Museum Mate
PDR

Team 7

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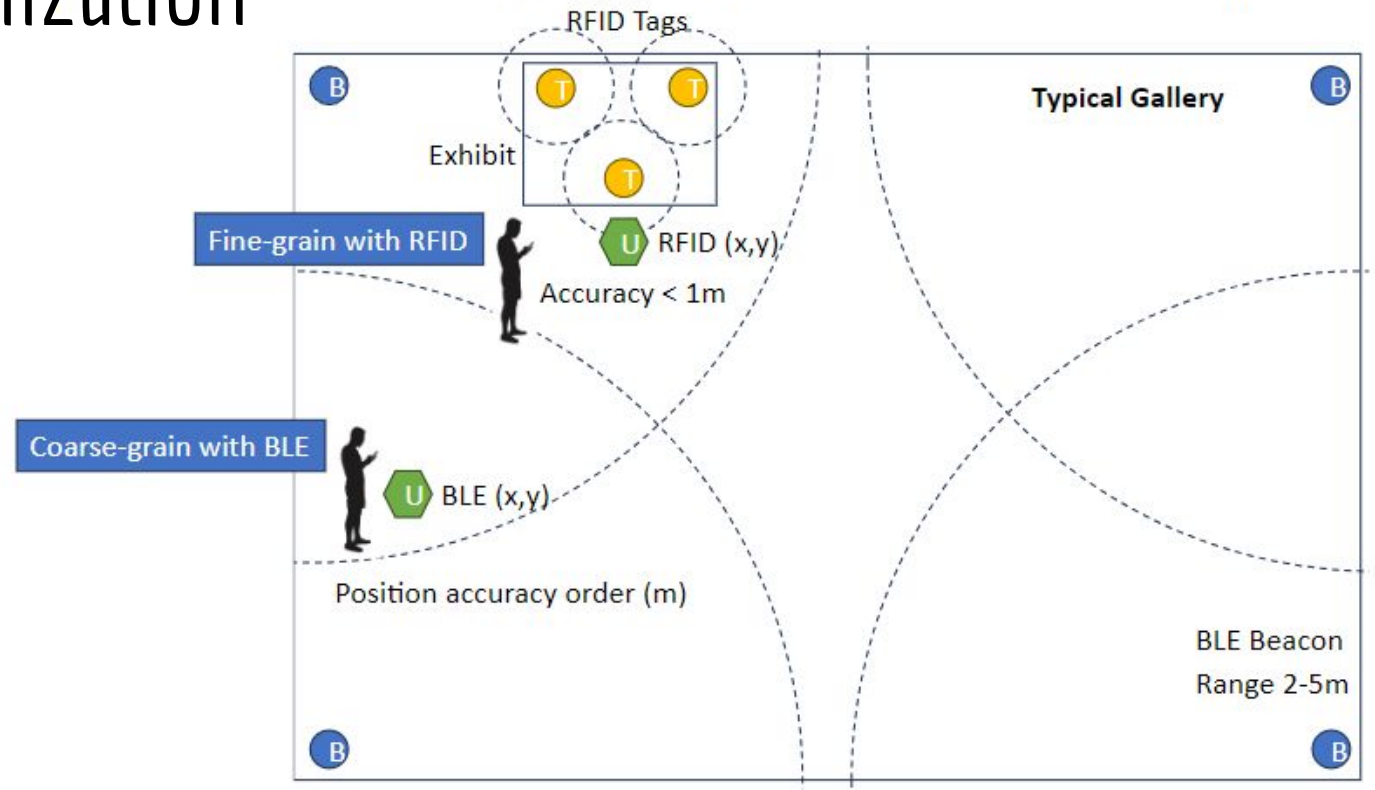
Introduction

Problem Statement:

- Museums can be crowded and hard to navigate
  - Bottlenecks, popular exhibits, not optimized routes
- Exhibits don't provide enough engaging and informative information
  - Limited details, limited forms of providing information
- Museums are not always accessible to people
  - Limited tools for people who are auditory and visually impaired, small text on exhibits

Air and Space Museum
https://www.cnn.com/travel/gallery/best-aviation-museums/index.html

Visualization



Requirements

User Device:

- Efficiently reads RSSI signals from beacons
- Scans and identifies RFID chips in exhibits
- Communicates with Node.js server via UDP

Indoor Positioning Function:

- BLE provides RSSI data to Node.js server which uses a KNN ML model to determine location
- RFID provides precise location information to accurately display multimedia content

Routing Algorithms:

- Determine room location of each user device in system
- Create congestion values for each room
- Update weighted adjacency graph based on distance and congestion
- Calculate shortest path to visit different rooms

Front-End Application:

- Provide multimedia content relevant to nearby exhibits
- Display real time location of active user
- Provide routing to one or many exhibits

Deliverables

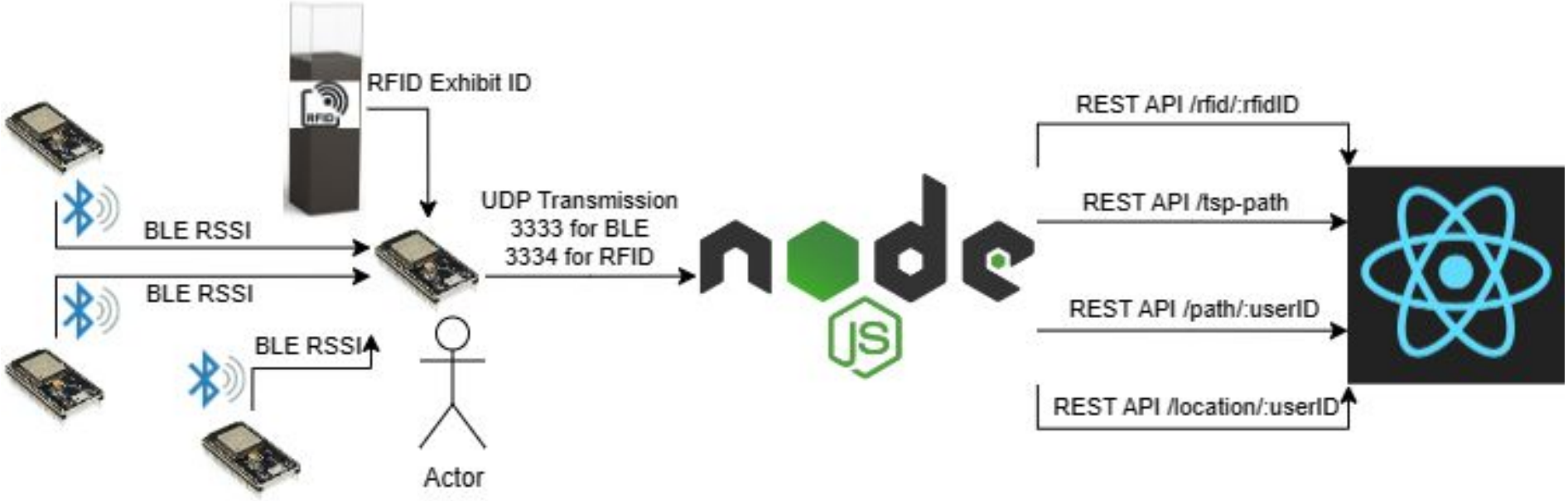
Our system will consist of the following hardware components:

- A handheld device, the TourTag, with the capability to scan BLE and RFID signals and send these signals to a server
- BLE beacons, allowing the system to trilaterate the position of each user
- RFID tags on each exhibit, providing automatic access to multimedia and additional location information

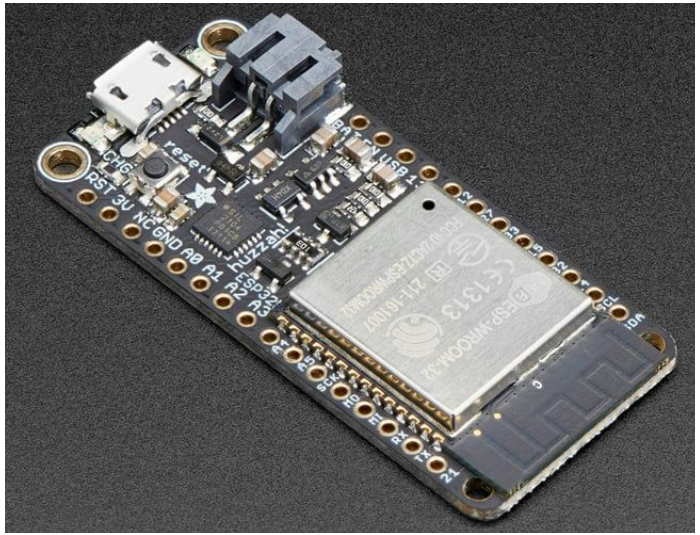
Our system will also consist of the following software components:

- A server, enabling the system to process raw data obtained from TourTags and facilitating data flow between the databases and the user
- Databases, serving as storage for location information and exhibit multimedia
- A mobile application, providing a medium for users to view exhibit multimedia and obtain navigational information from the server through the internet

Block Diagram



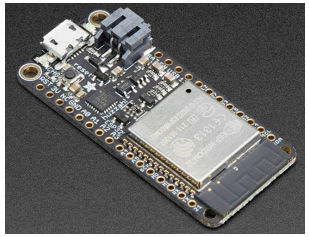
Technology/Design - Beacons



Adafruit HUZZAH32 - ESP32 Feather Board:

- Continually sending the BLE advertisement.

Technology/Design - User Device

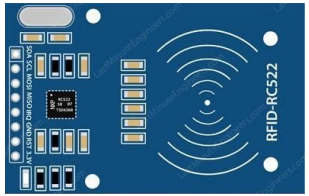


Adafruit HUZZAH32 - ESP32 Feather Board:

- Connect to campus eduroam wifi via WPA2-PEAP.
- Receive BLE Advertisement from beacons and read the RSSI.
- Sending BLE RSSI and RFID Reading to node server via UDP.

Lithium Ion Polymer Battery

- Power up the User Device and make it rechargeable.



RC522 RFID Reader Module

- Read RFID Tag ID.

Technology/Design - Node.js Server

- Input
  - The Node.js server receives data from each user device over the port 3333 in CSV format
    - beaconID,userID,RSSI
- Processing
  - Data that is received is stored/updated in a custom data type called “signalMap” which stores all of the most recent RSSI values by beaconID for each user device
  - A KNN machine learning model is trained with 2000 data points

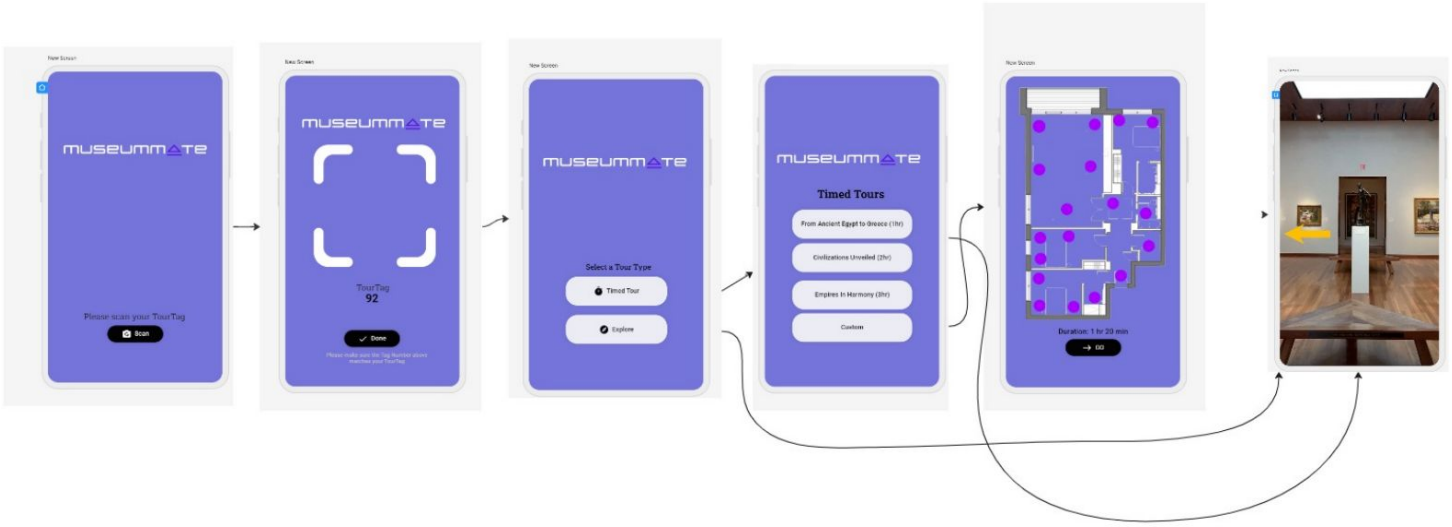
Technology/Design - Node.js Server

- API Gateway / Output (port 3000)
  - /location/:userID (GET)
    - The endpoint accepts a parameter of userID to then perform KNN of that userID and receive a room location that is then returned
  - /path/:userID (GET)
    - The endpoint accepts two parameters, a userID and a room node. The endpoint then finds the location of the user and with a weighted adjacency graph performs Dijkstra's algorithm to determine the shortest route. The route is then returned in a room by room format
  - /tsp-path (POST)
    - The endpoint accepts a request body that contains userID and an array of rooms that want to be visited. The endpoint starts by finding the location of the user and setting this as the start node. Then the endpoint performs the travelling salesman problem to return the shortest path to visit all of the rooms and returns this in a room by room format

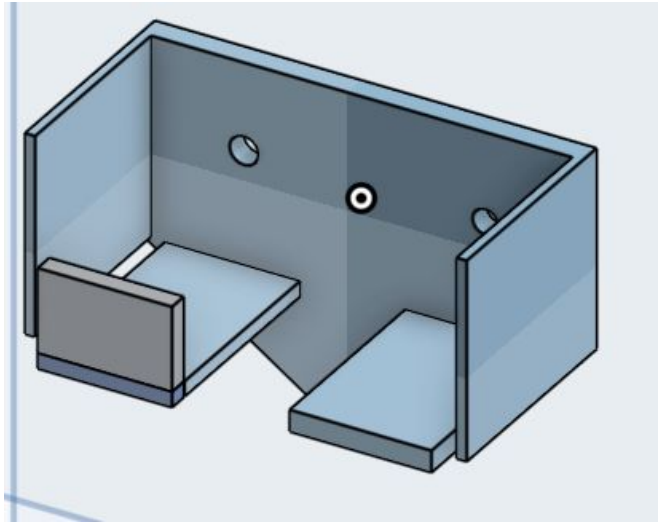
Technology/Design - Phone App

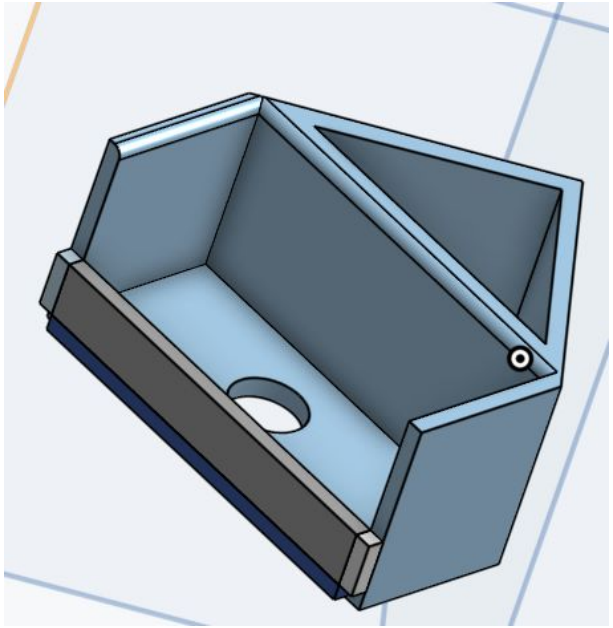
- React Native
  - StackNavigator for navigation
  - Expo for rapid development
  - Jest for Unit and Render Testing
- The custom tour screen sends the desired path nodes to the Node.js server
- Displays the current room for navigation

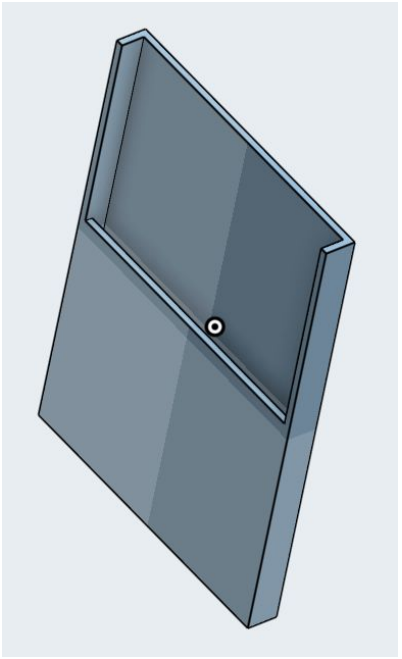
Technology/Design - Phone App



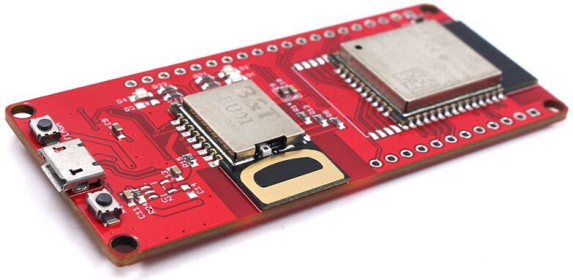
Technology/Design - Enclosures





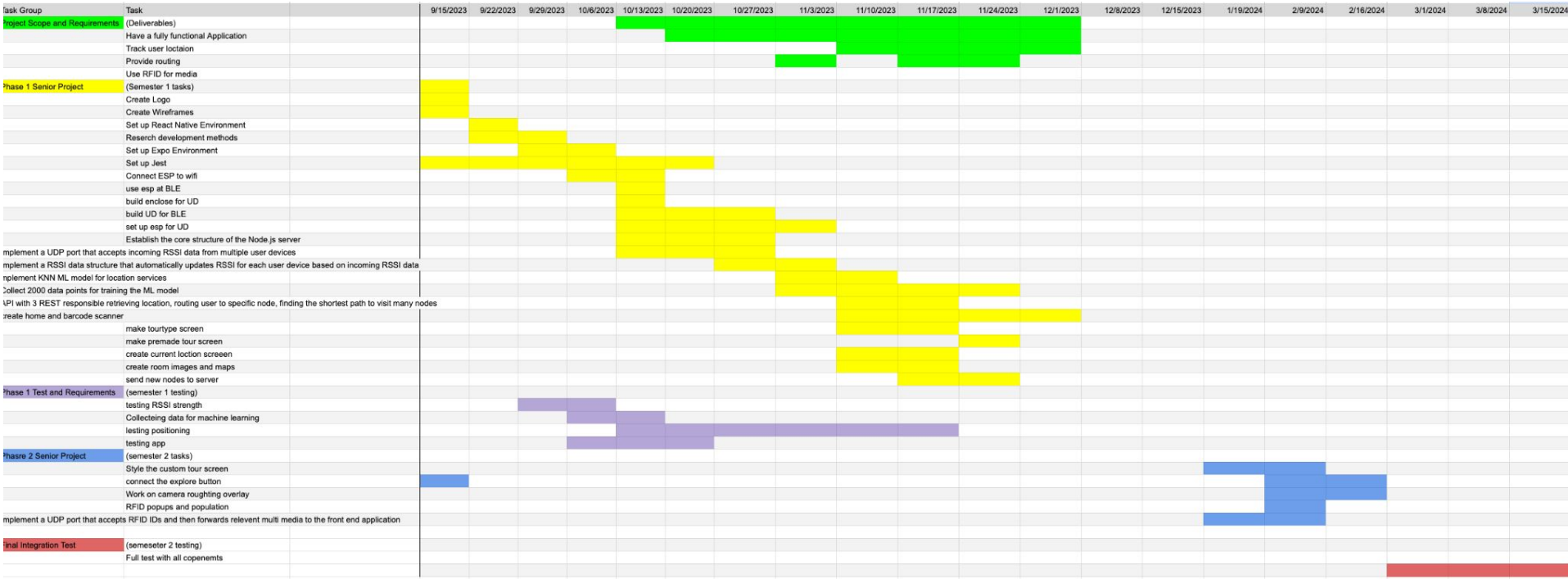


Next Step



Our system is currently implemented and functional utilizing BLE and KNN ML model, but our sponsor has provided access to compatible ESP32 devices that use UWB (Ultra Wide Band) for improved ranging accuracy. Although we have determined that BLE is acceptable for project performance, we are evaluating the UWB solution as an alternative that could be a swap-in replacement for BLE. The downside to this option is the increase in beacon cost, which is contrary to our original specification.

Schedule


Task Group
Task
9/15/2023
9/22/2023
9/29/2023
10/6/2023
10/13/2023
10/20/2023
10/27/2023
11/3/2023
11/10/2023
11/17/2023
11/24/2023
12/1/2023
12/8/2023
12/15/2023
1/19/2024
2/9/2024
2/16/2024
3/1/2024
3/8/2024
3/15/2024
Project Scope and Requirements
(Deliverables)
Have a fully functional Application
Track user loctaion
Provide routing
Use RFID for media
Phase 1 Senior Project
(Semester 1 tasks)
Create Logo
Create Wireframes
Set up React Native Environment
Reserch development methods
Set up Expo Environment
Set up Jest
Connect ESP to wifi
use esp at BLE
build enclose for UD
build UD for BLE
set up esp for UD
Establish the core structure of the Node.js server
mplement a UDP port that accepts incoming RSSI data from multiple user devices
mplement a RSSI data structure that automatically updates RSSI for each user device based on incoming RSSI data
nplement KNN ML model for location services
Collect 2000 data points for training the ML model
API with 3 REST responsible retrieving location, routing user to specific node, finding the shortest path to visit many nodes
reate home and barcode scanner
make tourtype screen
make premade tour screen
create current loction screeen
create room images and maps
send new nodes to server
Phase 1 Test and Requirements
(semester 1 testing)
testing RSSI strength
Collecteing data for machine learning
lesting positioning
testing app
Phasre 2 Senior Project
(semester 2 tasks)
Style the custom tour screen
connect the explore button
Work on camera roughting overlay
RFID popups and population
mplement a UDP port that accepts RFID IDs and then forwards relevent multi media to the front end application
inal Integration Test
(semeseter 2 testing)
Full test with all copenemts

Thank You