# SALVS-01

SPECIFYING ANIMALS LOCATION VIA SOUND

# Contents

# Project Introduction

TerraTrack devices are used in SALVS-01 to detect wildlife species and their location using its noise. These devices record animals noises, process it using an AI, and transmit the data to the TerraTrack-Sat for storage and transmission back to Department of National Parks

## Ground Segment

TerraTrack Alert

TerraTrackHub

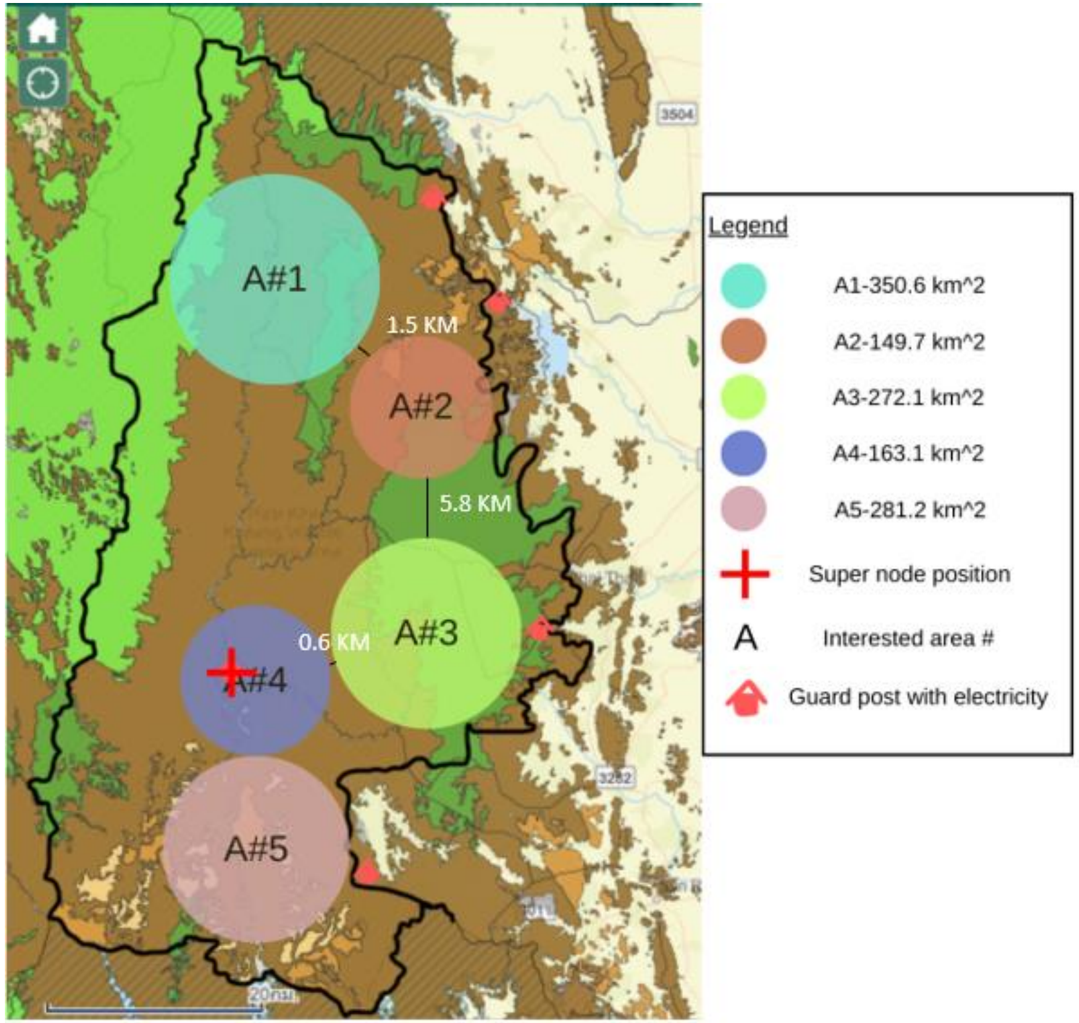
# Mission Component

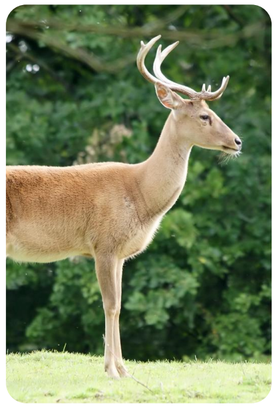
## Space Segment

TerraTrack-Sat

# Huai Kha Khaeng

## Wildlife Sanctuary



### Eld's deer

- A#2

### Malayan Tapir

- A#1
- A#3

### Plain-pouched hornbill

- A#4
- A#5

### Wild water buffalo

- A#4
- A#5

# Mission Objective

- Locating an animal from its noise
- Determine species of an endangered animal using an Artificial Intelligence from its noise
- Lighten a load for any forest officers

# Concept of Operation

## TerraTrack Alert

Record the animals noise, process them and relay them to the TerraTrack Hub

## TerraTrack Hub

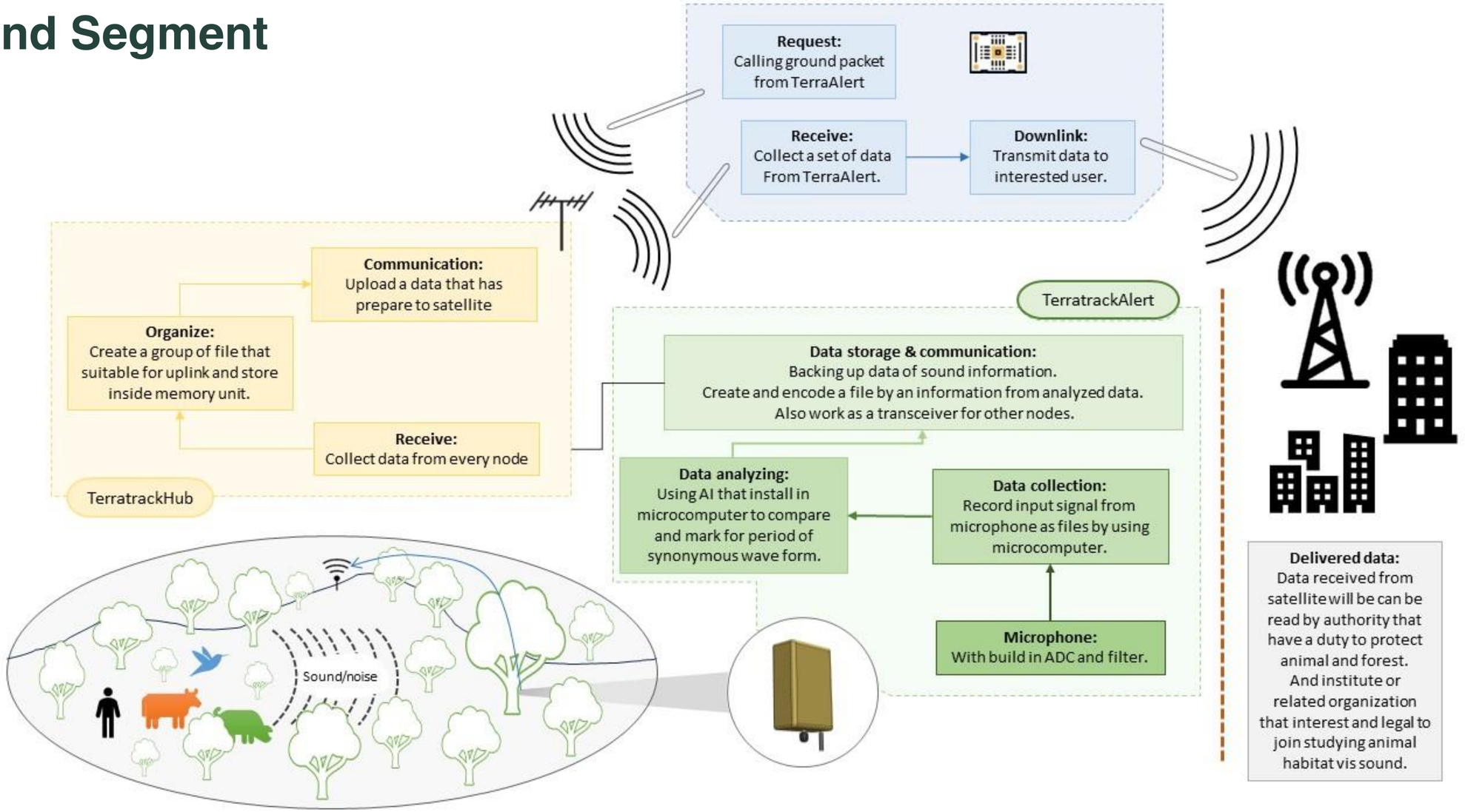
Collect the data and relay them to the satellite

## TerraTrack-Sat

Receive and transmit the data to groundstation

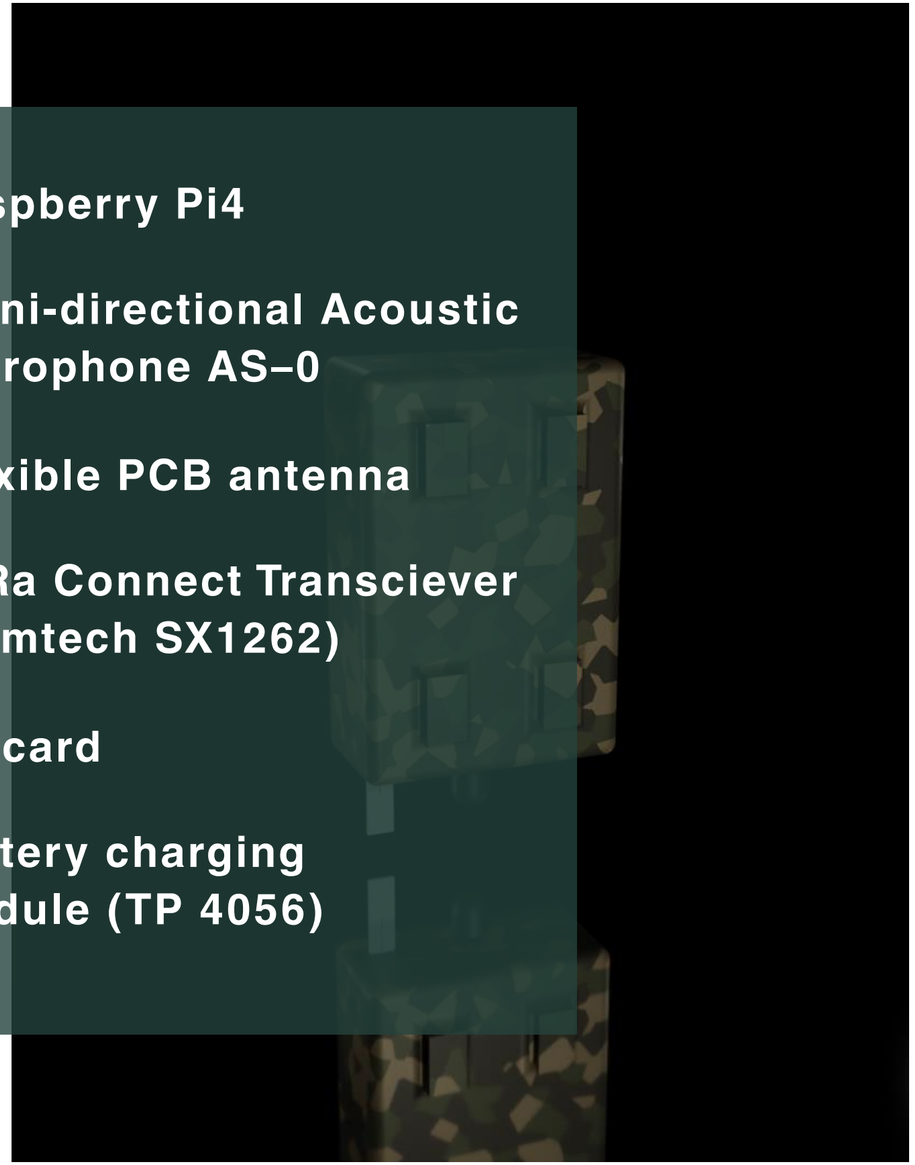
# Concept of Operation

## Ground Segment



# TerraTrack Alert

- detect and record animals noise
- analyze the animals species
- send and relay data from others to TerraTrack Hub



**Raspberry Pi4**

**Omni-directional Acoustic Microphone AS–0**

**Flexible PCB antenna**

**LoRa Connect Transciever (Semtech SX1262)**

**SD card**

**Battery charging module (TP 4056)**

# TerraTrack Alert

## Why this Design?

- Lightweight
- Capable of tolerating harsh environment
- The material used has less environmental damage
- Relatively cheap

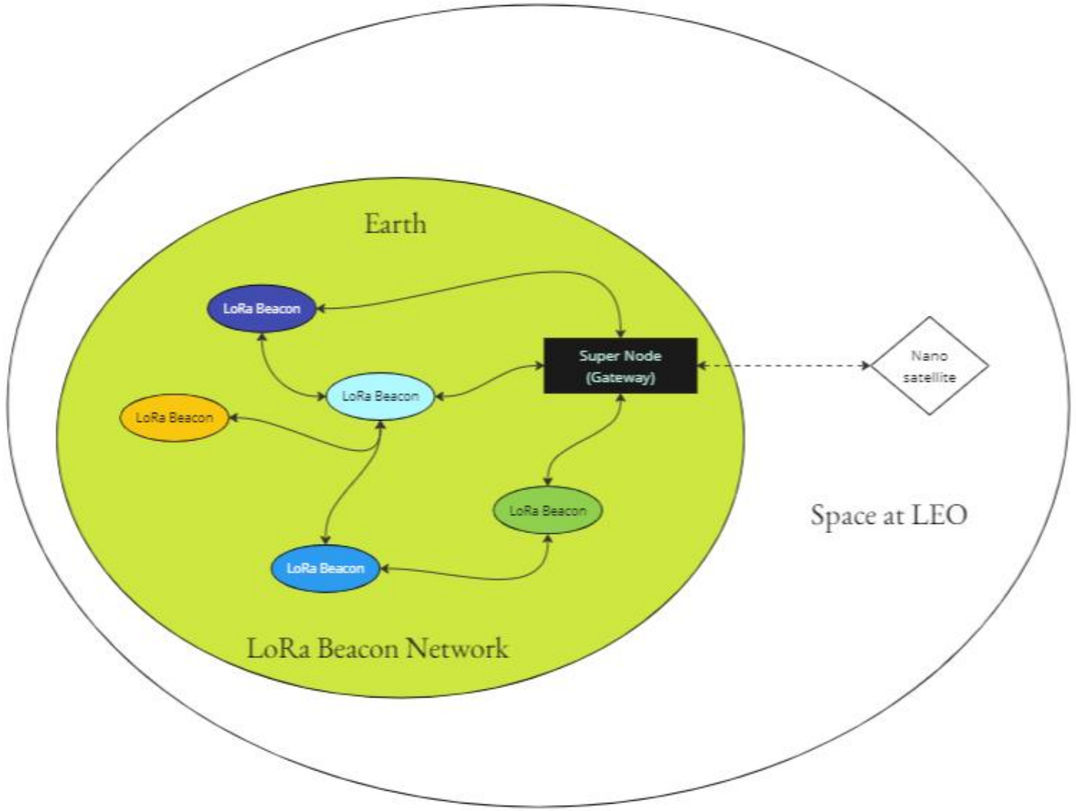
## Why this microphone?

**Omni-directional Acoustic Microphone AS–0**

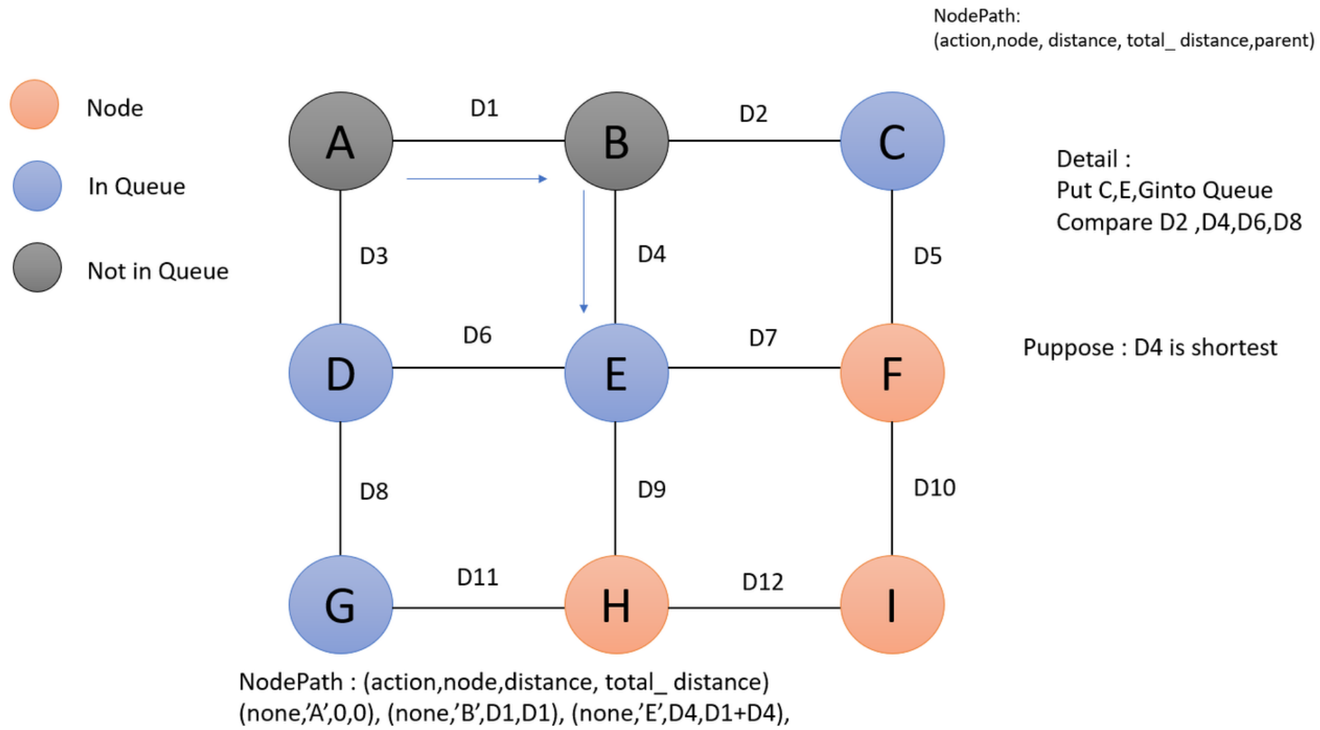
- Capable of sensing the acoustic frequency range
- Low power usage
- Capable of tolerating harsh environment
- Many organizations used

# TerraTrack Alert

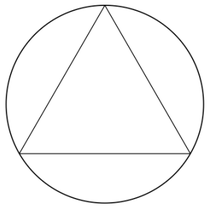
TerraTrack Alert LoRa network



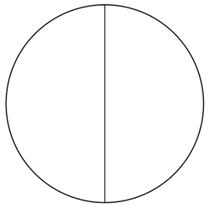

## RadioHead Packet Radio



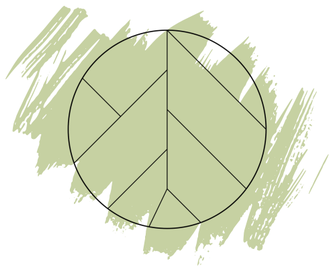
Triangle

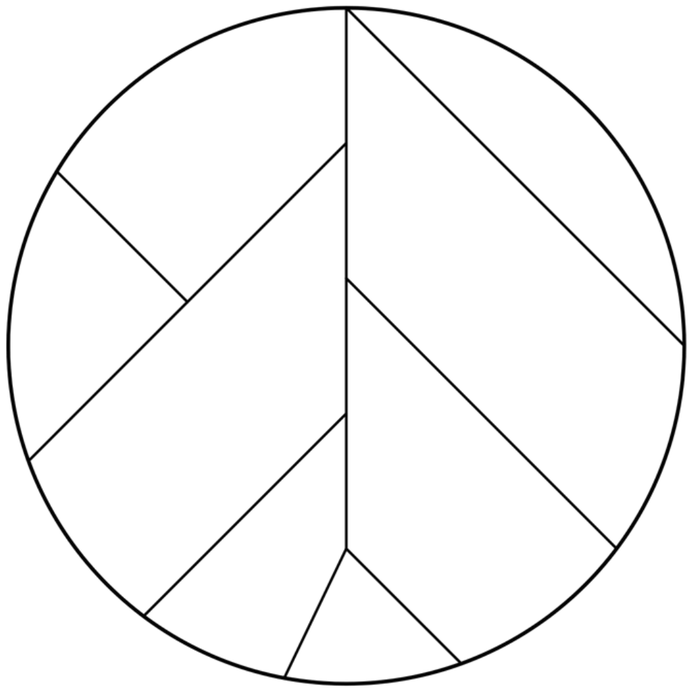


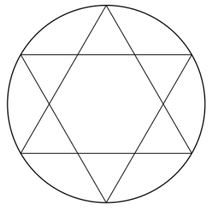
Straight



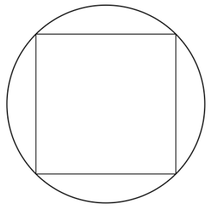
**Roots**







Star of David



Square

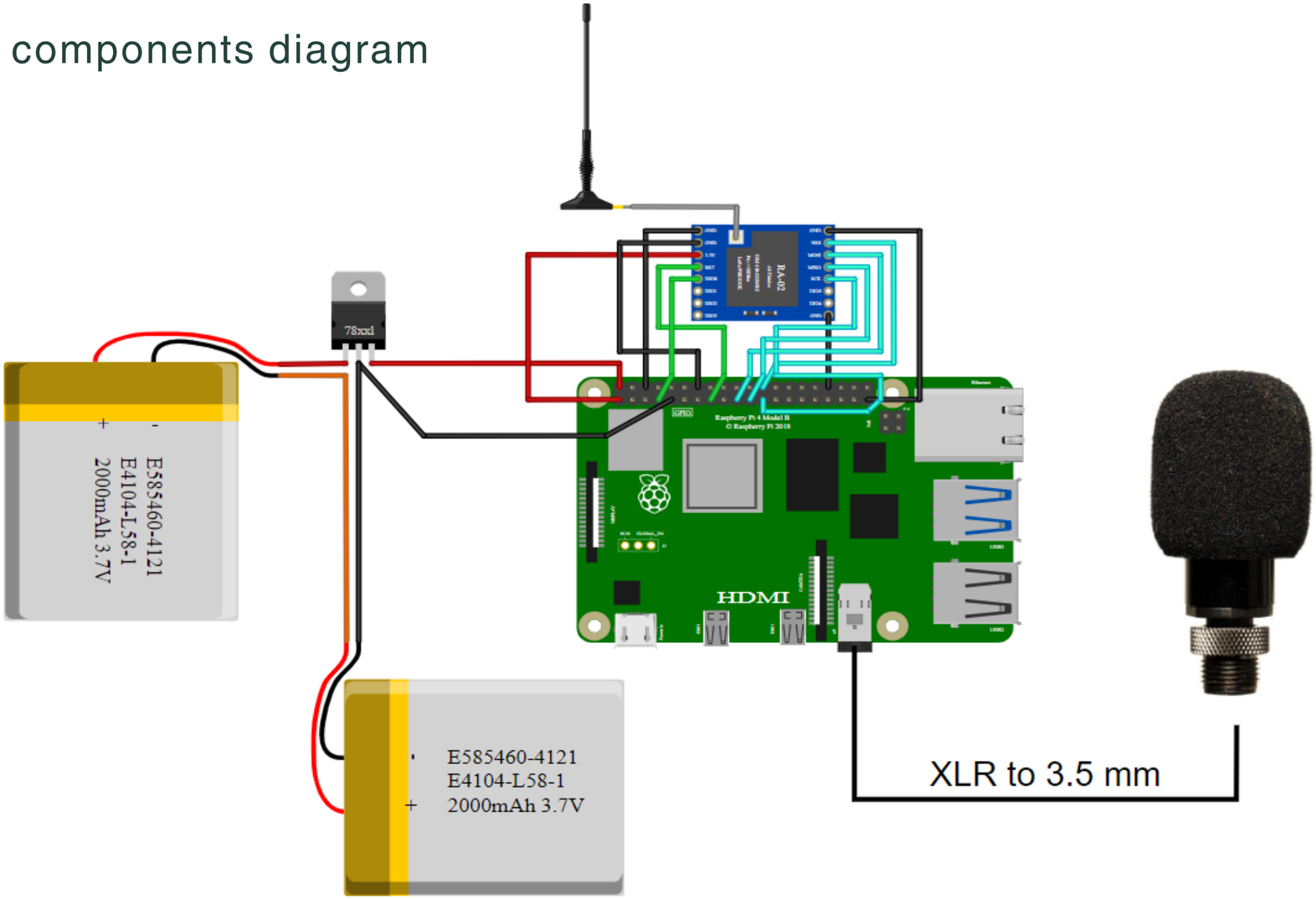
# TerraTrack Alert

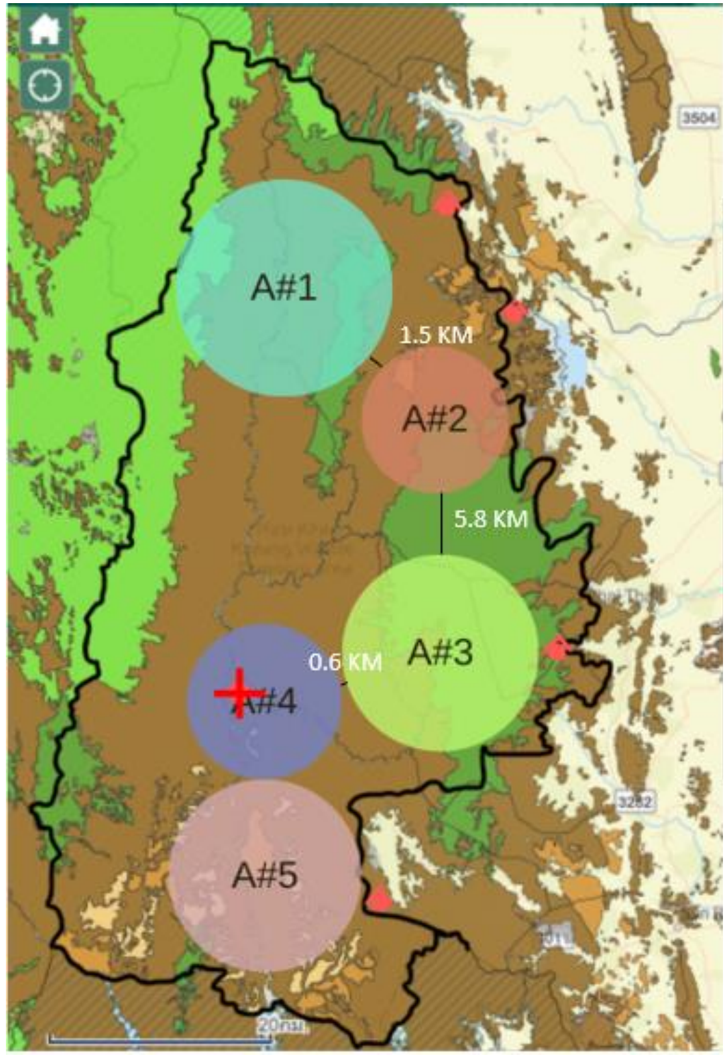
TerraTrack Alert placement formation

- Don’t require too many TerraTrack Alert to cover a sufficient area
- The geometry of this configuration allow us to easily relay data from Alert->Alert->hub.

# TerraTrack Alert

TerraTrack Alert components diagram






TerraTrack Hub will be place at the red “+”

Legend

- A1-350.6 km^2
- A2-149.7 km^2
- A3-272.1 km^2
- A4-163.1 km^2
- A5-281.2 km^2
- Super node position
- A — Interested area #
- Guard post with electricity

# TerraTrack Hub

## Communication coverage

- Sufficient number of TerraTrack Alert
- Right position

## Environmental condition

- Density of the forests

## Power

- Use generator to suffice

# AI Training

## The Process

The process involves a Fourier transform, filtering with Low Pass and High Pass filters to obtain two types of sound data. These data are then used to train an AI model, which will be analyzed for performance in sound classification. The model will be placed on a Raspberry Pi 4 connected to a microphone to capture and classify various animal sounds while recording observed animal data.

### Fast Fourier Transform


### Training AIs

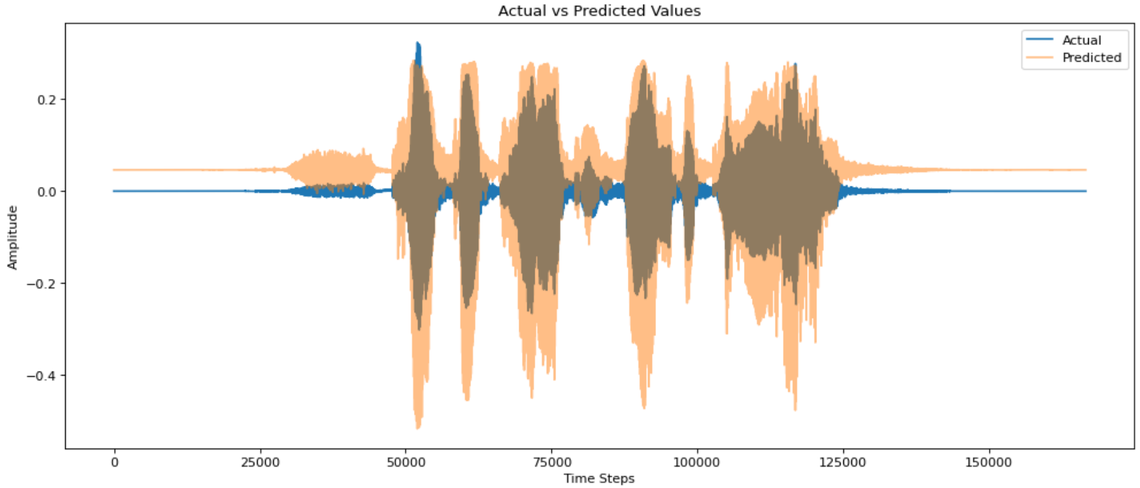
# AI Training - AI's key performances

- **Precision**
- **F1-score**
- **Recall**
- **Percentage of Accuracy**
- **Numbers of Correct Classification**

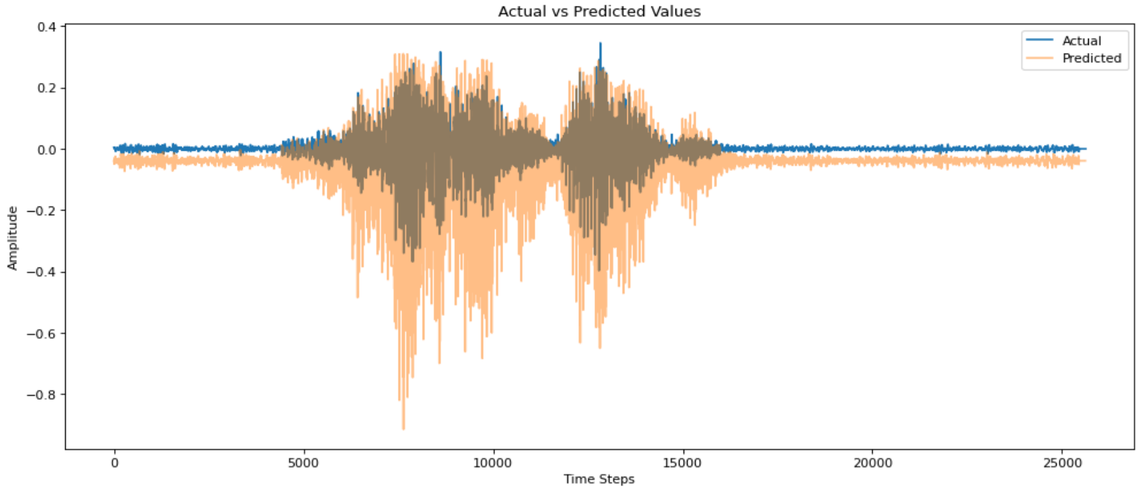
## Examples

| Model | Precision | F1-Score | Recall | Accuracy Percentage | Number of Correct Classification | Summation of score |
|---|---|---|---|---|---|---|
| Model 1 | 0.727 | 0.811 | 0.452 | 75.16 | 3 | 4 |
| Model 2 | 0.527 | 0.466 | 0.952 | 24.84 | 1 | 1 |

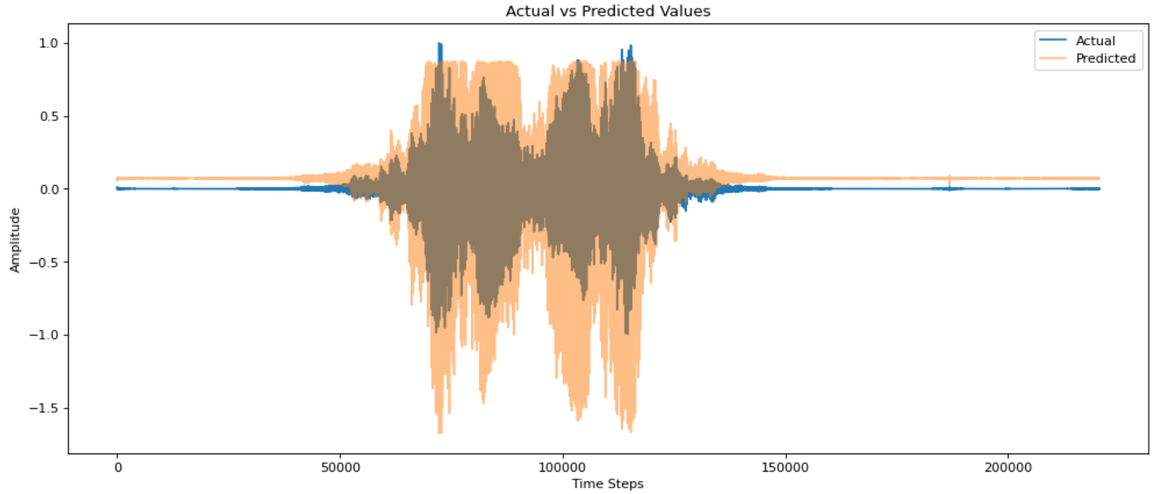
# AI Training - Recurrent Neural Network (RNN)




Tested using a familiar sound specimen




Tested using an unfamiliar sound specimen




Tested using a familiar converted sound specimen from .csv to .wav

# AI Training - Recurrent Neural Network (RNN)

## Output Evaluation

Evaluate the AI's exactness by calculating for the Mean- Absolute Error (MAE) and Root Mean Square Error (RMSE).

```
y_true_array = np.array(y_true)
y_pred_array = np.array(y_pred)

rmse = np.sqrt(mean_squared_error(y_true_array, y_pred_array))
print("Root Mean Square Error (RMSE):", rmse)
```

```
Root Mean Square Error (RMSE): 0.0
```

```
f1 = f1_score(y_true, y_pred, average='weighted')
recall = recall_score(y_true, y_pred, average='weighted')
accuracy = accuracy_score(y_true, y_pred)*100
precision = precision_score(y_true, y_pred, average='weighted')

correct_predictions = np.sum(y_true == y_pred)

print("F1-score:", f1)
print("Recall:", recall)
print("Accuracy:", accuracy,"%")
print("Precision:", precision)
print("Number of Correct Predictions:", correct_predictions)
```

```
F1-score: 1.0
Recall: 1.0
Accuracy: 100.0 %
Precision: 1.0
Number of Correct Predictions: 10
```

## Implementation plan (ground) #1

3 teams to standby at each area and another team is at TerraTrack hub to test its capabilities in the field.

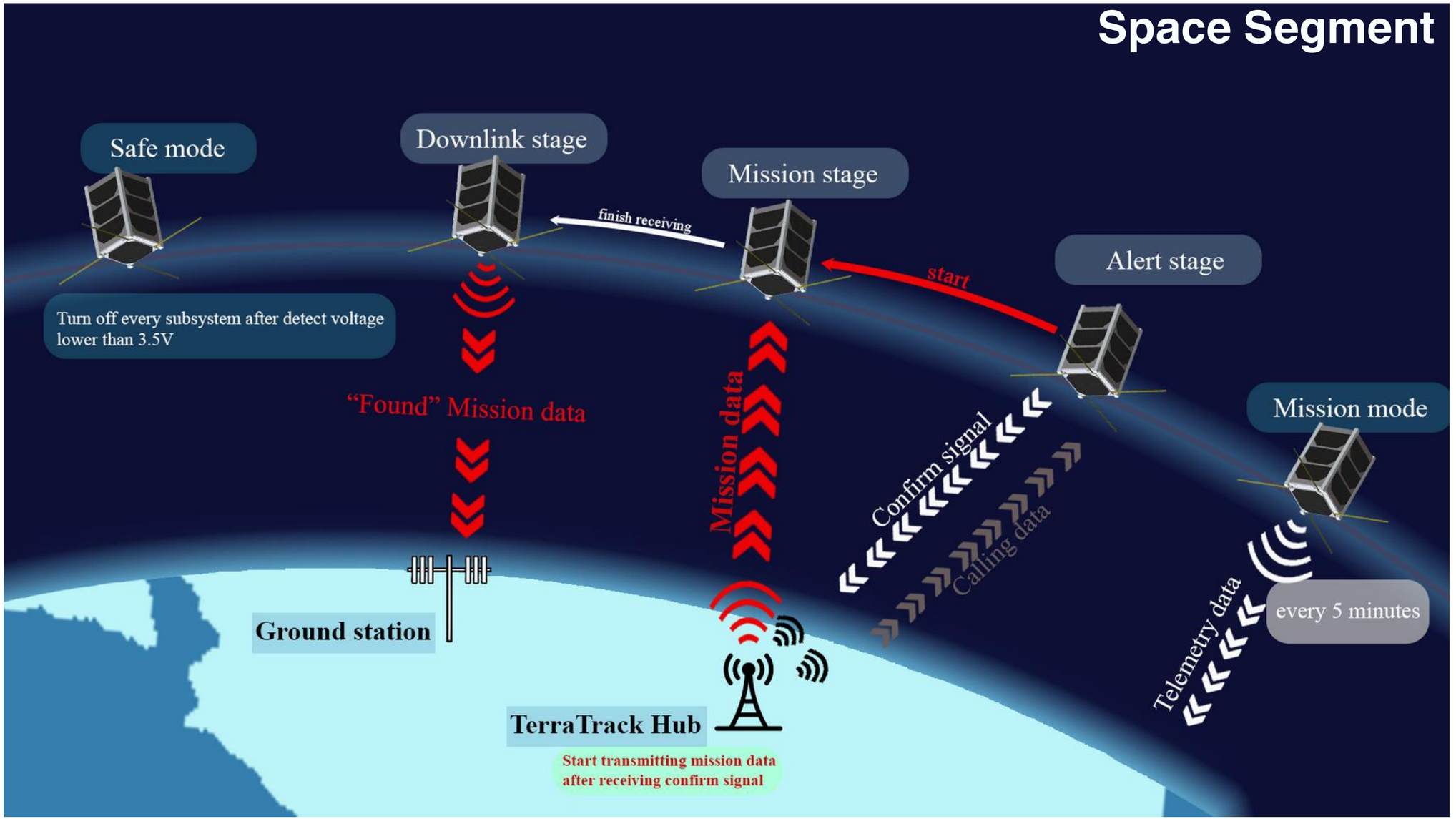
## Implementation plan (ground) #2

The TerraTrack Hub will also be assemble in a sanitize and uncontaminated of human scent, because animals tend to avoid the presence of humans.

## Implementation plan (ground) #3

Increasing the database for AI as much as possible by find a noise base from internet or recording interest animals noise at zoo.

# Concept of Operation



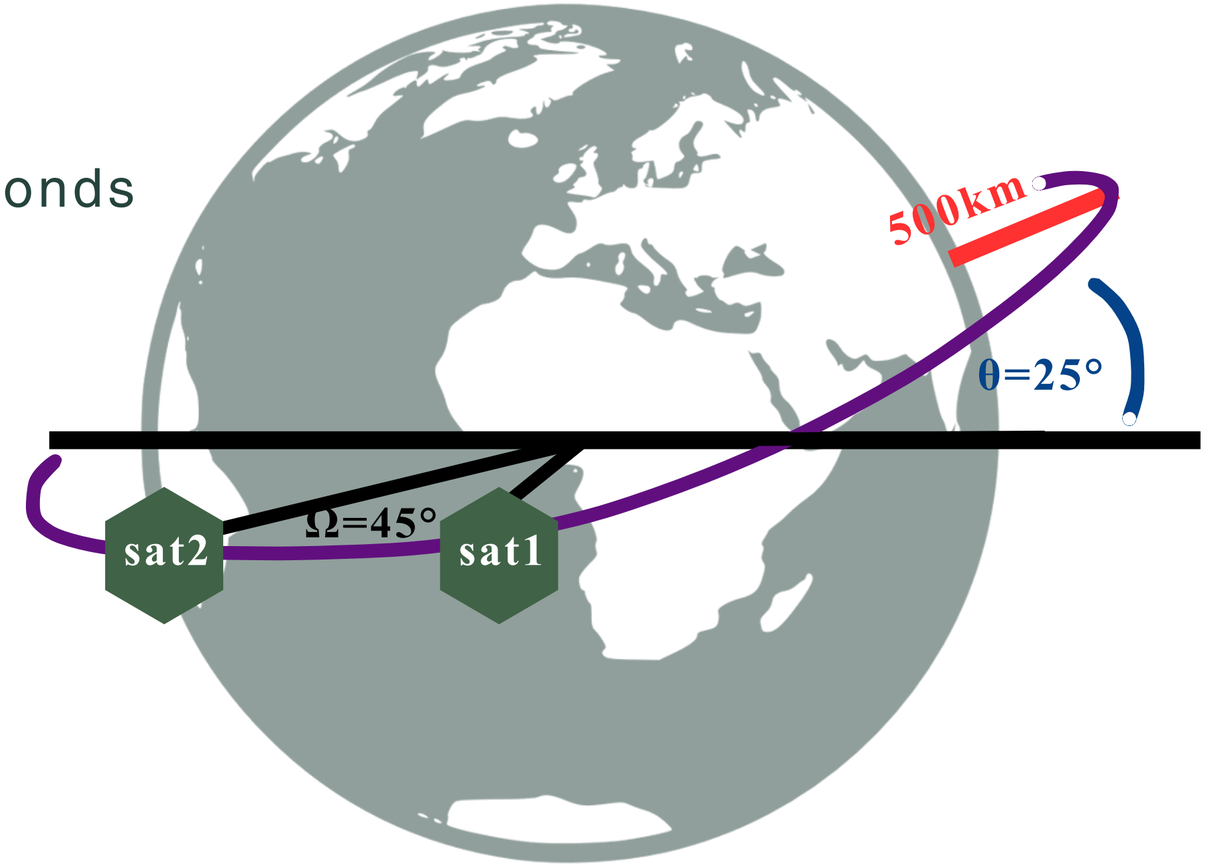
# Orbit and Constellation

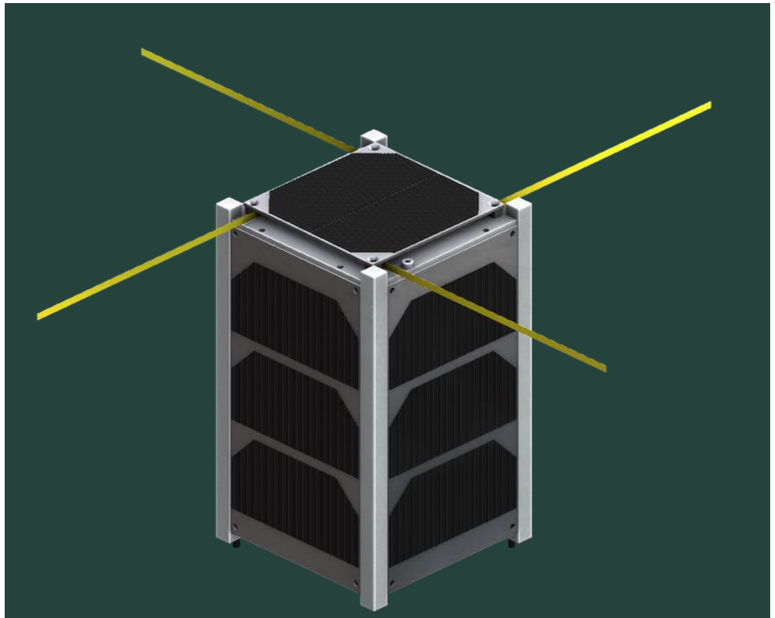
## Constellation

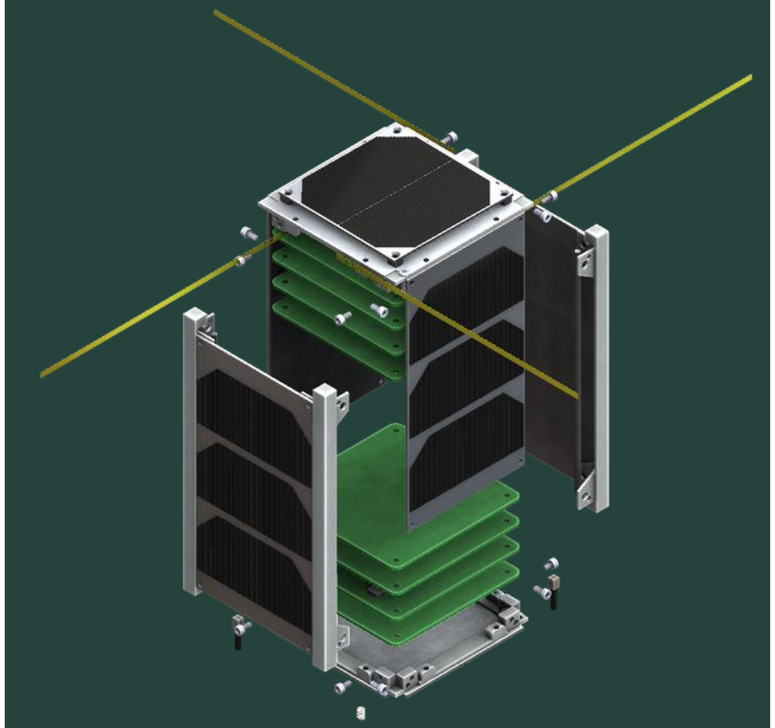
- Group of 8 satellites
- Altitude 500 km
- 1 hour, 34 minutes, and 36 seconds

## Orbit (LEO)

- Cost effective







### Implementation Plan (space) #1

More of TerraTrack-Sat will be sent to space once the initial set are retired to expand the service of our project.

### Implementation Plan (space) #2

Some of the TerraTrack-Sat will be designed by students to support the industry in the future.

# Space Segment

# Key Performance

## Ground Segment

**325 m**

minimum communication range

**20 m**

minimum detection range

## Space Segment

**300 s**

maximum delivering data time

**Status(+)**

power consumtion

# Risk Management

**An antenna was turned away**

Tighten the antenna base

**AI Performance**

Increase the training data, training cycle, and training models for the AI

**Natural direct disturbance**

Test the durability of our instruments in a simulated environment

**Power Shortage**

**Make more efficient Circuits**

**Instrument falling off placement**

Tighten the placement

**Ambient noise Interference**

Using the internal filter to filter it out

**Insufficient data storage**

Clear cache data, and compress data


THANK YOU