SMARTPARK

Outline:

Intro:

*Abstract*— Smart Park is an application that will direct users to an available parking stall on campus via a UI (user interface). To accurately determine an occupied or vacant parking stall, the team has implemented a sensor package that can detect a vehicles presence and then send the data to the app. The team is split into a CS component and an EE component. The CS side is responsible to the app while the EE team is responsible for vehicle detection and wireless communication. Since this is an EE technical document only the EE component will be discussed in detail.

Individual project:

My responsibility within the project is to assess and improve signal integrity for the utilized hardware.

LoRa Protocol:

The LoRa protocol, which stands for Long Range, allows for low data low power long range wireless communication.

LoRa Modulation (MKR WAN 1310 transciever):

LoRa modulation uses a chirp spread spectrum modulation to transmit data across a free space medium (air). Spread spectrum means that it utilizes the entire allowable bandwidth. It does this by linearly increasing or decreasing the frequency with time. This is called a chirp or linear frequency modulation.

[Type ABZ | CMWX1ZZABZ | Datasheet | LoRa Module | Murata Manufacturing (arduino.cc)](https://content.arduino.cc/assets/mkrwan1310-murata_lora_module-type_abz.pdf?_gl=1*d51rbg*_ga*MjA5ODU3NDE1My4xNjQ0NzE5MTQw*_ga_NEXN8H46L5*MTY0NDcxOTEzOS4xLjEuMTY0NDcxOTE0MC4w)

LoRa Demodulation (RAK 2245):

Capabilities:

OTAA:

Over the air activation is a join server application that takes an end node key and application key to authenticate a device. The end node key is commonly referred to as the device extended unique identifier (EUI). During activation a device address is created which is used for the primary communication after a join accept has occurred. The device EUI is no longer used after activation. Each new activation prompts the “join server” application to create a new device address rendering each new session. OTAA requires the end node to receive a downlink from the authenticator (gateway) to complete the connection. This can cause a successful handshake to become more challenging than ABP.

ABP:

Activation by personalization does not require a handshake at all to verify an end node device. Therefore, no downlink is required. In ABP the blank must set the dev address for both the application of the device on the gateway and the node through hard code. No dynamic dev address is created upon activation and one can technically send packets without verifying a connection between devices.

RSSI: Received signal strength indicator.

Link Budget: The “net” gains and losses of the original signal from the transmitter to the receiver through a medium due to attenuation of said medium.

The MAXIMUM link budget can be determined by taking the maximum TRANSMITTED power minus the lowest received sensitivity. An example; if our Arduino transmits a signal at 20 dBm and our gateway has a receiver sensitivity of -100 dBm then the link budget is:

Link Budget = 20dBm – (-100dbm) = 120dBm

Link Margin: Is the difference between RECEIVED power and receiver sensitivity. So If our Arduino transmits a signal at 20 dBm and our gateway receives a signal with an RSSI of -60dBm then the link margin is:

Link Margin 20 - (-60) = 80

Attenuation:

Receiver sensitivity: the lowest capability of signal detection of a receiver.

Antenna properties:

Signal boosting:

To increase signal strength and reliability of forwarded packets a possible solution was to increase the power of the transmitted signal. Through documentation of the Murata receiver it is possible to increase the default signal power from 17 to 20 dBm. This of course would increase power consumption presumably decreasing battery longevity. To test the signal boost I used the PA\_BOOST pin and set the transmit power to 20. This implementation must be set before serial.begin() is called. See code snippet below.



To test, I collected data on successful node uplinks from varying distances using both the default and signal boost setting. I did this by connecting our SmartPark gateway to my personal router and then setting up a VPN so that I can monitor the gateways live frames as I transmit signals with the node. I used my personal hotspot on my phone to maintain a mobile connection. In this test the distance, RSSI, SNR, estimated obstruction, and successful uplinks were recorded. Through this data collection it is easy to determine if PA\_BOOST is necessary for our application at the sacrifice of increased power consumption.



UDP:

Research

Conclusion