# TIU Tracking System

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Sponsored by Intel
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## Introduction

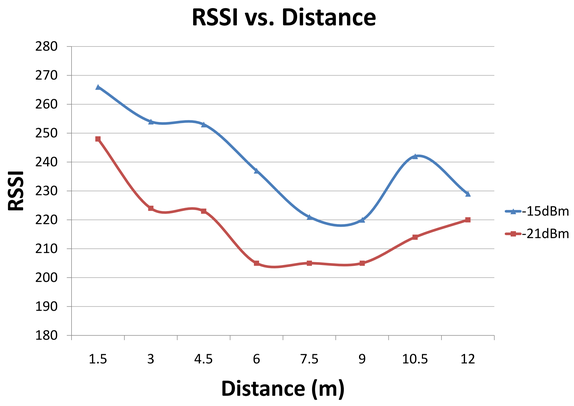
Intel's large and complex validation labs contain many Test Interface Units (TIUs) used in validating hardware. A TIU is a custom PCB that provides test points that a testing machine can probe. Since the hardware to be tested is varied, there exists a variety of different TIU's, and as such, finding a particular TIU is useful because, previously, the testing machine had to be broken down to identify the TIU it was using.

## Approach

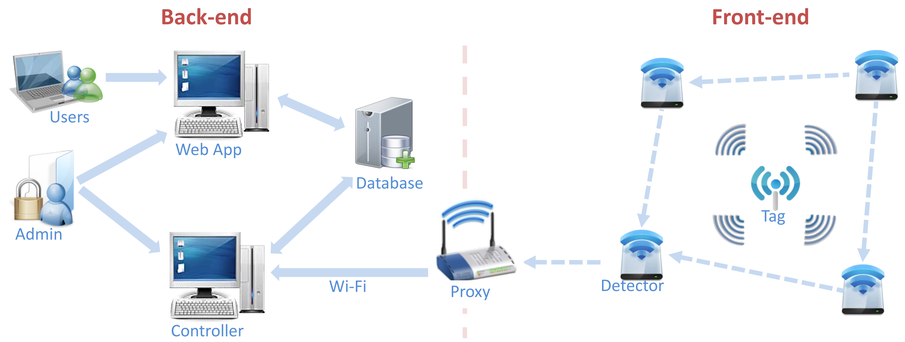
The system uses an RF transceiver mesh network to track mobile tags indoors. The system determines a tag's current location by matching the RF signal strength pattern of a tag's periodic broadcast with pre-collected patterns stored in a database.

Radio Received Signal Strength Indication (RSSI) is a measurement of the power received by an antenna. Signal strength based location method has several advantages over other methods such as GPS, IR, and Acoustics as it is easy to implement and does not require line of sight. Also, low cost RF transceivers are readily available.

For scalability, a **mesh network** of detectors relay all data to a centralized controller where locations of the tags are calculated and saved in a database. An easy to use web application provides visualization of tag locations, as well as other configuration details.




## Design




### Controller

- Receives RSSI and battery data from the mesh network
- Executes the locating algorithm
- Communicates with the Database

### Fingerprint Algorithm

- A pattern matching algorithm based on Euclidean distance
- Employs heuristics and input/output filters to further enhance the accuracy and reliability of the locating process

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

where

- d = Euclidean distance
- N = Number of detectors
- $RSSI_{li}$ = RSSI value from detector i in locating phase
- $RSSI_{ci}$ = RSSI value from detector i in calibrating phase

### Web Application

- Primary user interface with an interactive 2D map
- Search TIUs and detectors via ID
- Display locations and battery levels of all tags and detectors
- Configure tags and detectors
- Configure the tracking area

### Tags

- Attached to TIUs
- Periodically broadcast
- When not broadcasting, in a low power state

### Detectors

- Listen to messages from tags and determine the RSSI values
- Forward the messages to the proxy via a controlled flooding mechanism
- Implements collision avoidance using time division

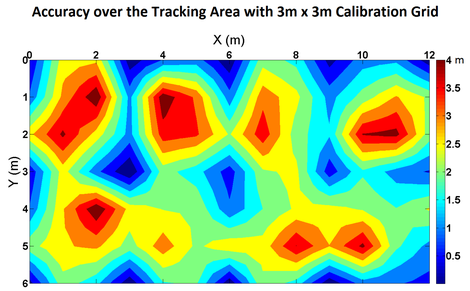
### Wi-Fi Proxy

- Relays data from the mesh network to the controller

### SQL Database

- Stores locations and battery levels of all tags and detectors
- Stores user accounts

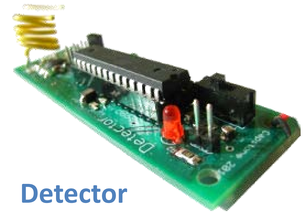
## Experiments




## Products

### Asset Tag

- Size: 1"x1"x1"
- ATMega328p MCU
- RF12B transceiver at 434MHz
- 20mm coin cell battery
- Battery life: at least 1 months
- Cost : $25

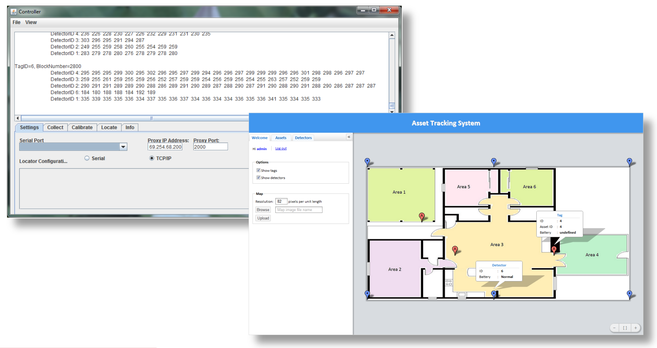


### Detector

- Size: 3.5"x1"
- ATMega328p MCU
- RF12B transceiver at 434MHz
- 9V battery/adapter
- Cost: $30

### Proxy

- ATMega328p MCU
- RF12B transceiver at 434MHz
- WiFly 802.11b/g transceiver
- 9V battery/adapter
- Cost: $80




## Conclusions

The system has been able to meet three important requirements: small size, low cost, and battery life exceeding one month. As for accuracy, the average value is roughly 2m. The result is much better when the tags are close to the calibration points.

Further work to be done includes

- Refine the testability of the system
- Analyze antenna radiation pattern
- Improve the robustness of the location algorithm