

# Project Final Report

## Step 1: Define the parameters

### 1.1. Signal strength parameters:

- Received Signal Strength Indicator (RSSI): Measured in dBm, indicates the strength of the received signal. A higher RSSI value represents a stronger signal.
- Signal-to-Noise Ratio (SNR): Measured in dB, indicates the ratio of the signal power to the noise floor. A higher SNR value represents a better signal quality.

### 1.2. Range parameters: (Optional Calculations for theoretical Limits)

- Path loss: Measured in dB, represents the decrease in signal strength as it propagates through the environment. Factors affecting path loss include distance, obstacles, and antenna characteristics.
- Link budget: Measured in dBm, represents the overall power budget of the LoRa system, considering transmitter power, antenna gain, path loss, and receiver sensitivity.

## PATH LOSS

$$FSPL = 20 \log_{10}(d) + 20 \log_{10}(f) + 20 \log_{10} \left( \frac{4\pi}{c} \right) - G_{Tx} - G_{Rx}$$

$$FSPL (\text{dB}) = 20 * \log_{10}(\text{Distance}) + 20 * \log_{10}(\text{Frequency}) + (27.59)*$$

- Distance is the distance between the transmitter and receiver in meters
- Frequency is the operating frequency in MHz

(27.59) Constant is derived from :

<https://www.omnicalculator.com/physics/free-space-path-loss>

## **Step 2: Set up the experimental environment**

### **2.1. Define the LoRa devices:**

- Identify the LoRa transmitter and receiver modules.
- Specify the transmission power, data rate, and spreading factor of the transmitter.
- Determine the sensitivity and antenna gain of the receiver.

### **2.2. Prepare the testing environment:**

- Choose an open space for unobstructed measurements.
- Set up obstacles, such as walls, trees, or buildings, for obstructed measurements.
- Establish a range of distances between the transmitter and receiver for range testing.

## **Step 3: Measure signal strength and range**

### **3.1. Without obstacles: (Actual calculations)**

- Place the transmitter and receiver at a fixed distance in the open space.
  - Outside Park / Soccer Play Ground
- Record the RSSI and SNR values for the received signal.
- Repeat the measurement for different distances to create a signal strength vs. distance profile.

### **3.2. With obstacles:**

- Place the transmitter and receiver at the same fixed distance as in the unobstructed case.
- Introduce obstacles between the transmitter and receiver.
- Record the RSSI and SNR values for the received signal.
- Repeat the measurement for different obstacle configurations to analyze the impact of obstacles on signal quality.

## Step 4: Analyze and compare results

### 4.1. Compare RSSI and SNR values for unobstructed vs. obstructed scenarios.

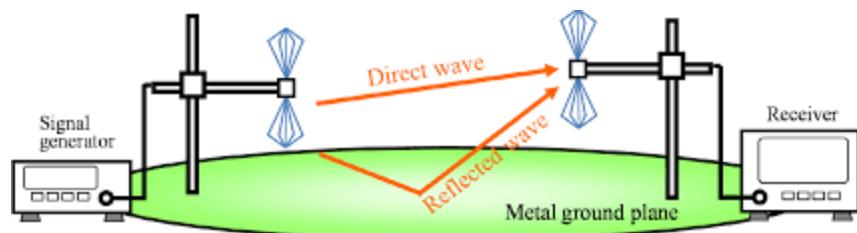
- Identify the effect of obstacles on signal strength and signal-to-noise ratio.
- Determine the minimum distance at which the signal is still usable with obstacles.

### 4.2. Compare range profiles for unobstructed vs. obstructed scenarios.

- Analyze the reduction in range due to the presence of obstacles.
- Identify the critical distance at which the signal becomes unreliable with obstacles.

### 4.3. Evaluate the impact of different obstacle configurations on signal quality and range.

- Determine the most significant factors affecting signal propagation in the presence of obstacles.
  - Metal Obstacles in Closed space
  - Walls and Other Objects as Obstacles



- Develop strategies to mitigate the impact of obstacles on LoRa communication systems.
  - Adding Antenna (Optional)



## Step 5: Document and present findings

### 5.1. Prepare a comprehensive report summarizing the experimental setup, methodology, results, and analysis.

- Include graphs and tables to illustrate the impact of obstacles on signal quality and range.
- Provide recommendations for optimizing LoRa system performance in obstructed environments.

Setup	Max Range (Successful Com > 70% times)	RSSI	SNR
<b>Theoretical Limits (Optional)</b>	Upto 1 KM (idle conditions)	<b>None</b>	<b>None</b>
<b>Without Obstacles (Open Space)</b>	60cm to 120 cm	-125	-9
<b>Without Obstacles (Closed Space)</b>	60cm to 120 cm	-125	-9
<b>Without Obstacles (Metal Ground)</b>	30 cm - 80 cm	-112	-7
<b>With Obstacles (Open Space)</b>	27cm to 85 cm	-110	-5
<b>With Obstacles (Closed Space)</b>	35cm to 55cm	-105	-3
<b>With Obstacles (Metal Ground)</b>	30cm - 40 cm	-117	-8

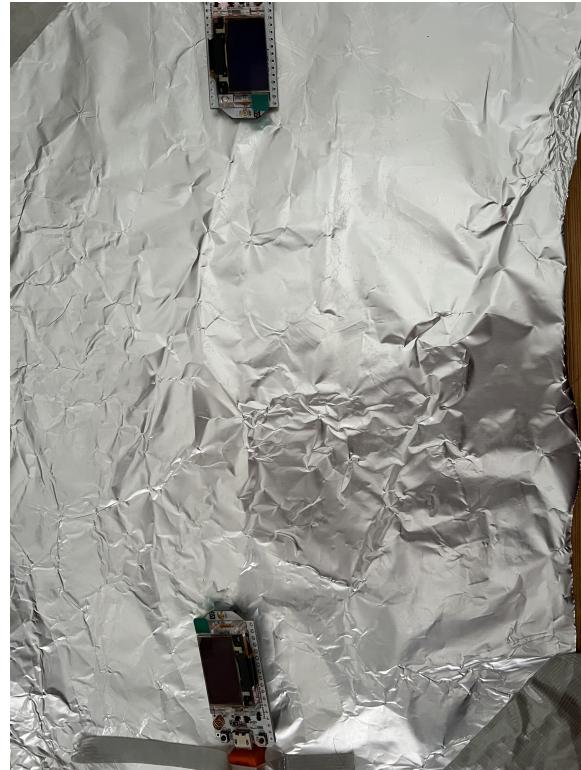
**Setting 1 Open Space:**

Communication range < 2 Meters



**Setting 2 Metal Ground Closed Space:**

Communication range < 1 Meter



Communication Range also depends on Antenna orientation



With obstacles on Metal Ground

