Capstone Project

Specialized Parking Oriented Technology

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Introduction

The purpose of this project is to design a power efficient parking management system that will make parking operations easier for parking services. This system will also give drivers an easier time with finding and paying for parking. Users are able to track the number of available spaces in parking lots and automatically verify their parking through their smart phones. Parking services can track parking spots and manage user account information through a website.

Gateway

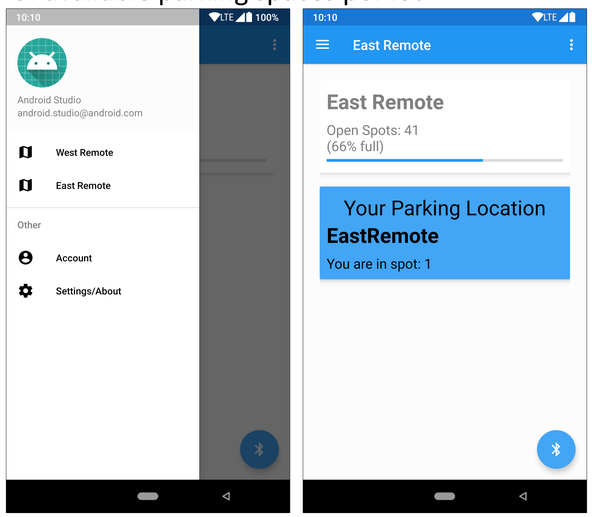
The gateway is a low power device that handles status information between SPOT sensors and the cloud. We are using a Raspberry Pi 3B as our gateway. The gateway does the following:

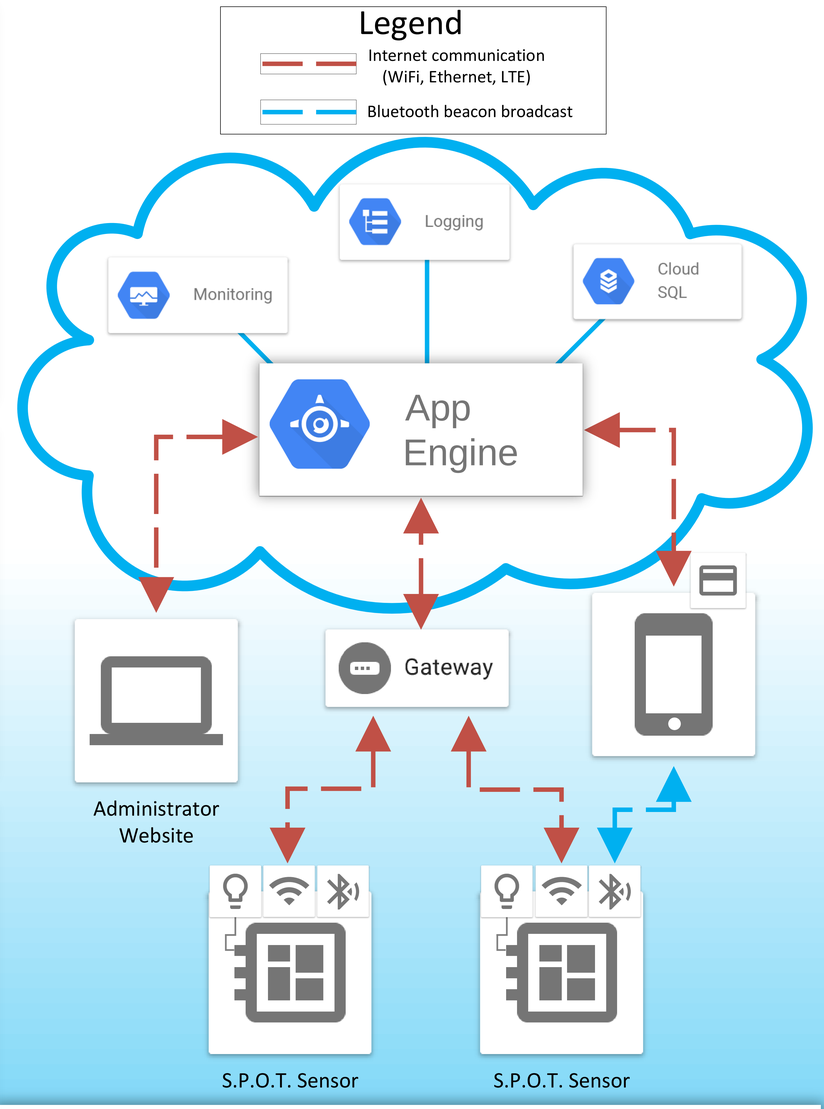
- Forwards spot statuses to Google Cloud's App Engine (AE)
- Forwards verification statuses from the AE to the SPOT sensors
- Messages are sent over TCP formatted as HTTPS JSON key/value pairs

Mobile App

The user primarily interacts with our system through the mobile app. The app allows the user to perform the following tasks:

- Automatically verify their parking permits with any SPOT unit
- Make payments for non-permit parkers.
- View the number of available parking spaces per lot
- Check the spot the user is in
- Look up current account balance and permit type
- The mobile app communicates with the App Engine (AE) with HTTPS messages formatted in JSON key/value pairs





S.P.O.T. Sensor

SPOT sensor units use a Ti-CC3220S microcontroller and Bluetooth beacon to communicate with the user and does the following:

- Units update the App Engine with spot statuses through a gateway using TCP over a 802.11n 2.4 GHz WiFi connection
- Detects cars entering and leaving spots
- Communicates spot status with the user through LEDs
- Controls a Bluetooth iBeacon used by the mobile app to identify the spot a user enters

App Engine

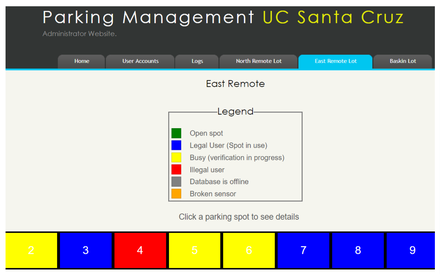
The Google Cloud's App Engine (AE) is used as a framework for hosting web applications, facilitating communication to the gateway, mobile app, SQL database, and administrator website through the use of the HTTPS messages formatted in JSON key/value pairs. The AE serves multiple functions:

- Updates sensor statuses from gateways to the SQL database
- Verifies a user's permit with the parking spot type
- Handles payments and deductions from a user's balance
- Delivers availability of the parking spots to mobile app
- Sends parking lot statuses to the admin website and updates user account changes

Administrator Website

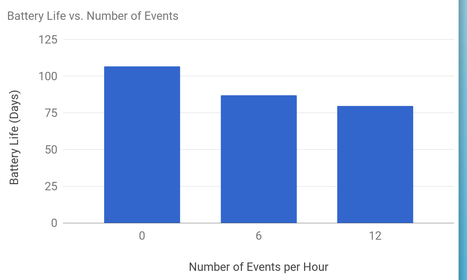
Admins can:

- View lot usage live using HTTPS JSON key/value pairs
- Add, edit, and remove user accounts from the database using HTTPS POST messages
- View transaction/occupation history on a per-user basis



Power

The SPOT unit maintains low power consumption (15 to 350 mAh depending on activity) using the microcontroller's power management, constantly sleeping to conserve power. The graph assumes a 3000 mAh battery from 2 sets of 3 AA batteries in series in parallel.



Conclusion

While our current SPOT unit works just as intended, there is room for expansion: utilizing solar panels to increase self-sustainability, adding a camera to view license planes, and adding credit card payment options to the mobile app.