

# Automatic Tracking of Actors with Intelligent Theatrical Lighting System

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CLIENT: STORY THEATER COMPANY

ADVISORS: Dr. MAT WYMORE

# Project Overview

## Goal

Track a specific actor across the stage autonomously during an act regardless of other lights.

## Approach

Integrating control theater spotlight software with a programmable microcontroller hardware .

## Plan

Have a tracking system work with a control system to move and track the actor

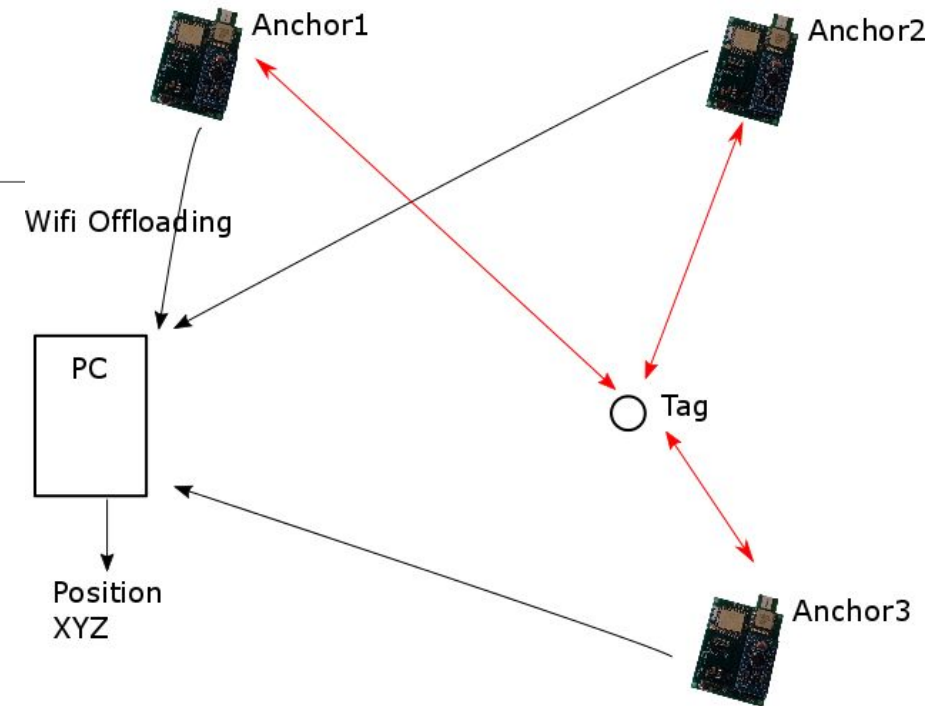
# Problem Statement

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- In small, low-budget theater organization, autonomous tracking spotlights could provide an easy way to program a show's spotlights and cut costs, but commercial tracking systems for spotlights are too expensive.
- An automatic tracking spotlight would allow Story Theater company to save time and money as they wouldn't have to hire a dedicated spotlight person.

# Conceptual Sketch

- One printed circuit boards (PCB) transmits the location coordinates of the actor.
- Three programmed PCBs mounted around the stage to locate this actor by receiving the data through the transmitter and sending it through Wi-Fi to the spotlight controller.
- The DMX spotlight controller receives these coordinates and translate it into DMX signals to move the spotlight accordingly.



# Requirements

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- **Functional:**
  - **System supports automatic tracking with at least one light.**
  - **System supports automatic tracking with at least one actor.**
  - **System supports tracking an actor assuming a fixed starting location for the actor.**
  - **Delay between actor movement and light movement is less than one second.**
  - **System supports a rectangular, two-dimensional playing space.**

# Requirements

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- **Nonfunctional:**
  - **System must be designed as an add-on to existing hardware.**
  - **System should be low cost(less than \$500 fixed cost).**
  - **System should be designed such that it could be integrated with typical theatrical lighting software in the future.**

# Technical Constraints

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- The localino system needs to have 3 anchor boards mounted on the walls around the theater stage
- The person being tracked has to hold onto the tag board
- The localino system has an approximate accuracy of  $\pm 2\text{cm}$
- The spotlight has cheaper components reducing accuracy

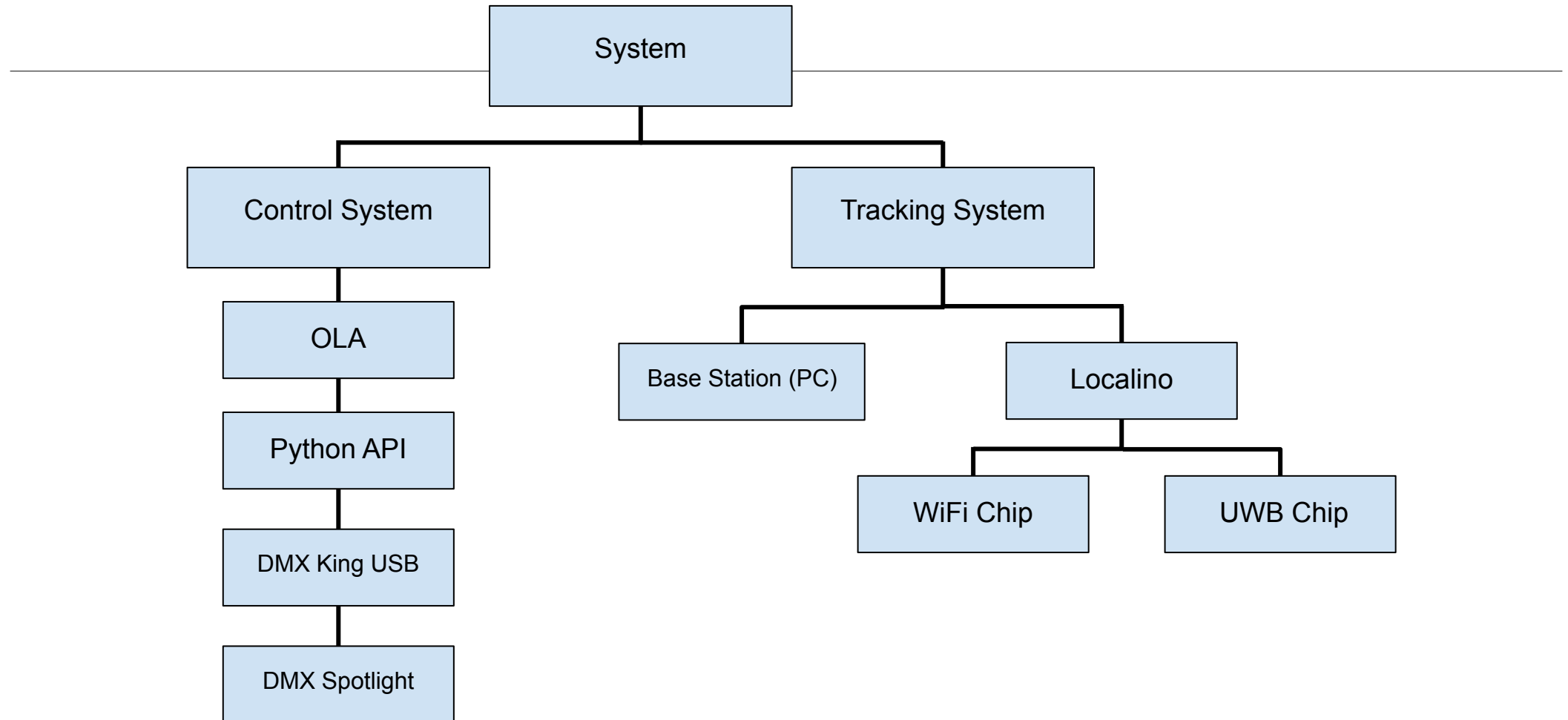
# Potential Risks & Mitigation

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- Replacement localino boards are not available.
- The boards require a wire to be permanently soldered on the board.
- OLA's Python API requires python 2.7 which is EOL



# Functional Decomposition



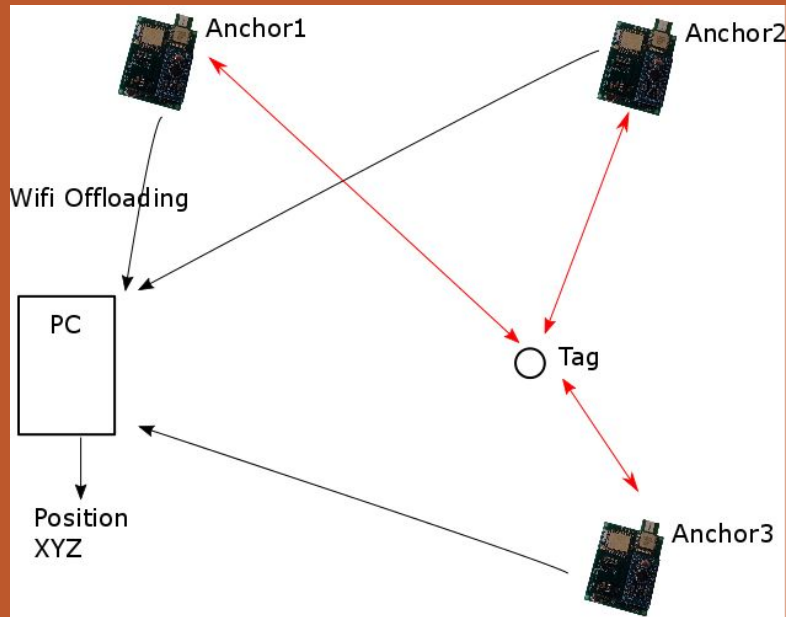
# System Parts

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- Localino tracking system. (Purchased and Assembled)
- Python Software Controller.
- Open Lighting Architecture Framework. (Open Source)
- DMX Spotlight. (Provided)

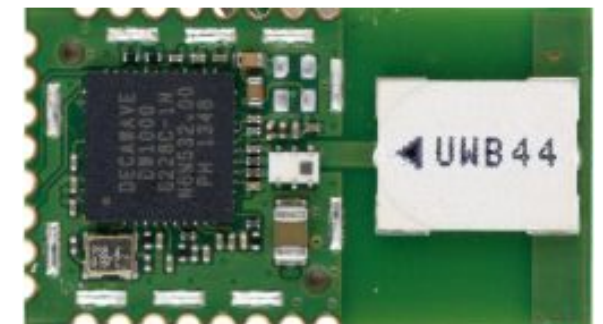


# Localino tracking system



## How Localino Works

- The localino tracking system is a custom PCB with a microprocessor that communicates with other 3 localino that will be mounted around the room.
- The system uses a DWM1000 Module which is a UWB transceiver for measuring object location.
- The system tracks the position of the actor/actress in the room.
- The positioning data in the form of coordinates will be sent to the python controller.



# Design Details

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- We have choose to purchase the Localino tracking system because of its:
  - Accuracy: +/- 2cm from the actor.
  - Price (\$200) is efficient.
- Components of the localino tracking system are:
  - Three localino Anchors are mounted around the stage to receive the location signal (x,y, z) of the fourth localino tag on the actor.
  - The localino microcontroller has a UWB chip that is used for the estimation of the actor distance and a Wifi chip to transmit to the PC server.
  - The DMX spotlight receives the location signal from the tag and follows the actor according to this signal.

# Design Details

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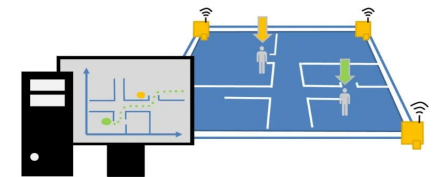
- **Control Components:**

- Created a python control module that uses a framework called Open Lighting Architecture to control the DMX spotlight from our own source code

- **Localization:**

- Soldered UWB chip, Wifi chip to Localino board.
- learned to flash the Wifi chip alone and the microcontroller on the Localino Board.
- Achieved some communication with the Tag and anchors.

Localino  
do it yourself localization system



[www.localino.net](http://www.localino.net)

# HW/SW/Technology Platform(s)

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- Linux (Ubuntu)
- Open Lighting Architecture
- Python 2.7, 3.6
- VSCode
- DMX spotlight
- DMXKing ultraDMX Micro USB device
- Localino (Custom Arduino)
- Arduino software
- Router

# Engineering Standards and Design Practices

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- **J-STD-016-1995 - Standard for Information Technology--Software Life Cycle Processes--Software Development--Acquirer-Supplier Agreement**
  - **This standard outlines good development practices and activities for software development. It includes planning practices and examples of good software products**
- **American National Standard For Evaluation of Wireless Coexistence**
  - **This standard explains the use of GPS (radio frequency), to coexist with other equipment (PCBs) to function (communicate data) in its intended operational environment (stage theater).**

# Test Plan - Individual Components

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## Tracking System:

- Test the Localino kit to find its range of tracking.
- Estimate the accuracy of coordinates given by the localino system
- Record delay of actor coordinates & find an acceptable delay range.
- Does any material affect location accuracy?

## Control System:

- We mounted the spotlight with a laser pointer attached to it in the theater classroom in Carver 308
- We setup the stage space choosing a zero point and input the calibration information into the controls program
- We were planning on measuring the accuracy of the spotlight by inputting coordinates and measuring the difference of the actual positions from the laser pointer's position but were unable to due to COVID-19



# Current Project Deliverables Achieved

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## Tracking System:

- We purchased the localino tracking system and WiFi chips and soldered them together.
- We have been able to flash the localino boards and solder them to distinguish each as either anchor or tag (3 anchors and 1 tag), as well as we have established intercommunication between the boards but not with the PC server .
- We were able to compile and run the python code that is supposed to a base server for the localino

## Control System:

- We have a working python controller that uses OLA's APIs to send signals to the DMX spotlight.
- The controller takes a three-dimensional coordinate and calculates the correct DMX tilt and turn values and sends it to the spotlight.

# Problems/Issues

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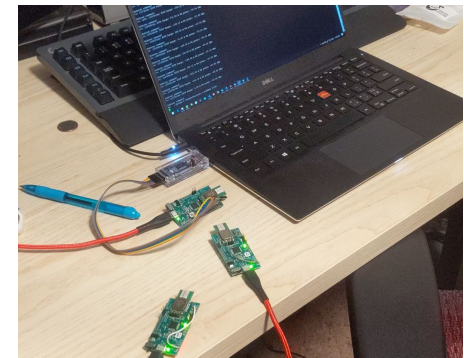
- The soldered wires on the localino board come loose easily and can destroy the contact pad on the board
- The localino code wasn't well documents and wasn't as straightforwardly as we thought, so it was hard to utilize it for our own purposes.
- In the future it might be more ideal to create a similar custom PCB by scratch would be more familiar with how it works
- OLA uses Python 2 which hit EOL and doesn't install packages for Python 3



# Localino Board Specific issues

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- Figuring out how to assemble and flash the Localino kit.
- Understanding the actual communication between the boards.
- Group testing of hardware.
- Understanding the Wifi requirements for the localino kit



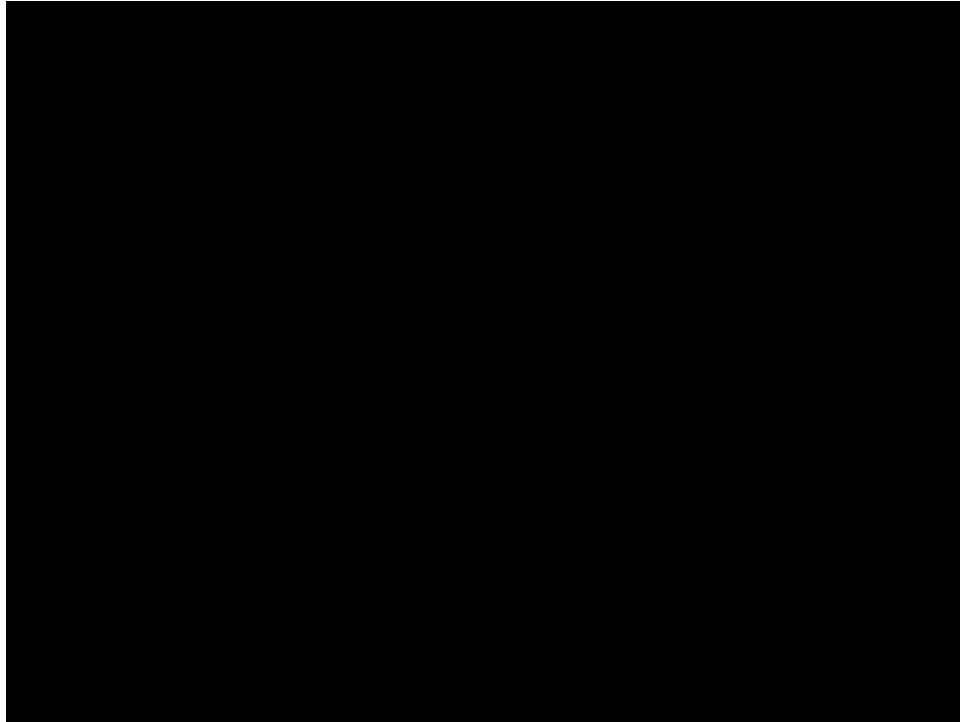
# Localino Board Specific issues

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- No clear source code provided.
- Intercommunication between boards and PC server.
- Movement of the localino kit from open source to a more private business model .

# Video

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# Tracking System intercommunication

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```
COM3 - PuTTY
INIT : Cold Boot
>Settings

System Info
IP Address   : 192.168.1.2
Build       : 137
Unit        : 0
WifiSSID    : localino
WifiKey     : localino-wlan
Free mem    : 27752

Ok
>t: 1136from: 5488 Range: 0.60 m RX power: -67.48 dBm

Unknown command!
>t: 1197from: 5488 Range: 0.60 m RX power: -67.26 dBm

Unknown command!
>t: 125t: 10667from: 5488 Range: 0.62 m RX power: -67.68 dBm

Unknown command!
WD   : Uptime 0 ConnectFailures 0 FreeMem 27848
WD   : Uptime 1 ConnectFailures 0 FreeMem 27816
```

TAG Serial port , receiving from anchors

# Members Contribution

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## **JOEL OHGE:**

Setting up OLA, Python Spotlight Controller, Working with localino boards, Team Reports, Spotlight Accuracy Testing

## **RAED ALBLOUSHY:**

Set up and work the localino boards/software

## **MOUEZ ZAYED:**

Soldering the localino PCBs and flash the boards.

## **HASSAN ALMOHAMMEDSALEH:**

Localino Software Analysis and synthesis with our OLA functions, Testing the system.

## **HASSAN ALHADDAD:**

Soldered the printed circuit boards, helped fix hardware problems, Weekly reports.

# TODO List (Future Tasks)

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- Establish communication from the TAG to the PC server.
- Integrate both the tracking system and the spotlight control system through a websocket or consolidate the code into one package.
- Testing the system in Story Theater Company.
- Potentially have multiple actors with different spotlights.