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Concept

The goal of our project is to create a real-time, indoor localization web API for measuring and reporting relative **angle** and **range** information of an object.

Using three Ultrawide Band (UWB) radios and a time of flight (TOF) based ranging protocol, we can successfully track the range of an object within 5% accuracy and angle within 10° (0.15 rad) accuracy.
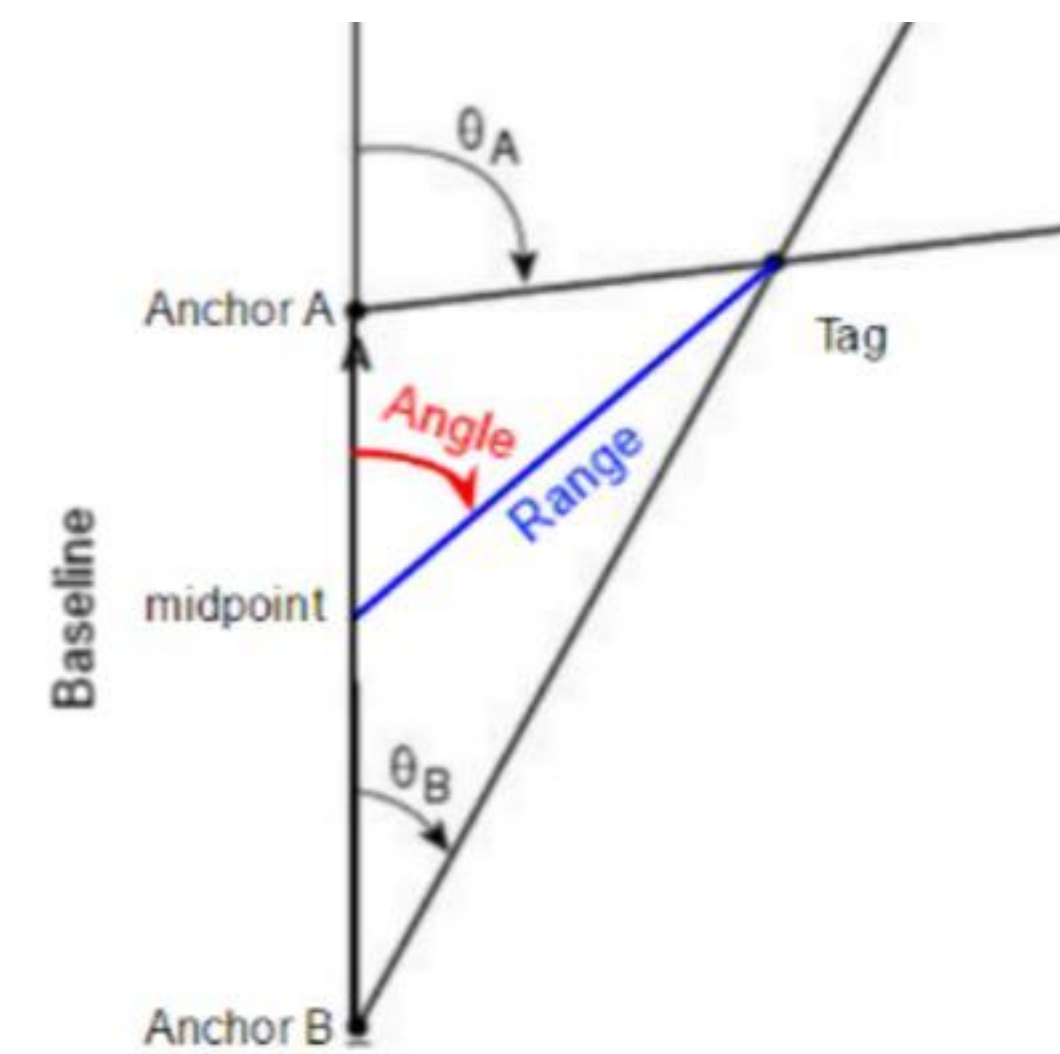
Quick Facts

- To achieve our 10 cm single tag-anchor range accuracy, message flight time measurements must be accurate within $\frac{1}{3}$ of a nanosecond

- That's nearly 100 times shorter than one clock cycle of our radio or microprocessor
- Clock drift on the radios, if not handled in the ranging protocol, can cause error of up to 12 meters
- UWB-based localization is very new. BLE or WiFi solutions have ~5m accuracy

Baseline Research

A large part of our project involved research into how baseline distances (between Anchors) affect the accuracy of the angle and range measurements.
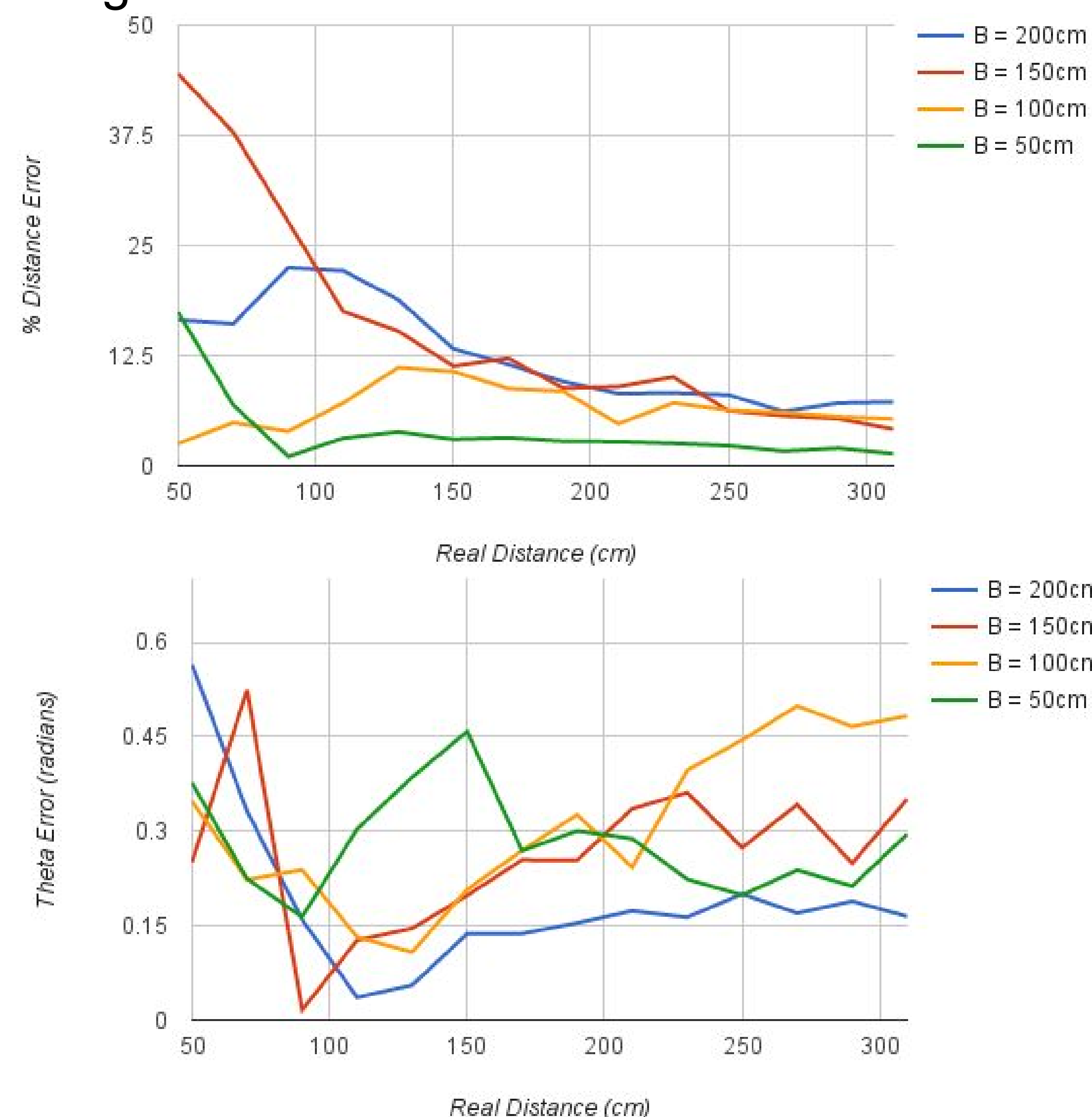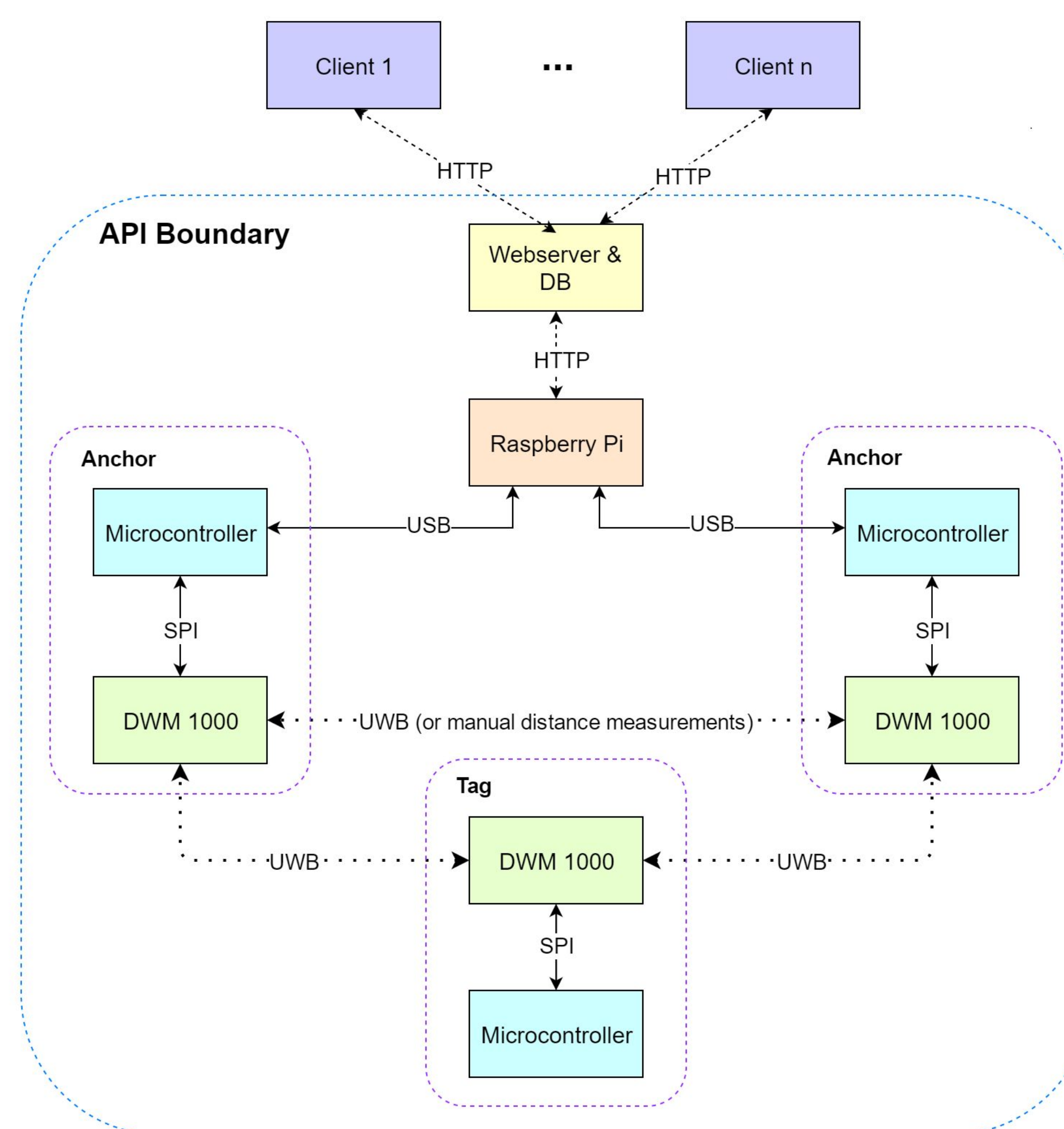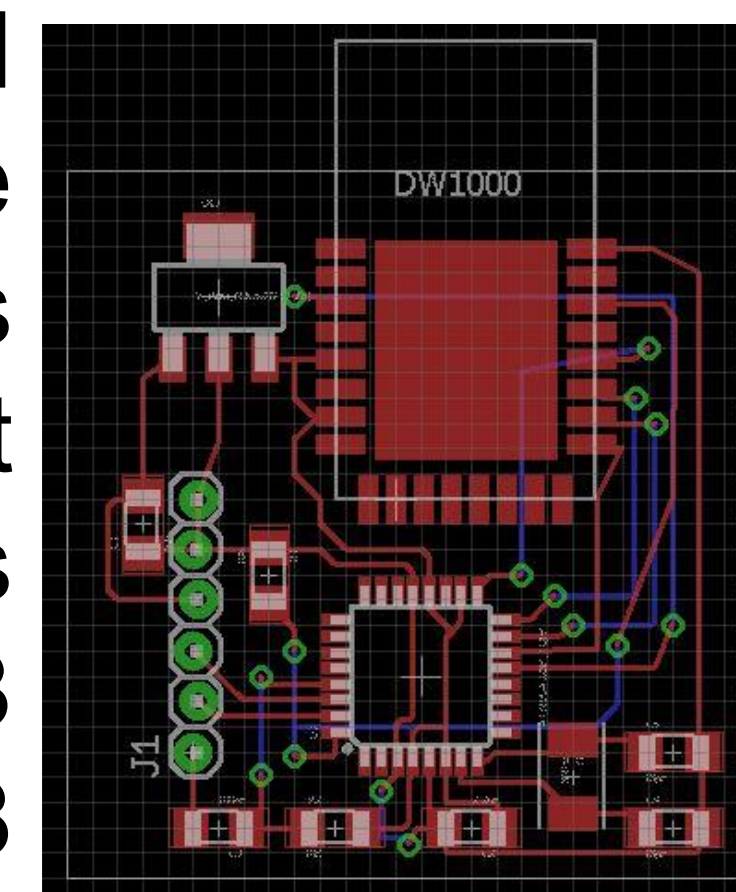

All data shown was collected at an angle of 45°.

The trilateration equations show that as the baseline increases, angle measurements become more resilient to individual measurement error. This is supported by the top graph above. Additionally, the equations show that range measurements are more robust to noise as the range grows compared to the baseline. Again, our bottom graph follows this trend.

Applications

Indoor localization has many uses:
- Indoor GPS-style navigation
- Robotics
- Targeted advertising
- Inventory tracking
- Augmented reality and more

Architecture

Communication Protocol

In order to collect ranging information with the UWB radios, we needed to define and implement our own communication protocol. Below is a diagram showing the messages needed to be passed between the two Anchors and the Tag in order to collect TOF information to determine range.

Hardware

We created a single printed circuit board (PCB) for both the Anchors and the Tag (the roles are defined in software, not hardware). The boards let us connect the DWM1000 UWB radios to our ATMEGA328 microcontrollers.

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