Indoor Navigational Aide Using iBeacon Technology

Group 14:

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Objective

This project provides an inexpensive, low-power, and expandable infrastructure for an indoor positioning system in conjunction to providing navigational support to the end-user via receiving bluetooth device. The goal of this indoor navigation system is to allow a user that has an android device to be able to connect to a building's navigation network, input where they need to go within the building, then be guided by audio through the building to their desired destination.

Specifications

Android Application

- Must be able to accurately calculate the users location within a meter.
- Must be able to intelligently generate a path to the user specified destination that is both accessible and direct.
- Must be able to detect when the user is getting off course and provide appropriate feedback; can reroute directions when user has gone off-course
- Must be able to verbally direct the user to their destination.

iBeacon Modules

- Must have multiple types of power supply. One type of module will be powered off the wall socket and the other type will combine solar energy and battery power. This allows for iBeacons to be set up on multiple kinds of rooms.
- The battery powered module should be able to last for at least a year and the power consumption of the wall socket modules must be negligible.

- The module dimensions should be reasonably sized - i.e. 125 cm^3 (5 x 5 x 5 cm) in order for it to be unobstructive.
- Adequate RF performance planning - i.e. least-number of modules possible to provide optimal coverage in location and minimal interference.

Budget and Financing

Part Name	**Price per Unit**	**Number of Units**	**Total Cost**
Nordic nrf51822 Development Kit	$100	1	$100
Nordic nrf51822 SoC	$3 - $4	20-30	$120
Crystal Oscillator	$0.50 (est)	20-30	$15
Antenna	$1.00 (est)	20-30	$30
Other components	N/A	N/A	$100

Total: $365

Task Breakdown

Android Application

- Description - Create an Android Application that runs on the Google Glass. The application will allow the user to choose a destination and by using the users location and the building mapping, the application will provide audible directions to the user.
- Team members assigned to task - Andre Compagno, Josh Facchinello
- Current Status - Design
- Sub Tasks
    - Calculating User Location

        - Description - Using the signals received from the beacons, calculate the location of the user in relation of the beacons. The application should be able to know which floor the user is on, where the user is, and which direction the user is facing.
        - Team member assigned to task - Andre Compagno, Josh Facchinello
        - Current Status - Design
    - Mapping Building
        - Description - The building must be mapped in a way the software can interpret where the destination, walls, beacons, and obstacles are located.
        - Team member assigned to task - Andre Compagno
        - Current Status - Design
    - Generating Directions
        - Description - Generate efficient and accessible directions from the users location to the user-specified destination.
        - Team member assigned to task - Josh Facchinello
        - Current Status - Research

Bluetooth Beacon (iBeacon Module)

- Description - Design Bluetooth 4.0 modules that broadcast the iBeacon signal. These will be spread across an area allowing the the Android Application to calculate the users location
- Team members assigned to task - Jonathan Mejias, Pedro Perez
- Current Status - Research
- Sub Tasks

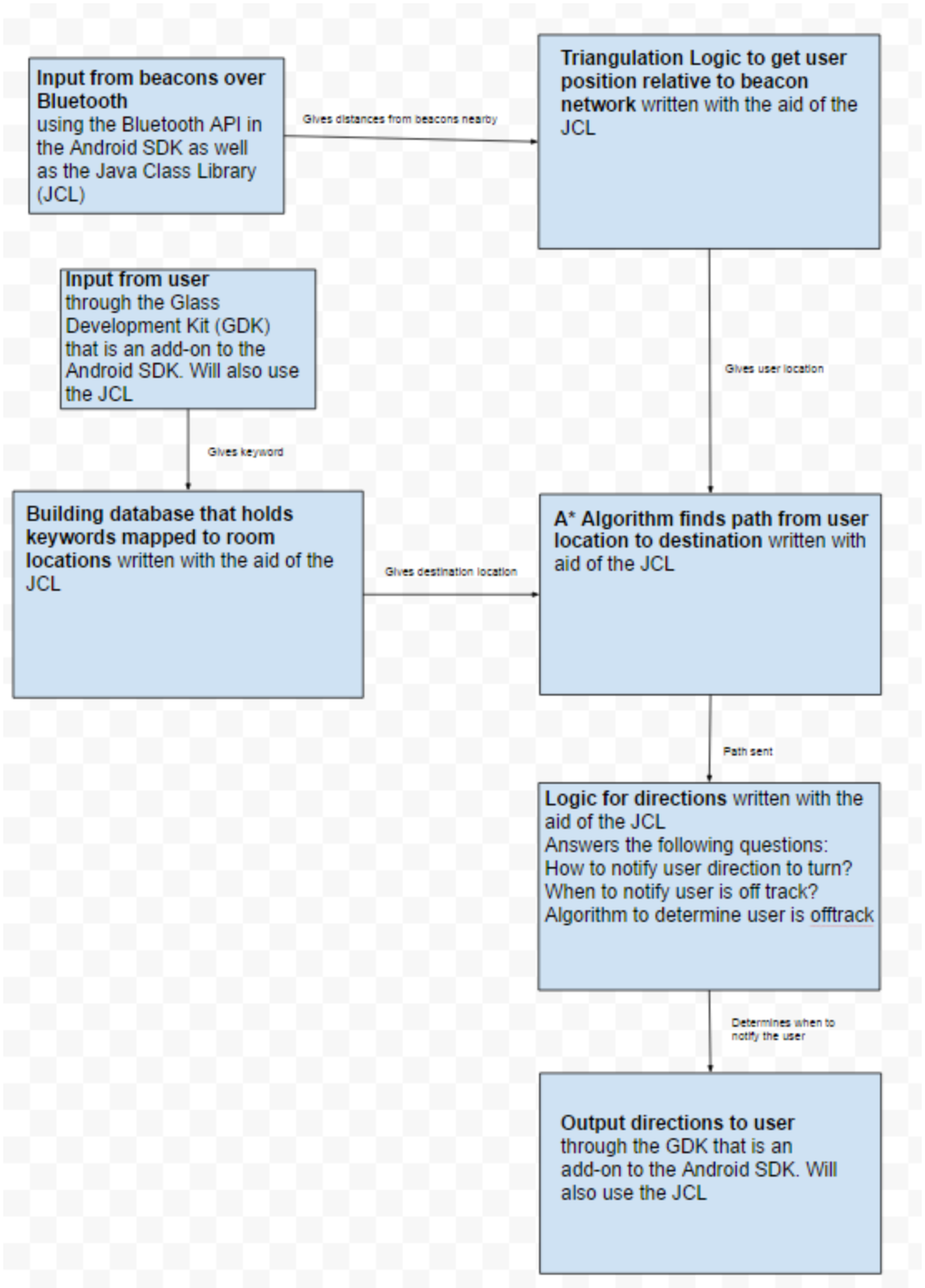
- SoC
    - Description - Choose an SoC that supports Bluetooth 4.0, can be implemented into the iBeacon design, and supports GCC for embedded programming.
    - Team members assigned to task - Jonathan Mejias, Pedro Perez
    - Current Status - Research
- RF/Antenna Design
    - Description - Design antennas that will maximize range and minimize interference. Multiple antenna designs are desired. One that is omnidirectional which can be used in the center of a larger area, and one that is unidirectional that can be used on a wall.
    - Team member assigned to task - Jonathan Mejias
    - Current Status - Research
- Power Supply Design
    - Description - Design power supplies that will allow for the modules to be placed in different places. This will require 2 different designs, one that is powered off a wall socket and one that runs off a combination of solar and battery power (similar to simple calculators).
    - Team member assigned to task - Pedro Perez
    - Current Status - Research
- Embedded Programming
    - Description - Program the module to broadcast the iBeacon signal.
    - Team members assigned to task - Jonathan Mejias, Pedro Perez

        - Current Status - Research
    - General Design (Other Components)
        - Description - Design the PCB for the modules and which components will be necessary for the module
        - Team members assigned to task - Jonathan Mejias, Pedro Perez
        - Current Status - Research

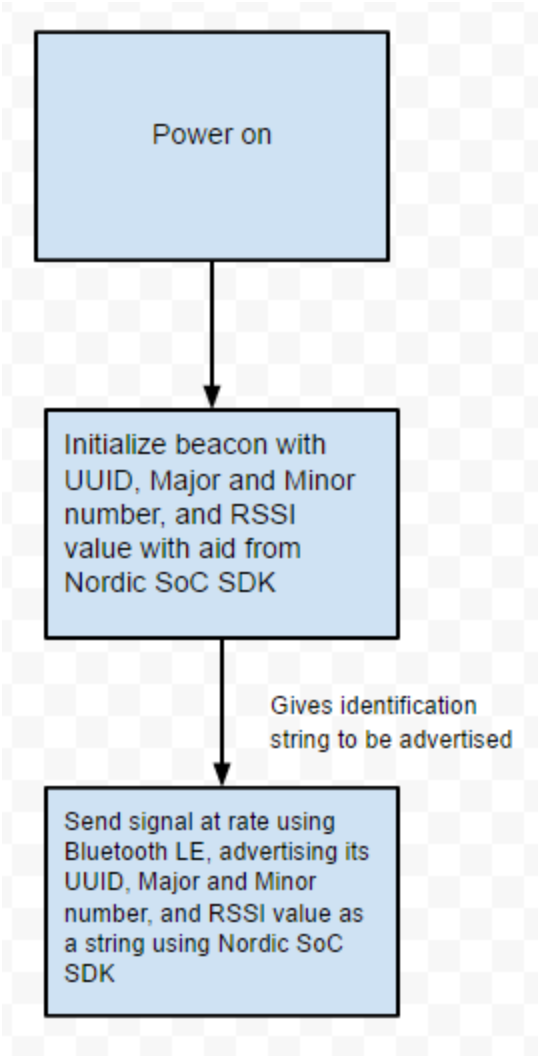
Block Diagram - System Interaction

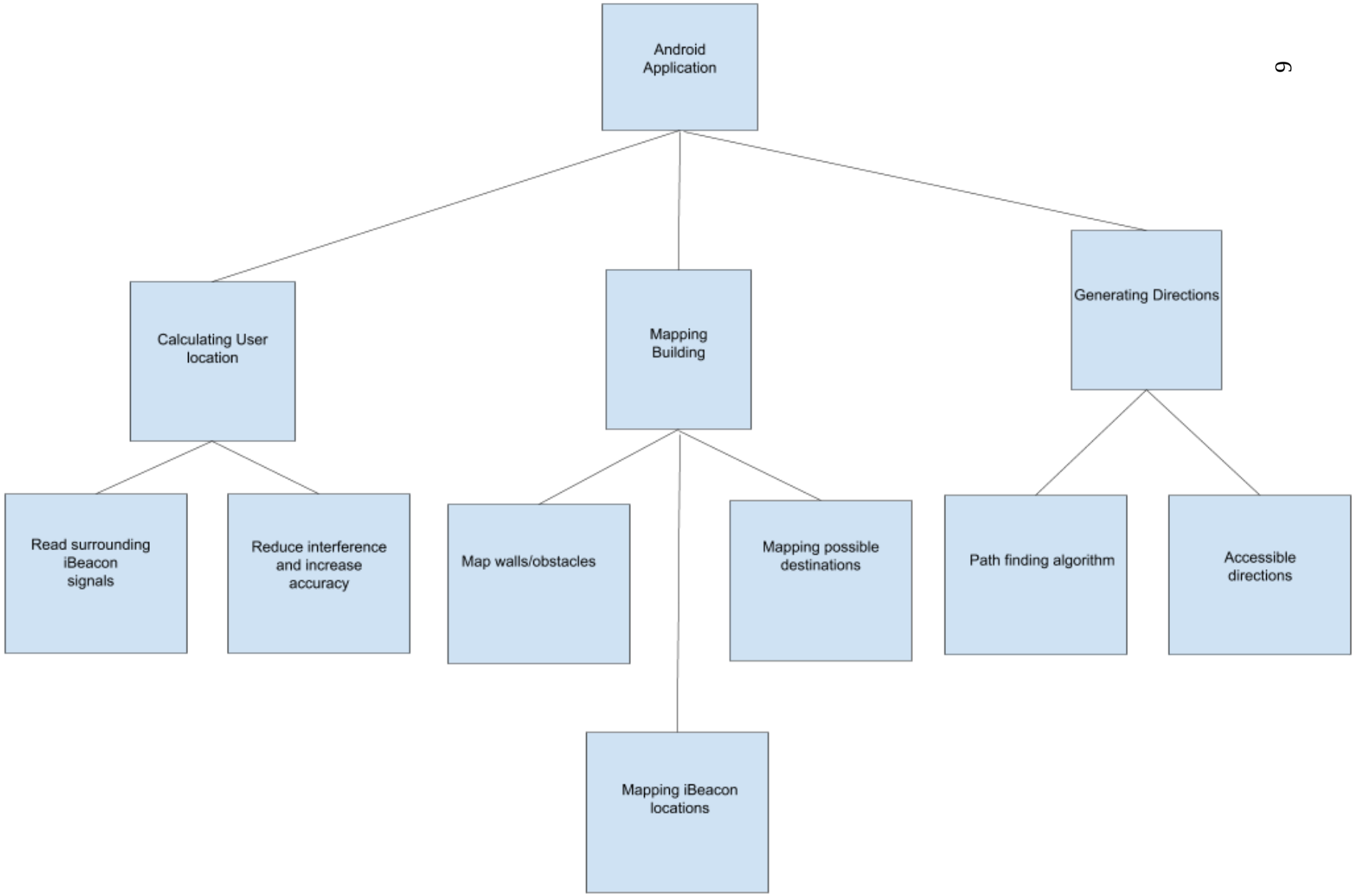
- The signal sent by the Bluetooth Beacon contains the following
    - UUID - 16 byte ID that will correspond to the buildings in which the beacon is located
    - Major - 2 byte integer that will represent the floor in which the beacon is located
    - Minor - 2 byte integer that represents the beacon itself
    - RSSI @ 1 meter - Measured RSSI at 1 meter away. This is used to calculate the distance of the user from the beacon.

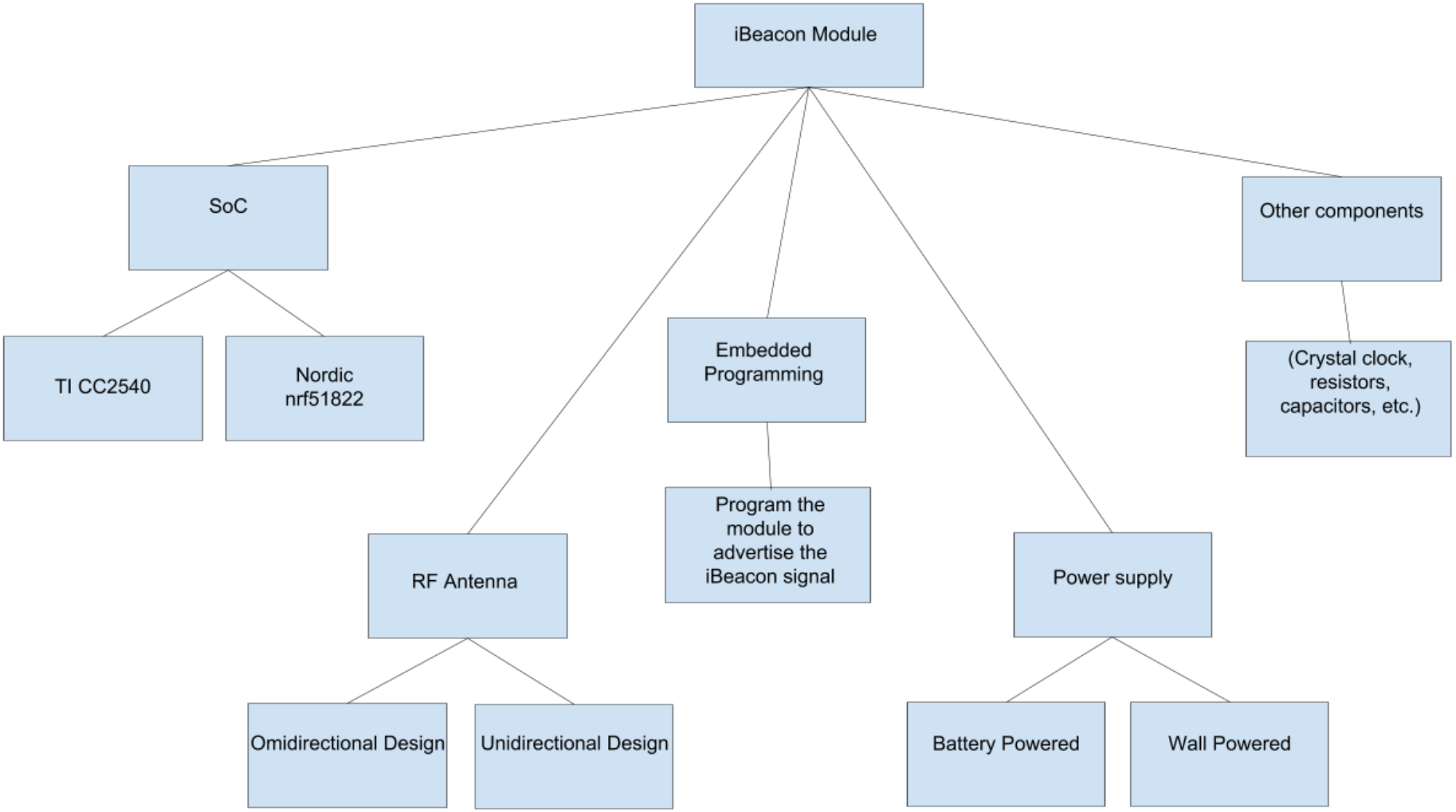
Android Application Block Diagram



iBeacon Module Software Block Diagram


Power on
Initialize beacon with UUID, Major and Minor number, and RSSI value with aid from Nordic SoC SDK
Gives identification string to be advertised
Send signal at rate using Bluetooth LE, advertising its UUID, Major and Minor number, and RSSI value as a string using Nordic SoC SDK


Android Application
Calculating User location
Mapping Building
Generating Directions
Read surrounding iBeacon signals
Reduce interference and increase accuracy
Map walls/obstacles
Mapping possible destinations
Mapping iBeacon locations
Path finding algorithm
Accessible directions


iBeacon Module
SoC
Other components
TI CC2540
Nordic nrf51822
Embedded Programming
(Crystal clock, resistors, capacitors, etc.)
Program the module to advertise the iBeacon signal
RF Antenna
Power supply
Omidirectional Design
Unidirectional Design
Battery Powered
Wall Powered

Project Milestone

Sept. 8	Get Project approved
Sept. 15	Research
Sept. 22	**Start**: map ibeacon location, map possible destinations, map walls/ obstacles
Sept. 29	**Start**: Map building, SoC design
Oct. 6	**Finish**: Sept. 22
Oct. 13	**Start**: wall powered design, omnidirectional design, path finding algorithm design Finish: map building
Oct. 20	**Start**: Accessible directions design, accuracy design **Finish**: SoC design
Oct.27	**Start**: battery powered design, unidirectional design
Nov. 3	**Finish**: Oct. 13
Nov. 10	**Finish**: Oct. 27, generating directions design
Nov. 17	**Start**: Embedded programming design **Finish**: Calculating user location design
Nov. 24	
Dec. 1	**Finish**: Embedded Programming design

Dec. 1 to Jan. 12 will be used to get ahead of schedule for spring semester in order to test the final product by Feb. 29

Jan. 12	Have Mapped building done
Jan. 19	**Start**: build power supply, RF Antenna, Calculate User location software, Generate Directions software
Jan. 26	
Feb. 5	
Feb. 12	**Finish**: final Bluetooth beacon
Feb. 19	**Finish**: Android Application
Feb. 29	Test Product
Mar. 2	Fix Bugs
Mar. 9	Test Product
Mar. 16	
Mar. 23	
Mar. 30	**Final product is complete**