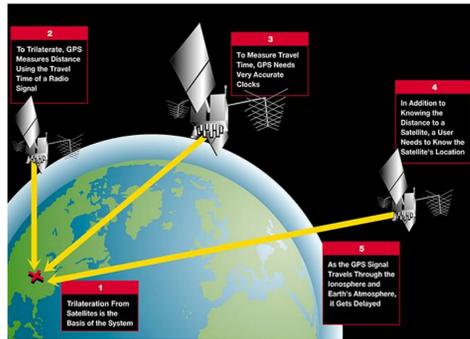
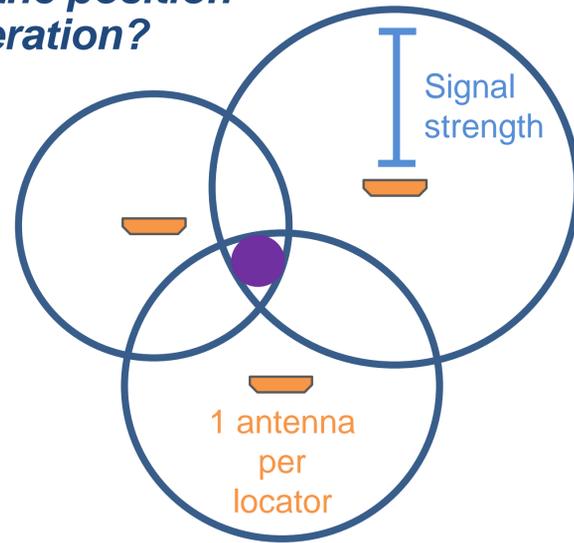


## How do we find the position using Trilateration?



Apply the principles of GPS...

...to Bluetooth

Satellite-user time difference → Distance

Device-beacon signal strength → Distance

### OUR GOAL

- Use Bluetooth waves from antennas and receivers to pinpoint a device's location within a building to a high degree of accuracy
- GPS is not accurate enough for what we want, so we can't use it. However, we can implement some of the strategies it uses.
- Use cases: Warehouses, hospitals, construction

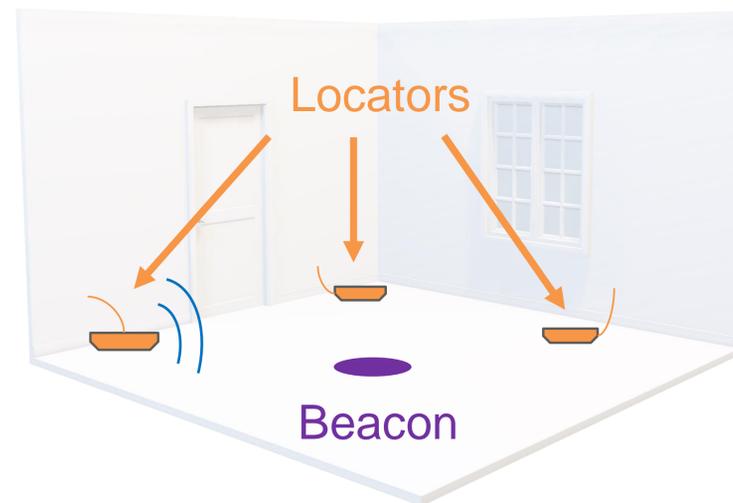
### OUR SECOND APPROACH - TRIANGULATION

- Use angle of arrival from different locators around a room to triangulate the location of a device
- Much more accurate, as it relies on angles rather than signal strength, but more difficult to calculate and implement

### ISSUES

- Within each locator, antennas receive data in a switching pattern, making it necessary to interpret which antenna is receiving data
- Identifying and removing outliers

## Testing environment



### OUR FIRST APPROACH - TRILATERATION

- Use signal strength of a Bluetooth signal from various locators to determine the location of a beacon within a room
- Use intersection of calculated distances the locators are away from the beacon to determine the beacon position

### SUCCESSSES

- Figuring out how to interpret the data we're given and what we need to do in order to get an accurate location
- Getting the phase angles from the data we are given
- Calculating the final angle of arrival, which can be used for triangulation

### IMPLEMENTATION

- Locators constantly report to a database over WiFi the signal strength of all of the beacons that are connected to them
- Python script was developed to
  - Retrieve data from database
  - Calculate distance between beacon and locator for each of the locators using signal strength
  - Output position map of beacon using trilateration

### RESULTS

- Distance calculation is inaccurate at longer distances and when obstacles are in the way of the signal path.
- Bluetooth asset tracking is optimal in open environments like a single room in a building like a warehouse.
- Trilateration-based asset tracking should not be used as a final solution. However, it can be used to assist triangulation-based asset tracking.

## How do we find the position using Triangulation/Angle-of-Arrival?

