

## Objectives

GPS signal for navigation is not always available, especially when indoors. This project establishes an 'Indoor GPS' tracking Android application for Washkewicz Hall, by using properties of existing WiFi access points.

### Application capabilities

- Displaying the user's location on the map of Washkewicz Hall
- Providing accuracy of 15ft of the user's current location
- Displaying building "landmarks"
  - Room numbers, restrooms, water fountains
  - Emergency exits, elevators, fire extinguishers, defibrillators
- Pathfinding throughout the building to guide the user

### Benefits

- Allows for unfamiliar visitors to know their precise location, allowing for faster navigation, and avoiding travel confusion
- Other possible areas for Indoor GPS technology
  - College campuses, arenas, large conferences, shopping malls, large manufacturing sites, etc.

## System Design

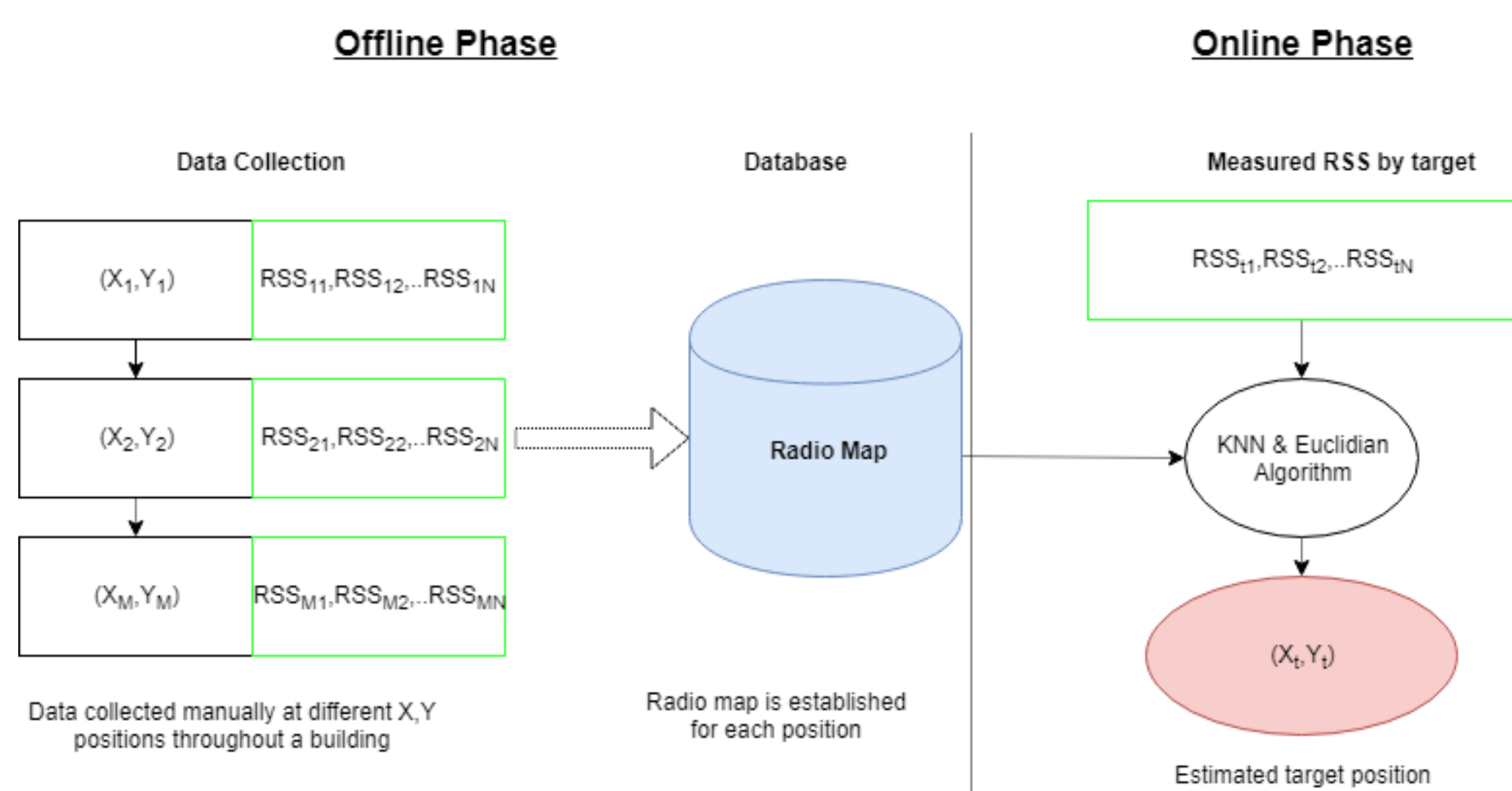


Fig 1: Fingerprinting Proposed Method

### Machine learning algorithm

- Estimate the user's location online using K nearest neighbor or kNN algorithms.

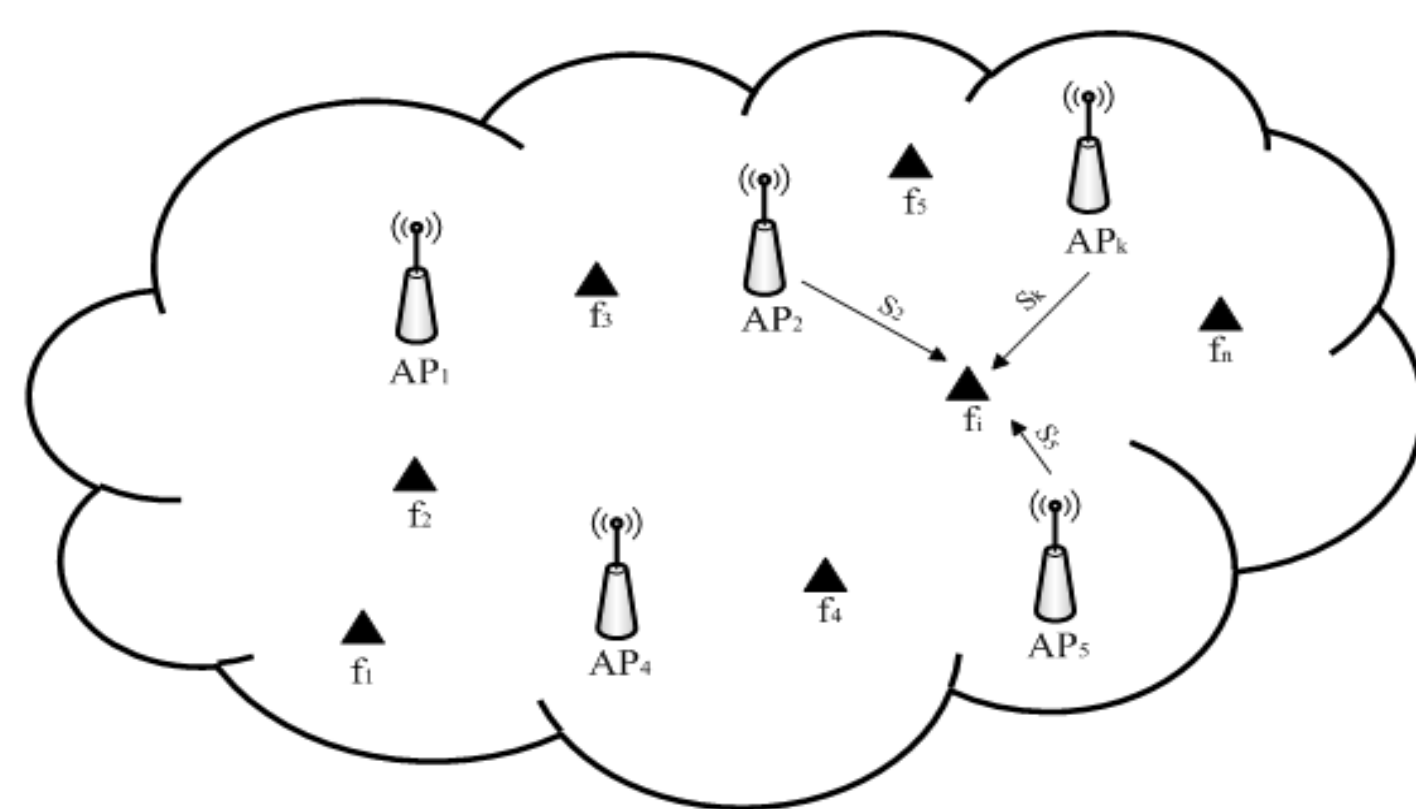


Fig 2: KNN algorithm classification

### Euclidian Distance:

$$d(\mathbf{p}, \mathbf{q}) = d(\mathbf{q}, \mathbf{p}) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \dots + (q_n - p_n)^2}$$

$$= \sqrt{\sum_{i=1}^n (q_i - p_i)^2}$$

Eq 1: Euclidean Distance Equation

## Implementation

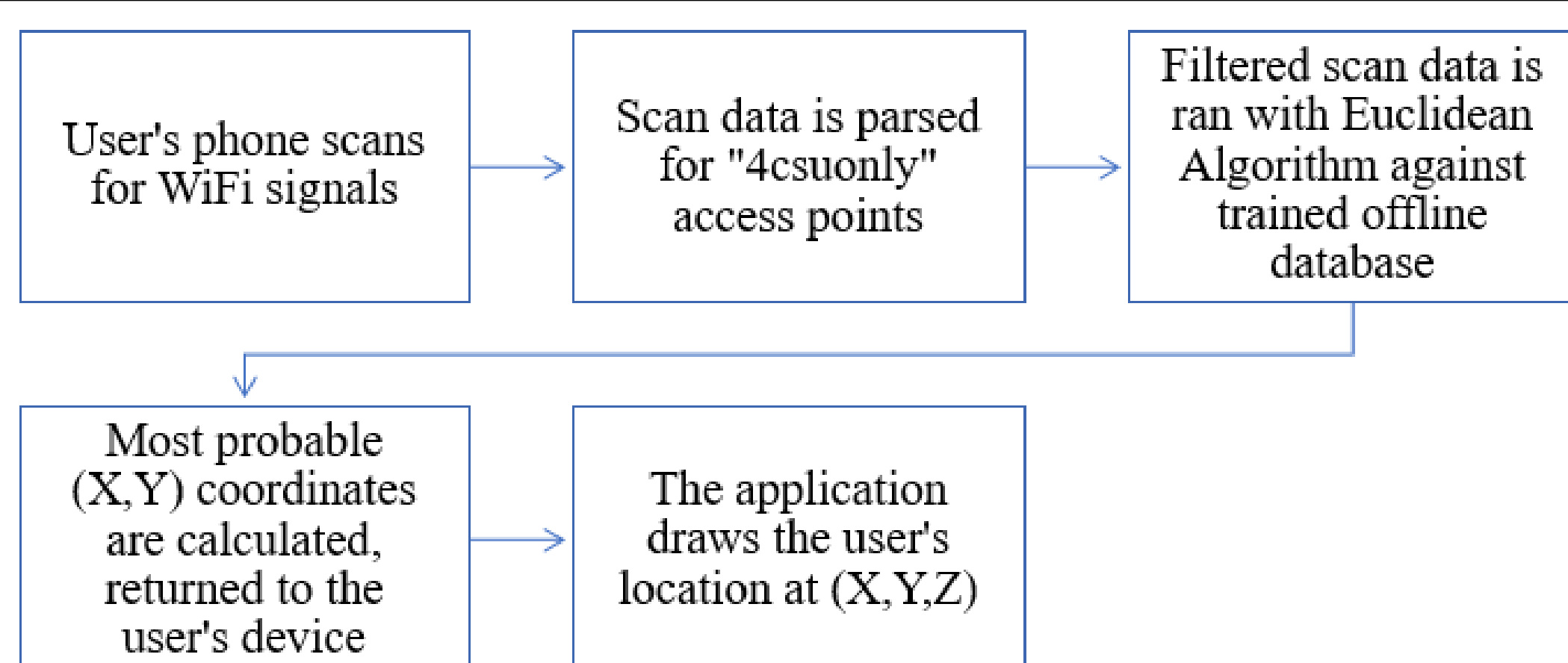


Fig 3: Displaying User Location Process

## Fingerprinting

- Collecting multiple samples of signal strengths and BSSIDs of the WiFi access points throughout Washkewicz Hall. Data is stored with the X,Y,Z position of the floor for later calculation of determining a user's location.
- WiFi data was collected in 268 different training positions, from the basement to the fourth floor. Each training position for each floor was spaced approximately 15ft. apart.

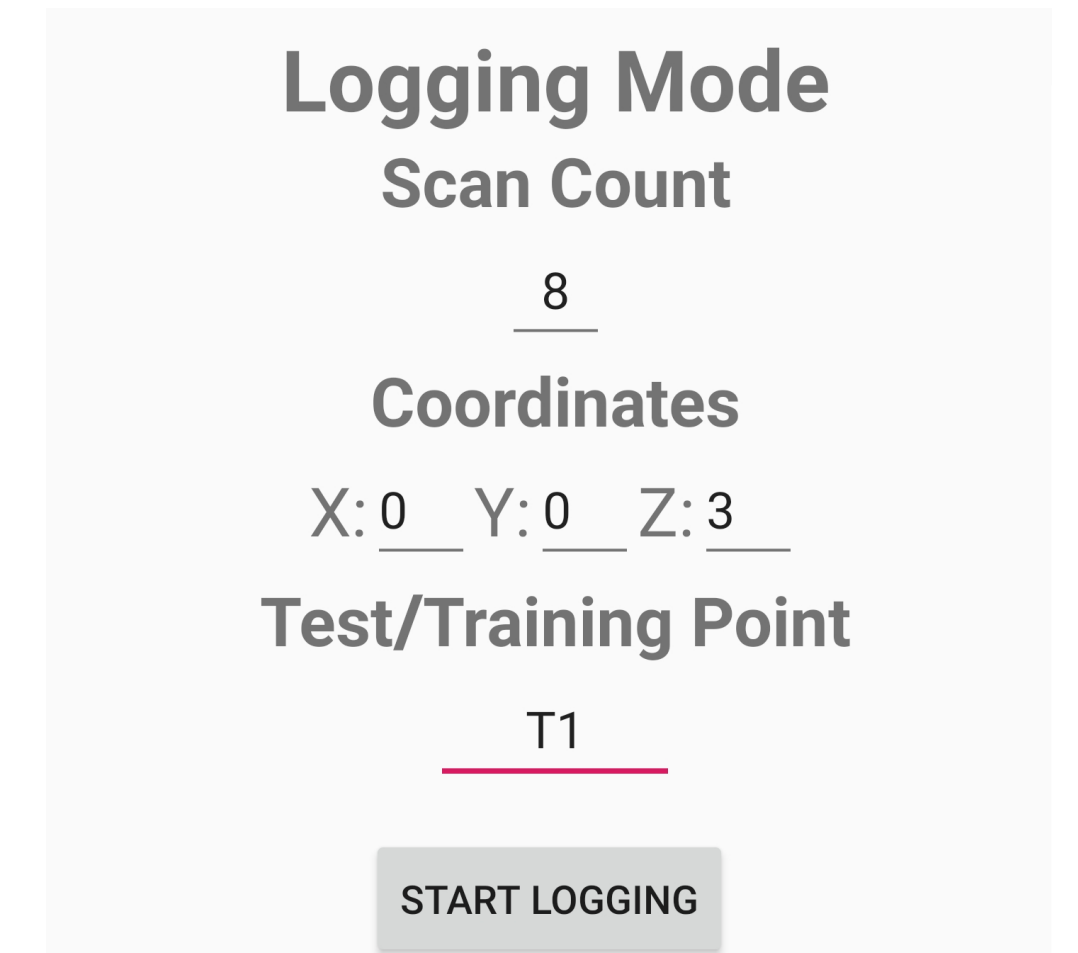


Fig 4: Logging mode with scan count, position, and training point entered

- Red box shows scanned point according to map (various data were taken from T1-T65).

T1 | 28-02-2019 12:46:10 | 8  
 \$-----SCAN1-----\$  
 BSSID: 40:ce:24:d5:4d:2f  
 dB: -49  
 BSSID: 40:ce:24:d5:4b:cf  
 dB: -72  
 BSSID: 40:ce:24:dd:29:c0  
 dB: -74  
 BSSID: 40:ce:24:ce:4f:a0  
 dB: -76



Fig 5: Floor 3 WH training points

Table 1: WiFi sample result from position T1 at coordinates (0,0,3)

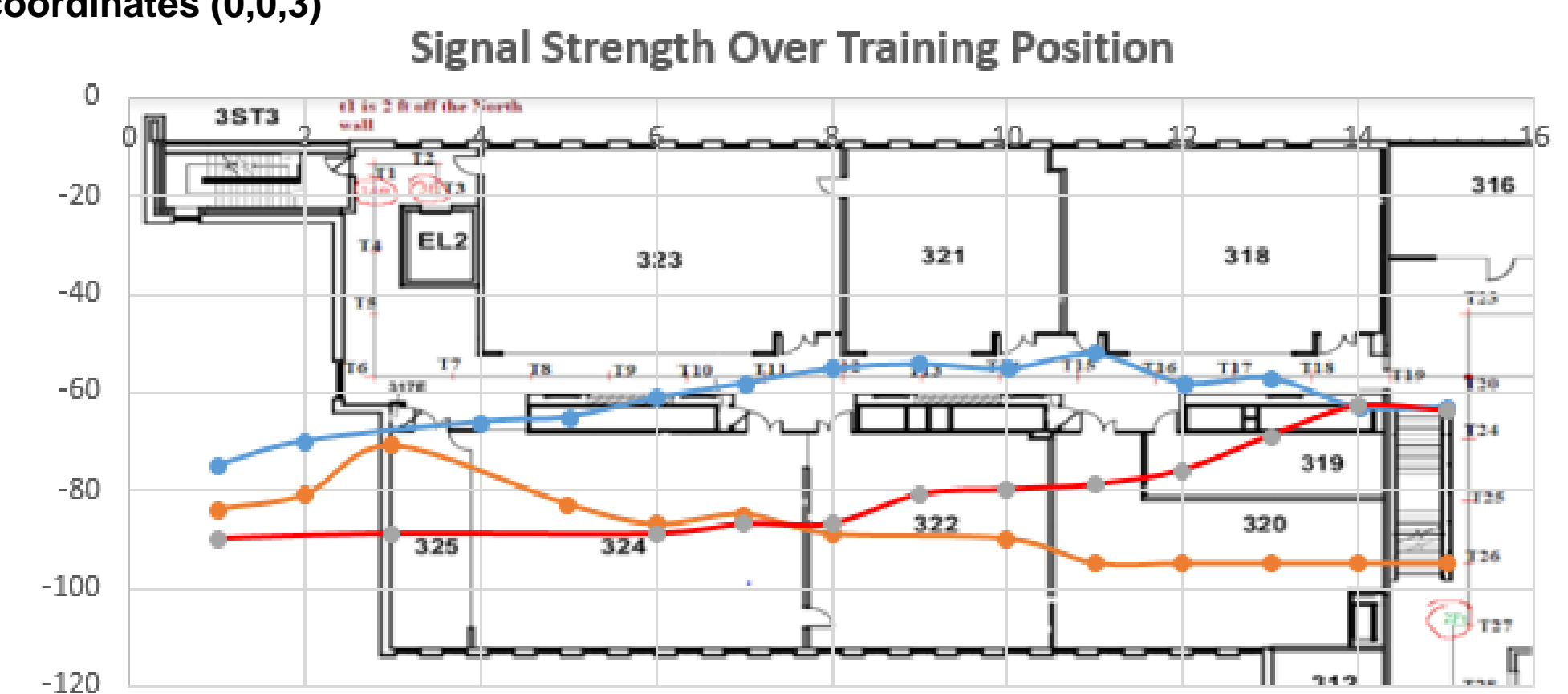


Fig 6: Signal strength in dBm over training position T6-T20, WH 3rd floor

## Experimental Results

### Washkewicz Hall Indoor Localization

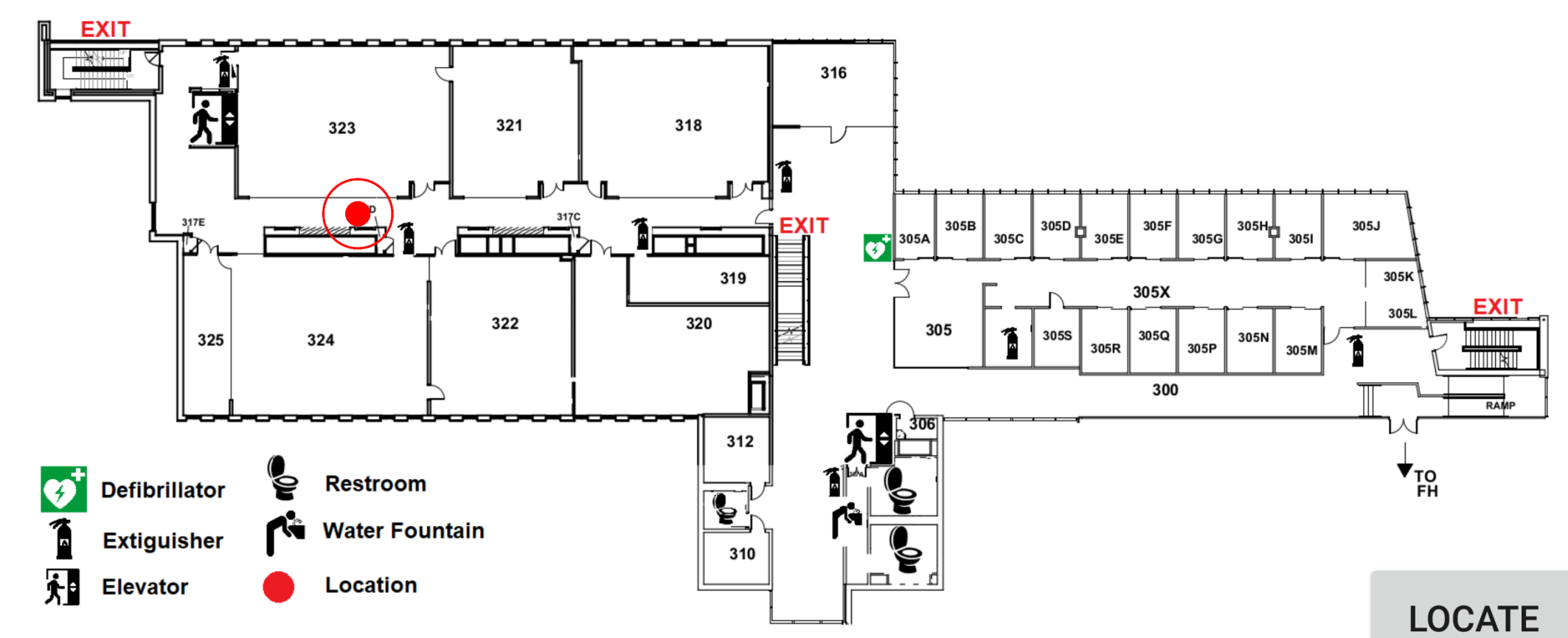


Fig 7: Complete application with accurate user location and landmarks.

## Conclusion and Future Work

### Conclusion

- Team was able to achieve majority of objectives, falling short of providing pathfinding.

### Future Work

- Implement with newer WIFI standard (802.11mc) for 3ft accuracy.
- Indoor location becomes more important with IoT.
- Try different machine learning algorithms
- Add events dynamically on the map
- Monitor location of equipment, store items, warehouse items, etc.