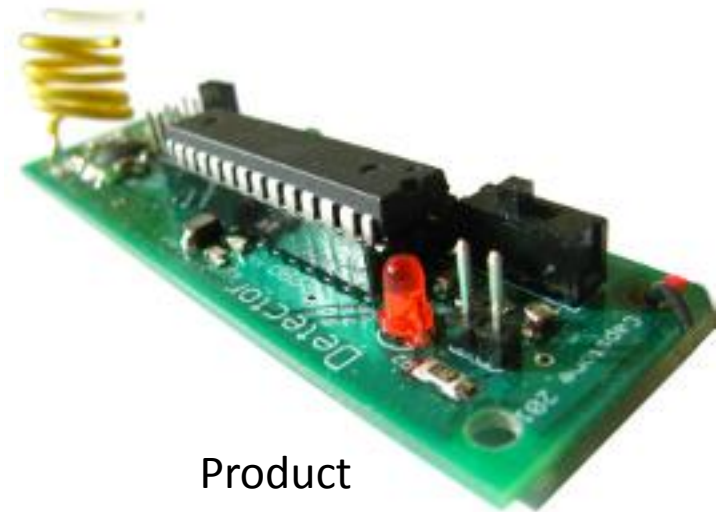
Product



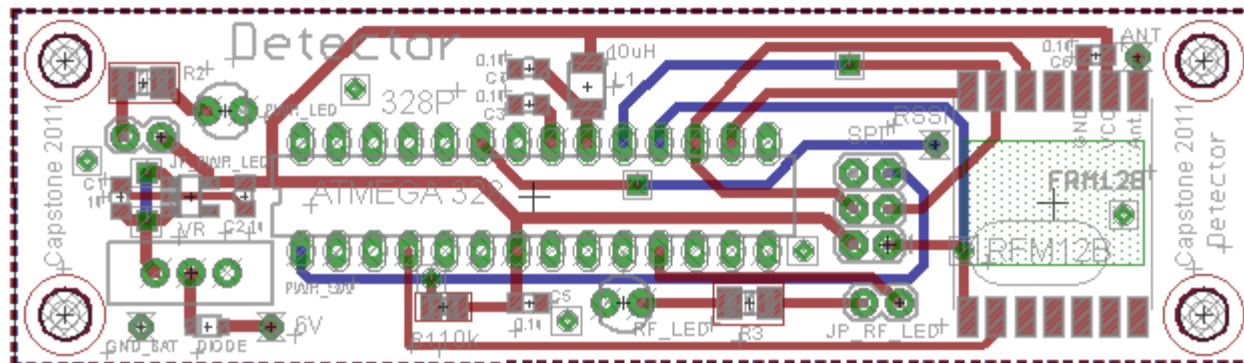
Layout

Hardware

- Detector
 - RF12 transceiver
 - ATmega328p MCU
 - Status LED
 - Size: 3.5" x 1"



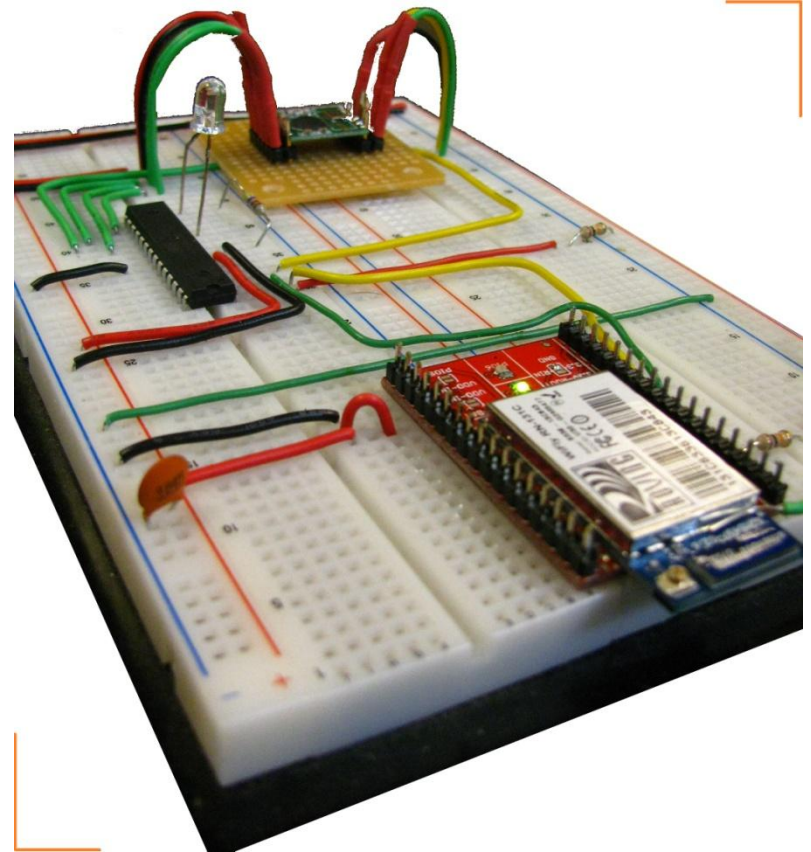
Product



Layout

Hardware

- Proxy
 - RF12 transceiver
 - ATmega328p MCU
 - WiFly 802.11b/g transceiver
 - Breadboard prototype
 - Ceramic antenna



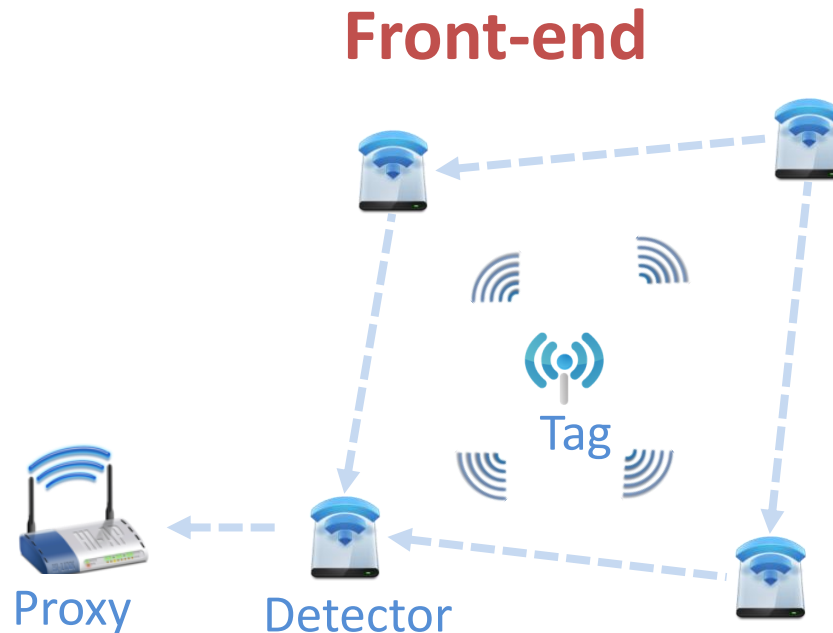
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- **Firmware**
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Firmware

- Tag broadcasts
- Detectors relay
- Proxy forwards to Controller



Firmware



- Tag
 - Mostly in low power state
 - Periodically wakes up to broadcast
- Detector
 - Listen for messages from tags and other detectors
 - Controlled flooding
 - Collision avoidance via time division
- Proxy
 - Listens for messages from detectors
 - Forwards messages to Controller
- Generally
 - All speak a common message format which includes
 - Battery Information
 - Infrastructure for a more sophisticated routing protocol
 - Fixed length

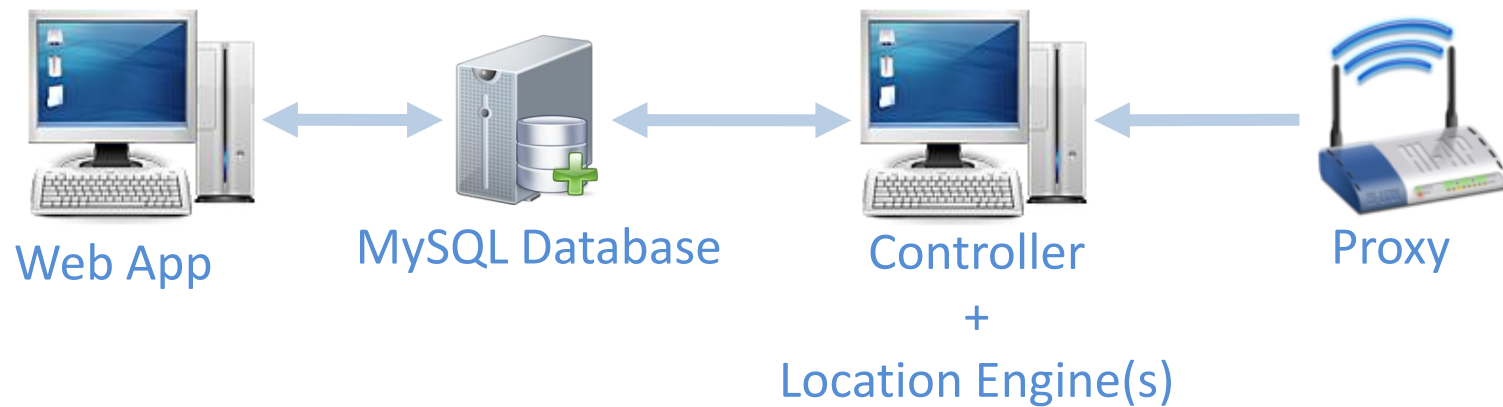
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Software

Back-end



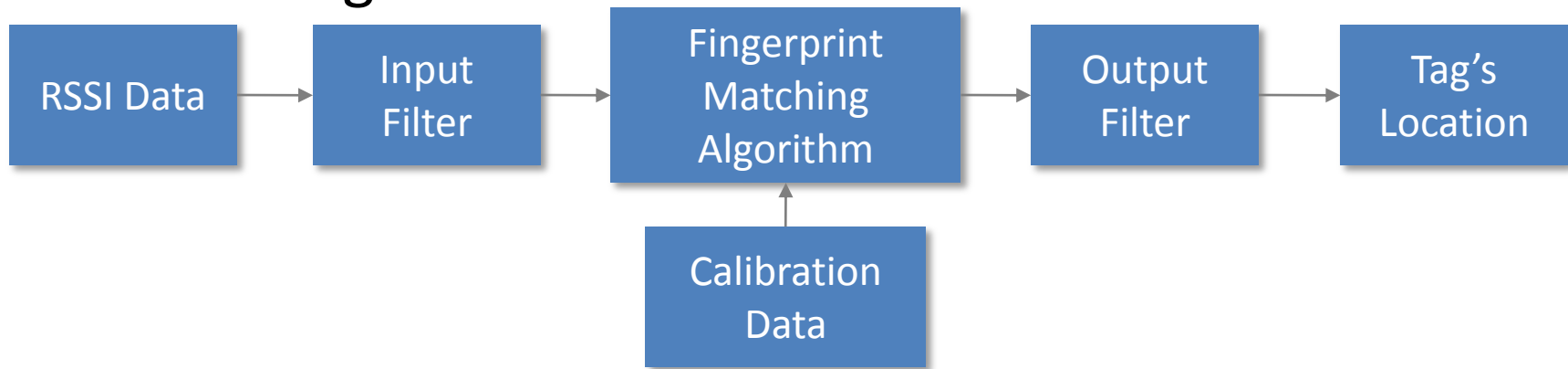
Software



- Controller
 - Collects data from Proxy
 - Feed data to Location Engine
 - Two operating modes
 - Calibrating
 - Collects RF signatures at calibration points
 - Stores calibration data in a local database
 - Locating
 - Passes calibration data to Location Engine
 - Collects and sorts data into packets
 - Feeds the packets to Location Engine
 - Stores results in MySQL Database

Software

Location Engine

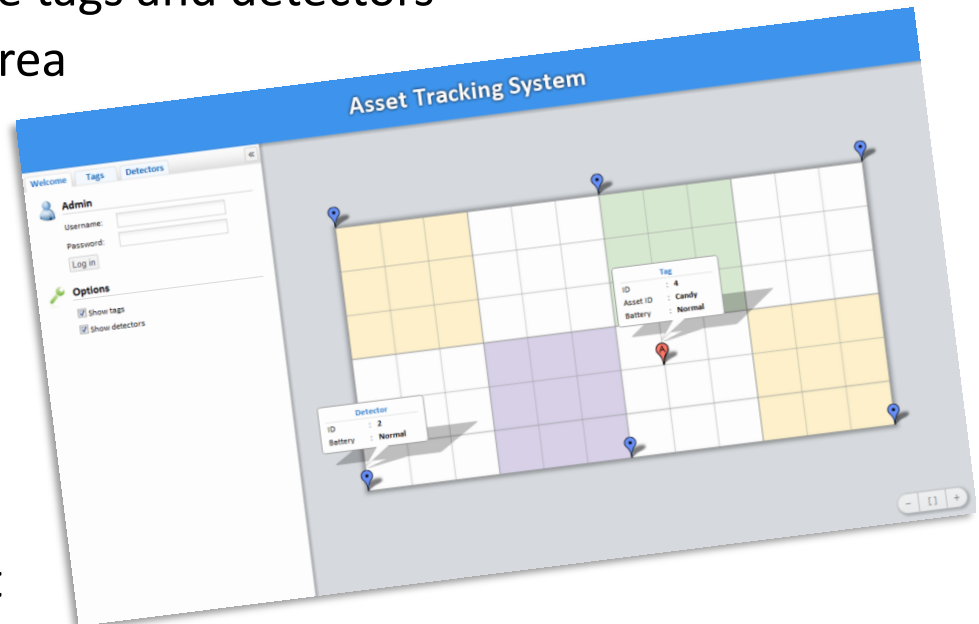


- Theory
 - Each location has a unique & consistent RSSI pattern
 - Euclidean distance
- Reduce aliasing by
 - Referencing the nearest detector
 - Interpolating between two closest locations

$$d = \sqrt{\sum_{i=1}^N (RSSI_{li} - RSSI_{ci})^2}$$

Software

- Web App
 - Functionalities
 - Visualize tags' and detectors' locations
 - Add, modify, and remove tags and detectors
 - Configure the tracking area
 - Design Goals
 - Fast
 - Simple
 - Easy to use
 - Technologies
 - PHP
 - HTML5, CSS3, JavaScript
 - Why Web?



Recap



Agenda



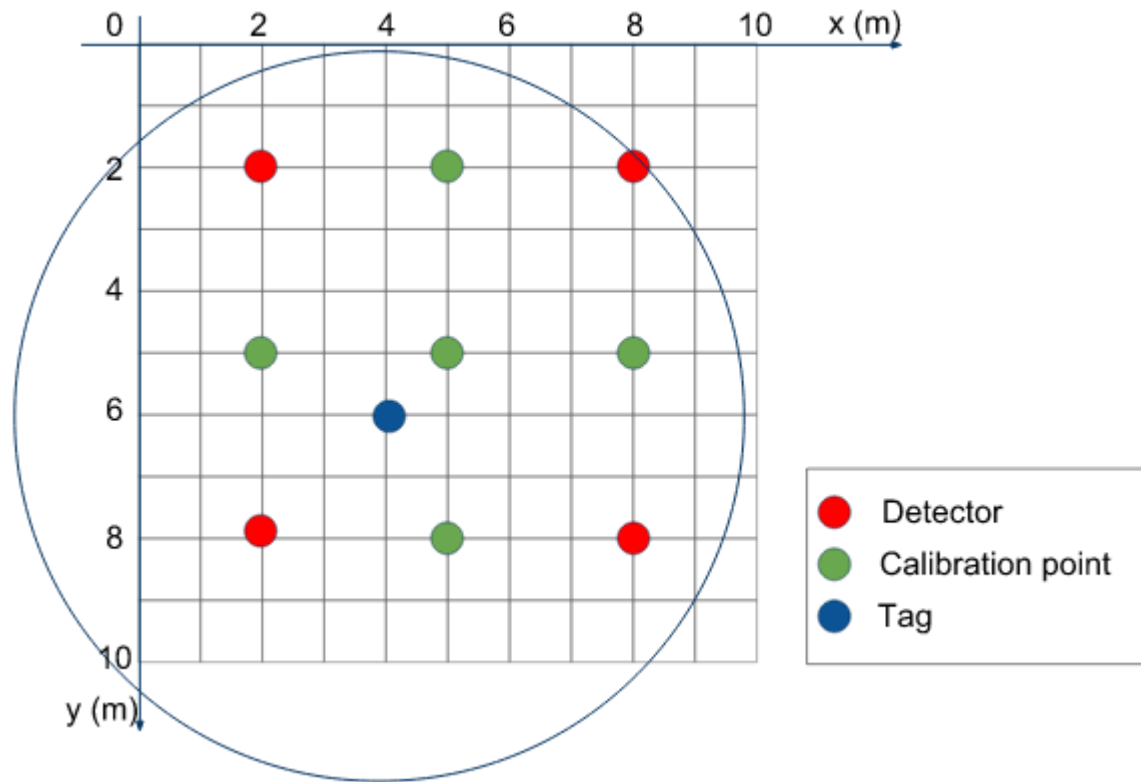
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- **Deployment**
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Deployment



- Detector placement
- Calibration density
- Each tag has a unique ID with respect to other tags
- Each detector has a unique ID with respect to other detectors
- Proxy possible configurations
 - Proxy must have access to LAN
 - Proxy must create an Ad-Hoc Access point for Controller to connect to

Deployment



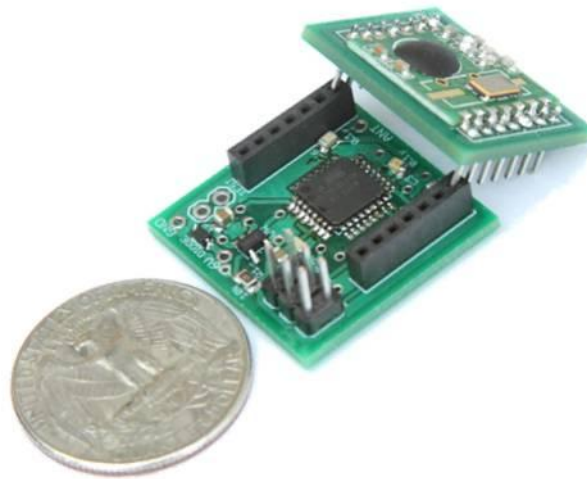
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Results

- Size: 1" x 1" x 1"



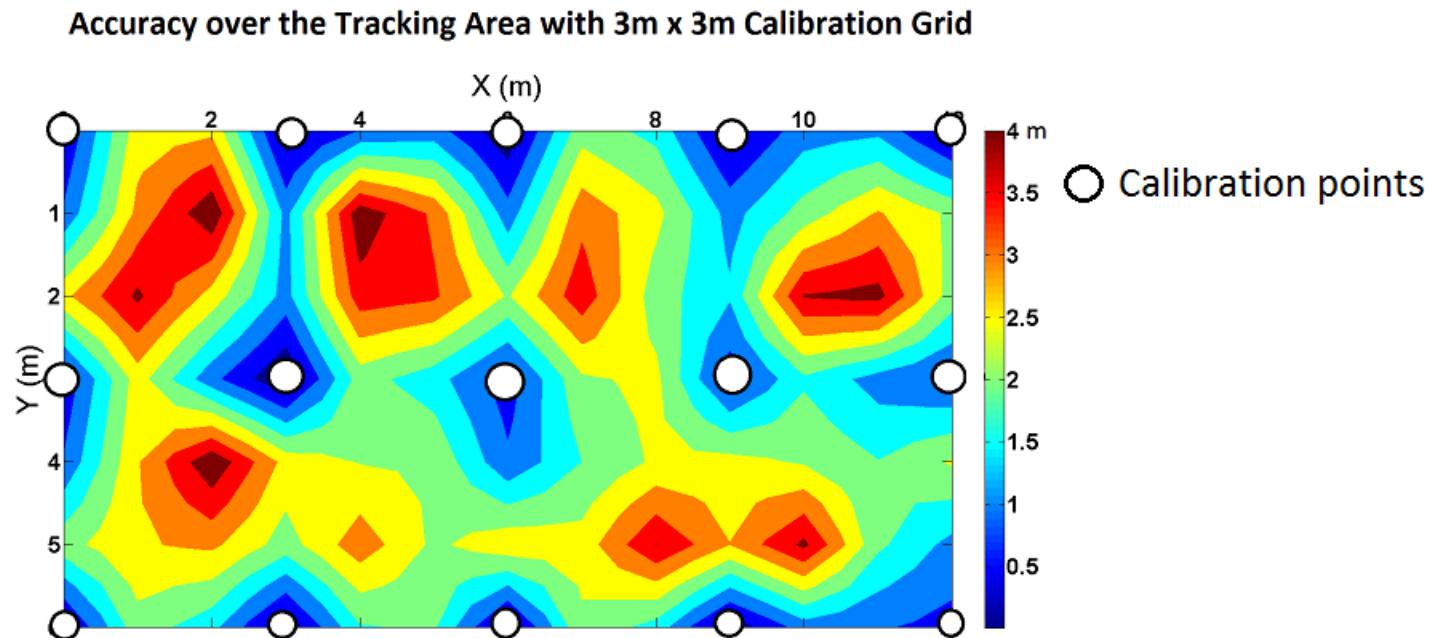
Results

- Power
 - 240mAh coin cell battery
 - 30mA transmit current
 - 40μA sleep current
 - 1sec broadcast interval
 - 3ms transmit window
 - 0.3% duty cycle

$$\begin{aligned} \textit{Lifetime} &= \frac{240mAh}{30mA \times 0.3\% + 40\mu A \times 99.7\%} \\ &= 1,847hr \\ &= 76 \textit{ days} \end{aligned}$$

Results

- Accuracy
 - Average 2m
 - Less than 1m at calibration points



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Conclusions



- Antenna design
- More testing
 - Calibration density
 - Detector placement
- Improve testability
- Different algorithms
- Environment & signal strength

Acknowledgement



- Professor Robert Daasch
- Alfonso Pereira & Sameer Ruiwale