Background and Motivation

Over
16 Million
Cats and Dogs in Canada

Canadian Animal Health Institute

Over
1 Million
Pets Go Missing Each Year

BC SPCA

Over
80%
Of Lost Pets Are Never Found

Ontario SPCA

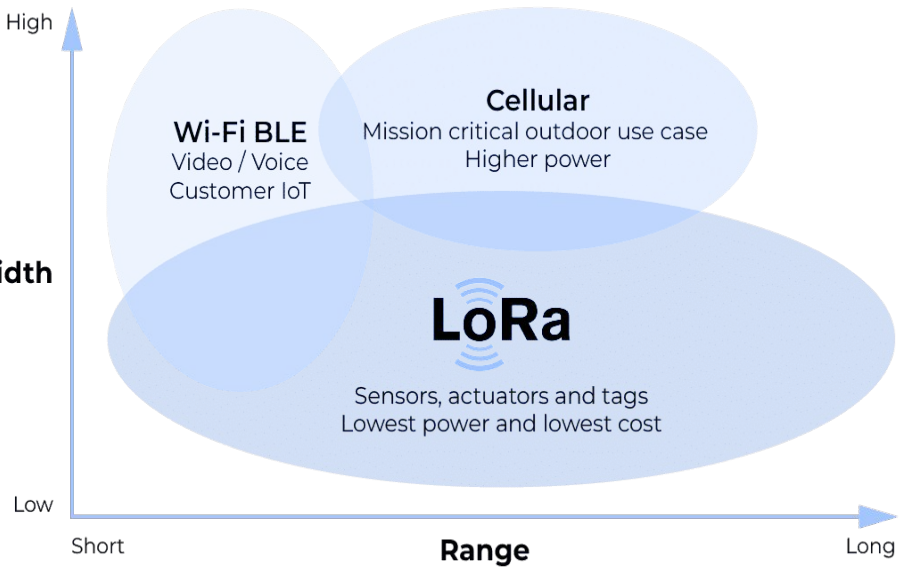
Existing products to track pets can be **costly** and have **limited ranges**

Goal - To create an **improved product** that is:

✔ **Long range**

✔ **Low cost**

✔ **Low power**



High Noise Immunity

Low frequency means **low signal attenuation**

Can detect signals with **noise up to 19dB** larger than the original signal

Low Power

Narrower bandwidth means **less power** needed for **same transmission quality**

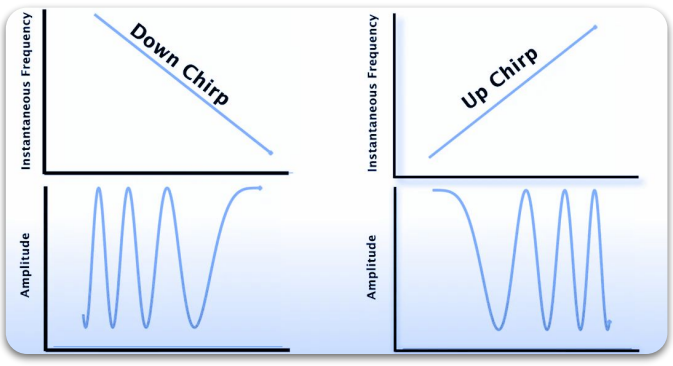
Low Cost

Operates on unlicensed, **free frequency band** of 915 MHz

How LoRa Works

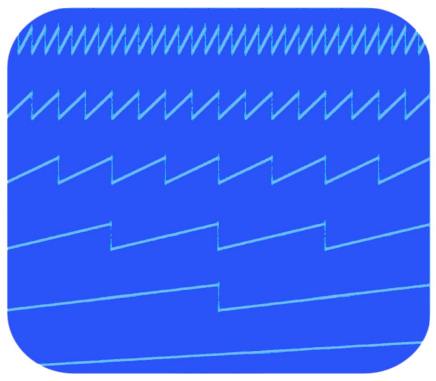
Frequency Modulation Technique based on ***Chirps:***

→ **C**ompressed **H**igh **I**ntensity **R**adar **P**ulses



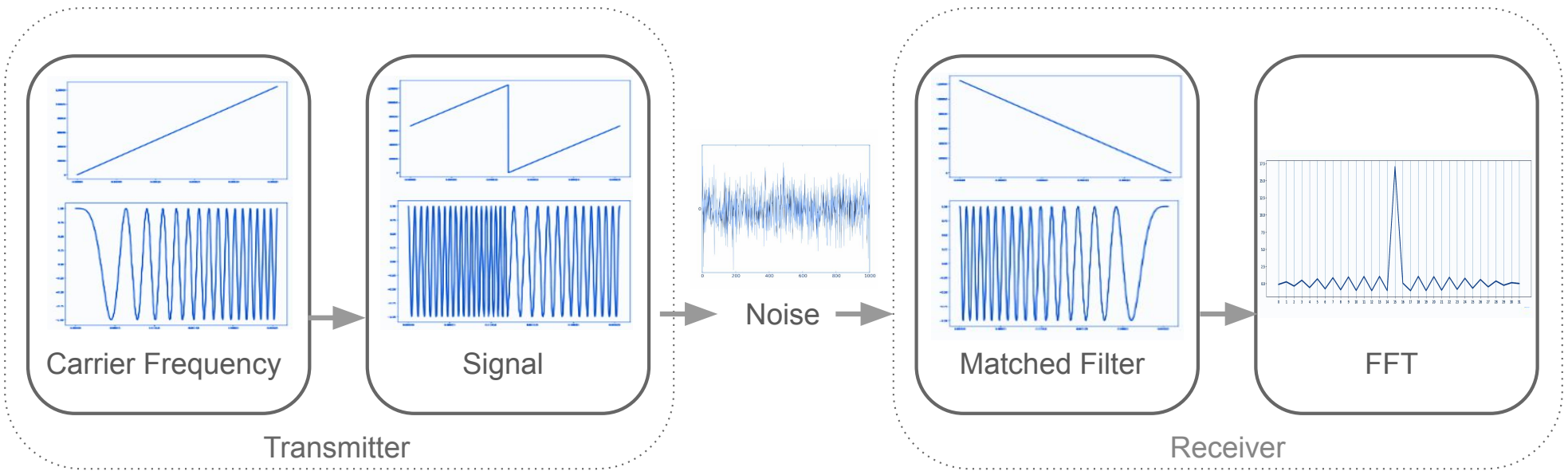
$$\tau_{chirp} = \frac{2^{SF}}{Bandwidth}$$

SF vs Chirp Rate



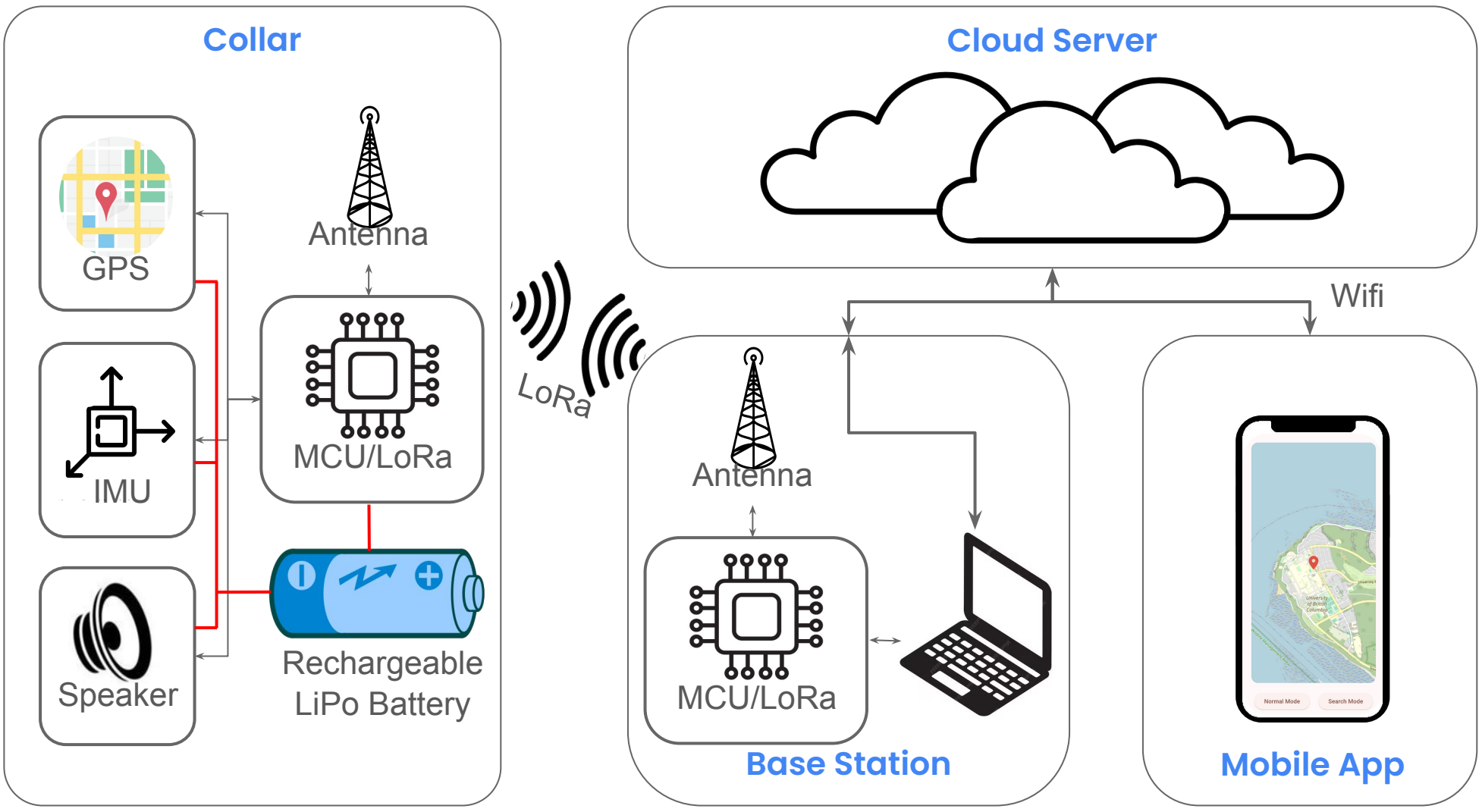
Spread factor **controls** chirp rate and bits per symbol

Increasing SF **increases** range, energy & time and **decreases** data rate



Shield by Kholifah - Noun Project, https://spacewell.com/resources/blog/building-iot-does-lora-interfere-with-wi-fi/

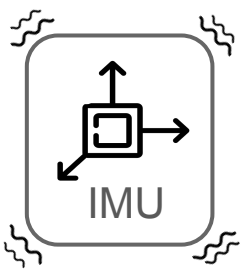
System Overview



Modes of Operation

Battery life is optimized through different **modes of operation.**

	Normal	Sleep	Search
GPS Update Period	5 min	OFF	1 min
IMU Activity	Active	Inactive	OFF
TX Power	Mid	OFF	High
Spread Factor	Mid	OFF	High

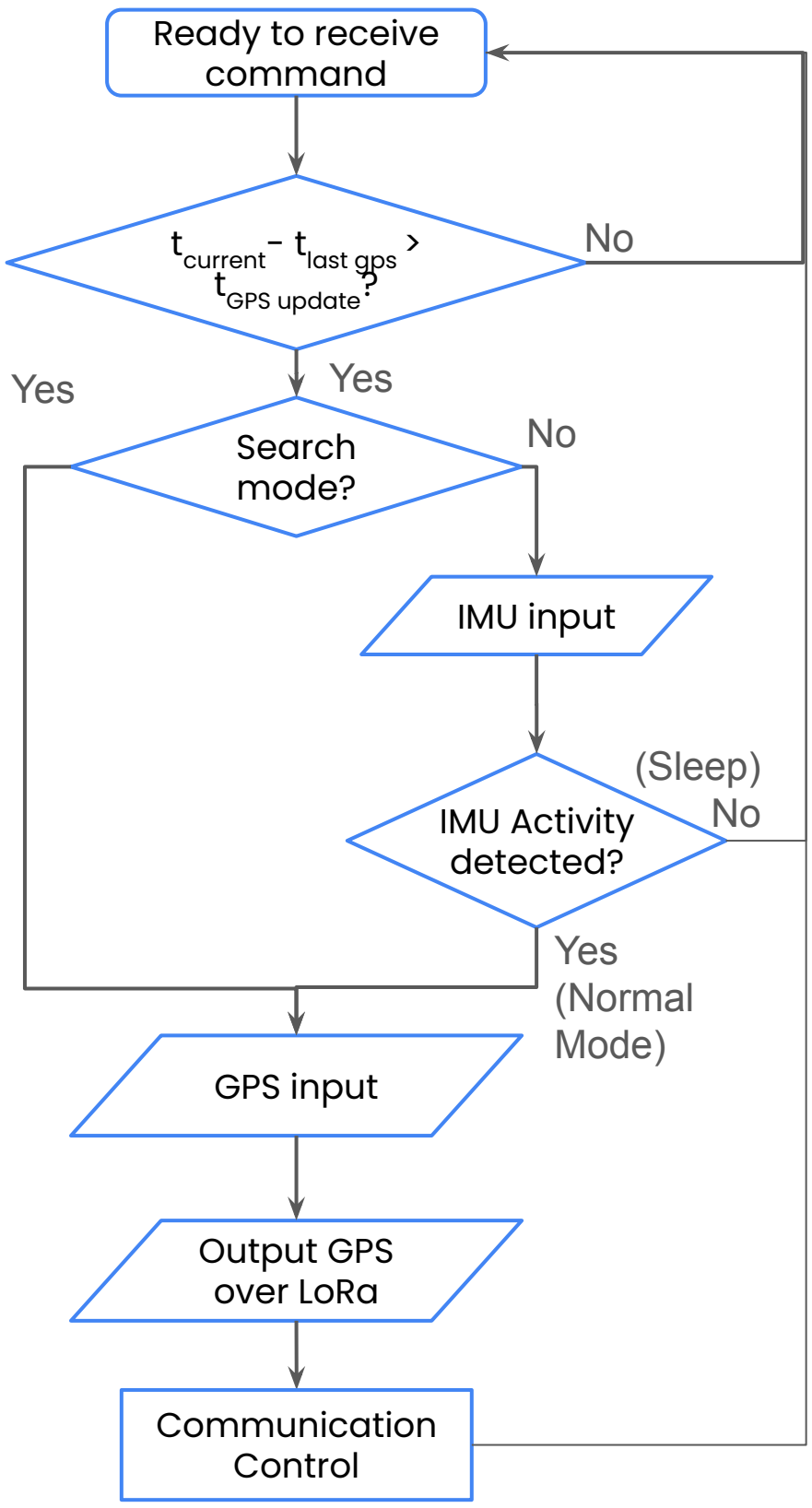


The system switches between **Normal** and **Sleep** modes depending on IMU input.

If no motion is detected, the last acquired position is still accurate such that a new position is redundant.

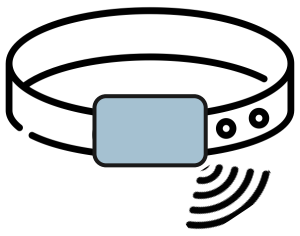
User-initiated **Search** mode increases GPS update frequency, transmitting (TX) power, and spread factor to maximize the probability of the message being received when actively searching for the pet.

Collar Firmware Logic



https://freesvg.org/radio-transmitter-antenna-with-round-base-vector-illustration, https://www.freepik.com/premium-vector/laptop-vector-icon-icon_58532538.htm, Accelerometer by yuswita amieliana dewi - Noun Project, https://freesvg.org/index.php/aaa-battery, Cloud by miftakhudin - Noun Project

Communication



Sending GPS

Received message. Sending ACK.

Received ACK

Messages are acknowledged with an ACK message

Sending GPS

Sending “Change Mode” command

(ACK not received within timeout interval)

(ACK not received within timeout interval)

Waiting X seconds before retrying GPS send

:

Resending GPS

Sending ACK

Received ACK

Resending “Change Mode” command

:

Waiting Y seconds before retrying “Change Mode” send...

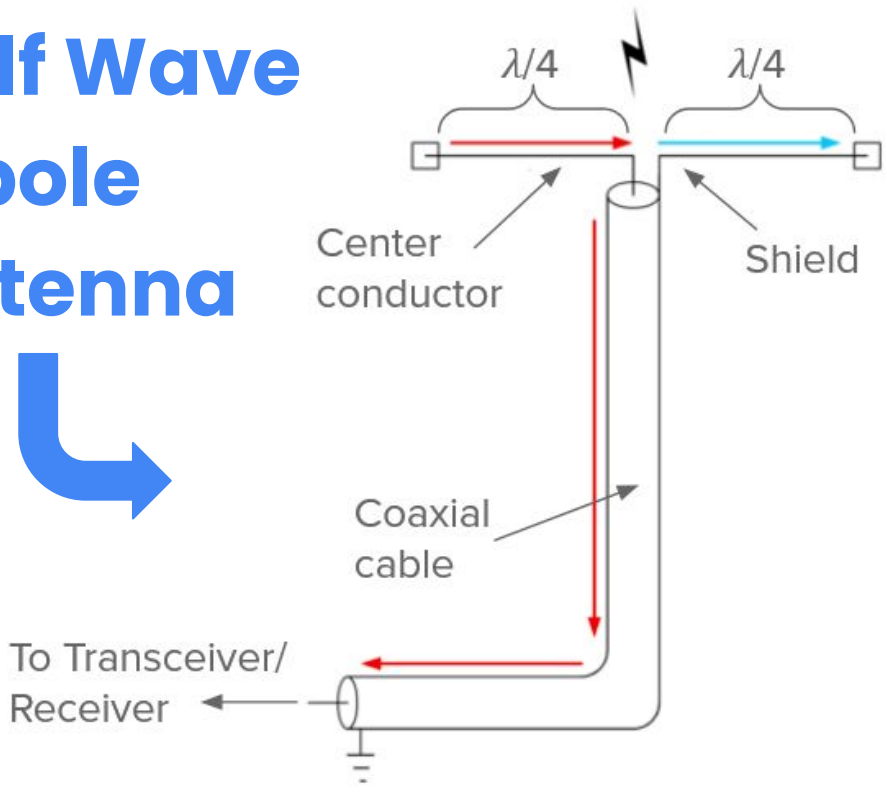
If no ACK is received in time, each system attempts to resend messages after some randomized time interval (Random Backoff)

Antenna

Design Requirements

Frequency	915 MHz
Wavelength	0.3276 m
Radiation Pattern	Isotropic
Impedance	~50 Ω

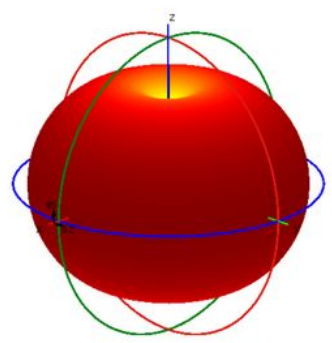
Half Wave Dipole Antenna

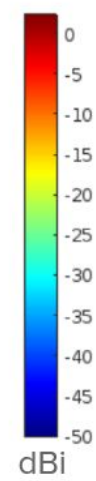


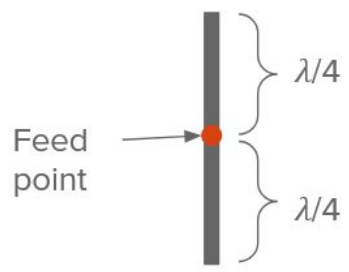
Matlab Simulation

Max Value
2.15 dBi

Min Value
-49.9 dBi



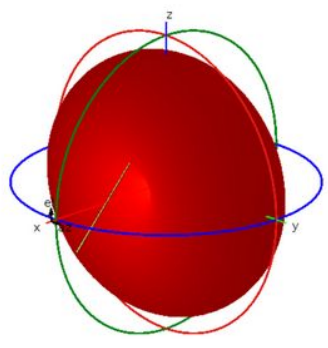


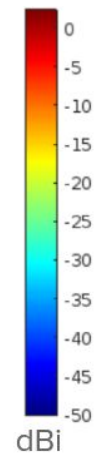


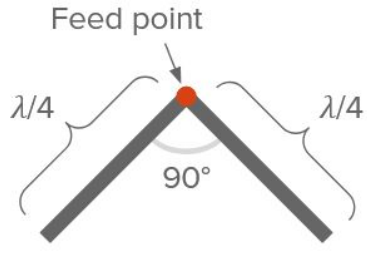
Base Station

Max Value
1.72 dBi

Min Value
-6.47 dBi







Collar

Sources: Collar: Candy Design - Noun Project, Home wifi: Fazrian Zahrawani - Noun Project, Power: NAPISAH - Noun Project, Antenna: https://freesvg.org/radio-transmitter-antenna-with-round-base-vector-illustration

Cloud Server & App

Cloud Server

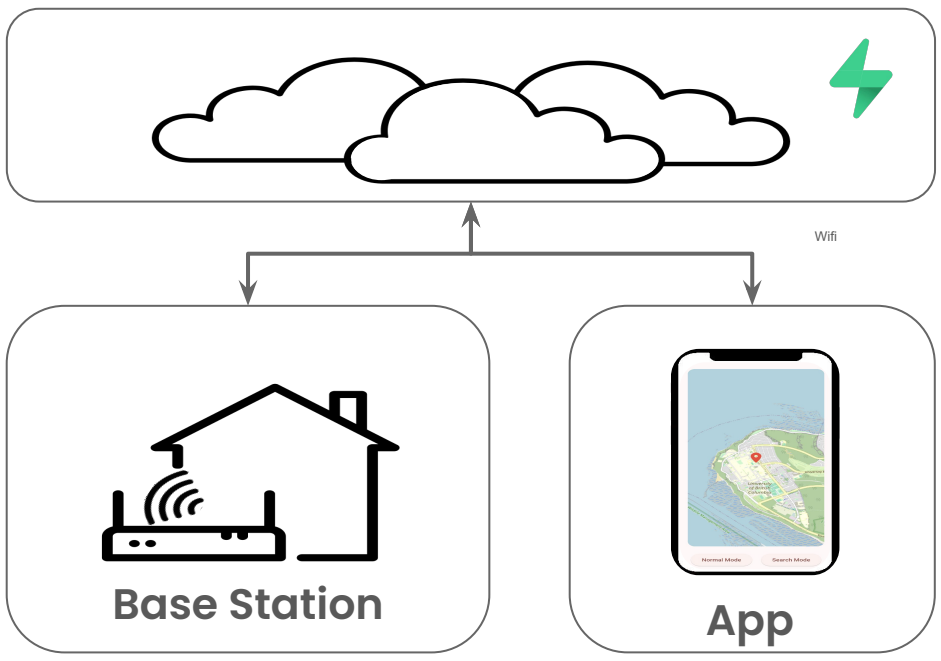
Supabase Backend

Opensource BaaS with PostgreSQL database, real-time syncing, authentication, and storage

Sends User Commands to **Supabase**

Queries **Collar Data** in **Real Time**

Visualizes Data in a **User Friendly Way**



Sends Collar Data to **Supabase**

Queries **App Commands** and sends them to device

Marks **Commands** as **Parsed** once read

Latest **Pet GPS**

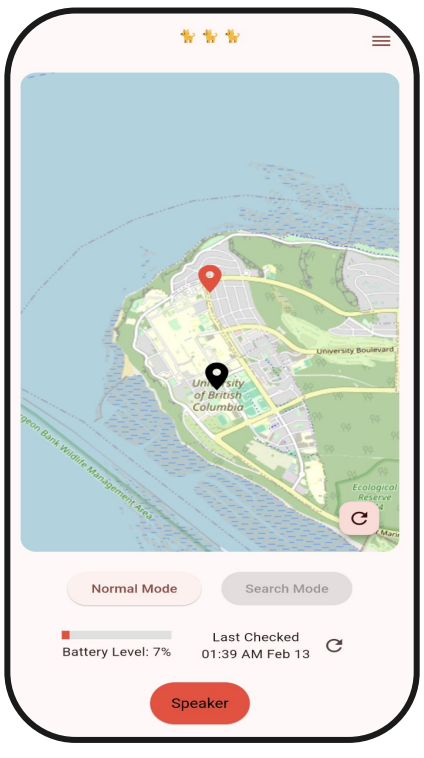
Realtime Phone GPS

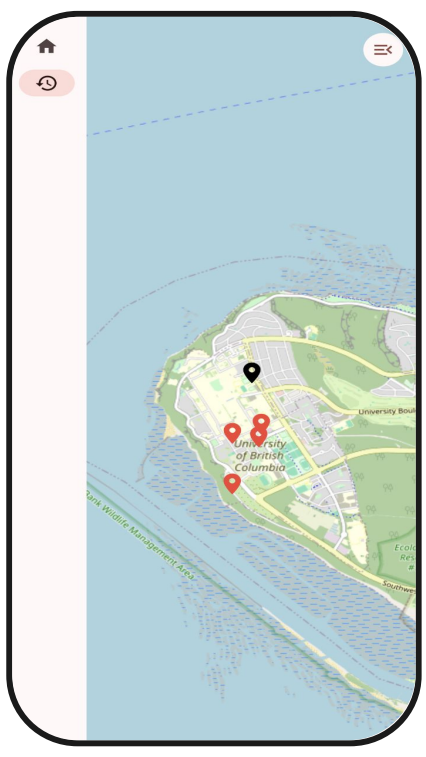
User **GPS Request**

Battery Level

Realtime **Battery Request**

Speaker





App

User **Interface**

History Page

Realtime **Phone GPS**

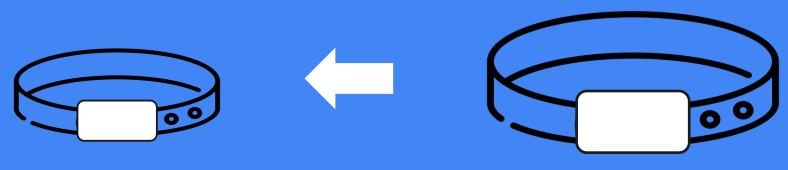
Realtime **Pet Path**

History Slider

Next Steps

Expand to a **star network** to track **multiple pets** within one app

Condense the collar size to be comfortable for **smaller pets**



Weatherproof the system to work in **any environment** the pet **explores**

Sources: Collar: Candy Design - Noun Project, Noise: Maria Zamchy - Noun Project, Shield: Kholifah - Noun Project, Home wifi: Fazrian Zahrawani - Noun Project, Cloud: miftakhudin - Noun Projec, Cat: https://en.m.wikipedia.org/wiki/File:Cat_silhouette_darkgray.svg