# Project Title: Cart-E Prototype 2: Low-cost Indoor Localization

Project Definition:

We propose to embark on the development of Prototype 2 of Cart-E, a cutting-edge localization system. Building upon the foundation of the previous prototype, we aim to overcome its limitations and create a more robust and versatile solution for room-level localization. Our goal is to extend the range, improve accuracy, and enhance battery life while introducing several key features such as improved power management, enhanced vibration sensing, Wi-Fi router triangulation, and the implementation of location signatures. Additionally, we plan to develop a semi-automated mapping system to accelerate the environmental mapping process.

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# Definition of initial (minimal) project for MEng completion:

The primary objective of this initial (minimum) project is to create a low-cost, energy-efficient indoor asset tracking system that may be put on carts or objects within a building. Using a web portal interface, this system will provide exact asset tracking to the room level, easing the process of locating objects within a facility. Key issues include attaining reasonable accuracy, extending battery life to 3-6 months, and assuring cost-effectiveness, with a mass-production cost of $5 per unit.

# Project Goals:

1. Evaluate Previous Versions: Analyse the strengths and weaknesses of previous iterations of the system to inform the design and development of the new asset tracking solution.
2. Battery Longevity Improvement: Integrate a vibration switch with the required sensitivity to optimize battery life by utilizing the sleep mode of the ESP32 module.
3. Local Server Deployment: Transfer the server infrastructure from Amazon EC2 to a local server to reduce costs and enhance communication efficiency.
4. Semiautomated Mapping Method: Develop a method, potentially involving a combination of bots and April tags, to efficiently map the Wi-Fi signal environment. This method should accelerate mapping while extending the range of coverage.
5. Router Signal Analysis: Investigate the distribution of Wi-Fi signals around routers and assess how non-static objects, such as humans or moving items, affect signal strength, especially during the triangulation process.
6. Signal Filtering and Modulation: Explore signal processing techniques, including continuous moving average, exponential moving average (EMA), and Kalman filtering, to identify and mitigate outlier router signals.
7. Triangulation for Improved Accuracy: Implement triangulation methods to enhance the system's accuracy, achieving room-level precision in asset tracking.
8. Prototype Development: Design and create a printed circuit board (PCB) for the first version of Prototype 2, incorporating the improvements and features outlined in the project.

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1. Multiple Simultaneous Tracking: Scale the system by producing 10-20 tracking boards and integrating them into the portal. Ensure simultaneous tracking and data visualization for multiple assets.
2. Enhanced Accuracy with Sensor Fusion: Extend the project scope to explore advanced sensor fusion methods, potentially involving additional sensors like IMUs, to achieve the highest possible tracking accuracy.

# Tests at each phase to ensure the working of each sub-system:

\*\* We plan to think of each of the phase wise tests and make the detailed plan of it with timeline once we are done with finalising the goals and order the above objectives in the most optimal manner.

If we talk in a broader sense, we plan to conduct tests at different level starting with the testing of each of the components and programs that goes into the system to crosscheck the claims made by the supplier and the output we can get from the components specially the power related components.

Once we are sure about the components, we start the testing of each subsystem against specially designed rigorous test to ensure optimal performance in worst possible scenarios ensuring robustness of each sub system before integrating all the subsystems to form a complete PCB and work in an integrated fashion.

Once we are done with the integration, we will divide our testing into 2 phases starting with a single PCB and ensuring its working and then bringing in multiple replicas of it and sync them to work simultaneously in the same environment without disturbing or hampering the performance of other.

1. Prototype 1 testing: