

# Feasibility of Networking Technology for Smart Farm: LoRa vs APRS

**Hyuk Lee**

Handong Univ.

**Woojin Jang**

Chungang Univ.

**Hye Won Yoon**

Kyunghee Univ.

**Dong Jun Kim**

Kyunghee Univ.

**Heejae Jung**

Kyunghee Univ.

**Gwoon Choi**

Dongguk Univ.

**Miran Lee**

Dongguk Univ.


**Chaehee Weon**

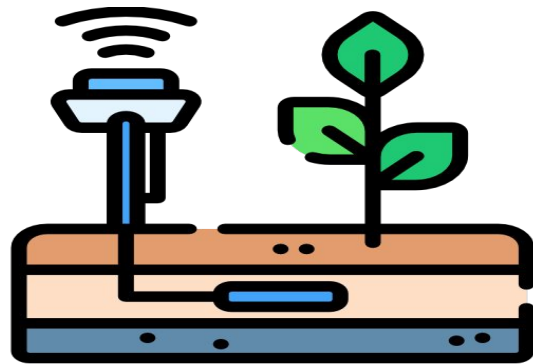
Seoul Women's Univ.

**Anthony Smith**

Purdue Univ.

# CONTENTS

- 
- Introduction
  - Related Works
  - Approach
  - Result
  - Conclusion
  - Q&A



AgloT

Scalability

Extended Range

Low Cost

Energy Efficiency



VS





**Long Range**  
**915 MHz**

Low Power Wide Area Network (LPWAN)

Long-range transmissions with low power consumption  
(more than 10km in open area)

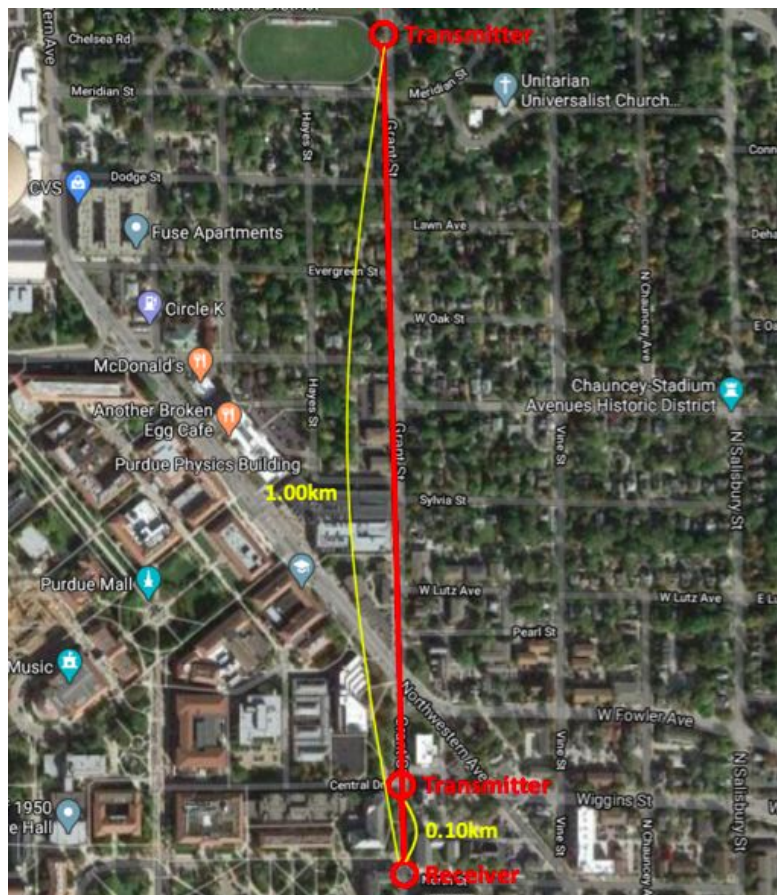


Amateur radio based system for real time digital communications of immediate value in the local area

**A**utomatic **P**acket **R**eporting **S**ystem

**144.39 MHz**

## LoRa

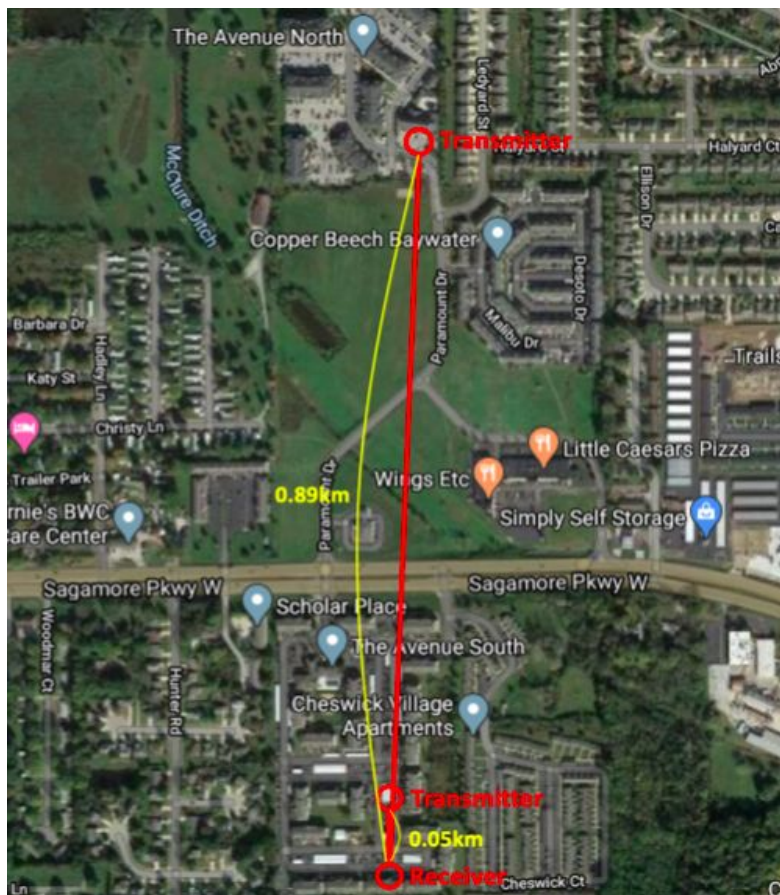


TX power to 13

Signal bandwidth to 125E3

Coding rate to 5

## APRS



Antenna's ground condition

Antenna's height

Polarized antennas



**EIRP**

$$EIRP = P_T - L_C + G_a$$

P<sub>t</sub>: Output power of the Transmitter  
(dBm)

L<sub>c</sub>: Cable Loss (dB)

G<sub>a</sub>: Antenna Gain (dBi)

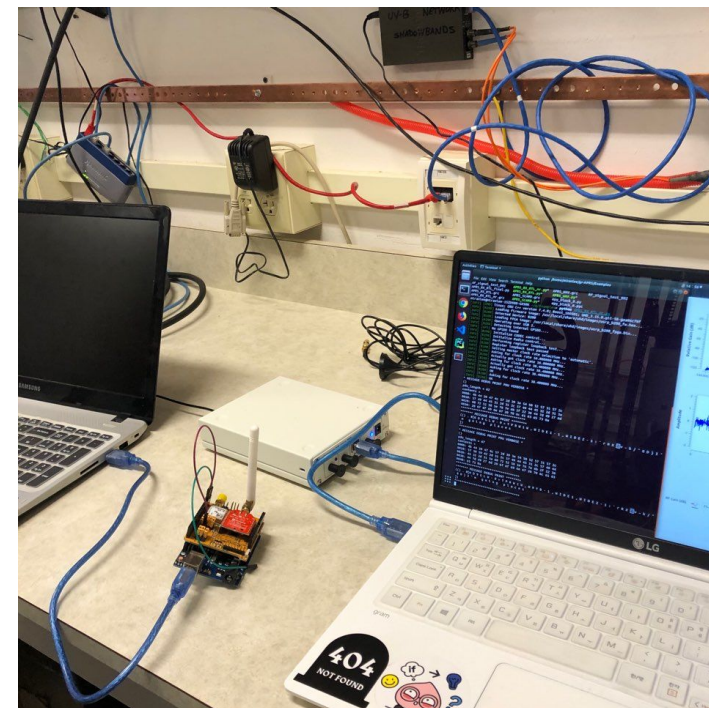
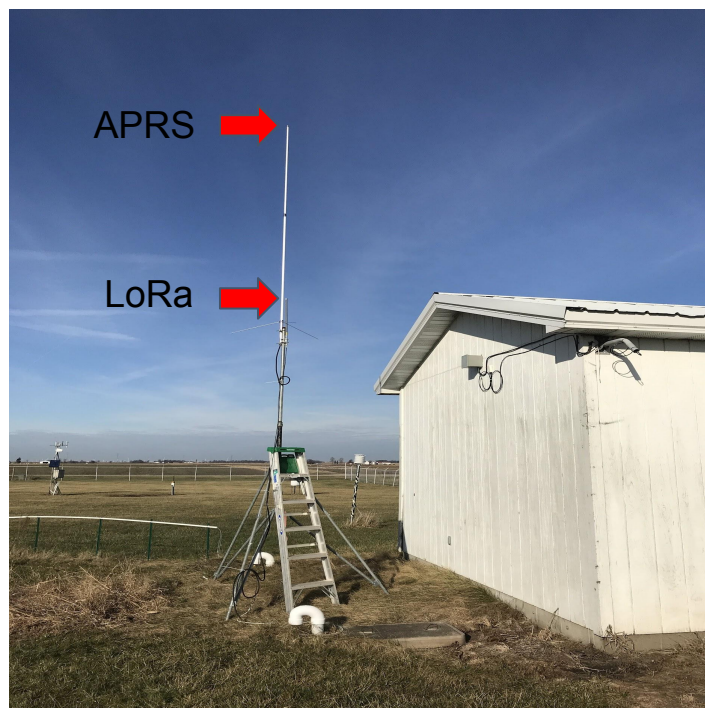


TABLE I  
RANGE RESULTS FROM MULTIPLE TRIALS

# Test	LoRa	APRS
1st Test	0.16 km	1.30 km
2nd Test	4.2 km	0.70 km
Final Test	4.2 km	0.86 km

TABLE II  
LoRA ANTENNA SPECIFICATIONS

Specifications	1st Test	2nd Test	Final Test
Transmitter Antenna Gain	2.14 dBi	9 dBi	9 dBi
Transmitted Power	16 dBm	16 dBm	16 dBm
Receiver Antenna Gain	2.14 dBi	6 dBi	6 dBi

TABLE III  
APRS ANTENNA SPECIFICATIONS

Specifications	1st Test	2nd Test	Final Test
Transmitter Antenna Gain	2.14 dBi	2.14 dBi	1.17 dBi
Transmitted Power	15 dBm	20 dBm	24 dBm
Receiver Antenna Gain	6 dBi	6 dBi	6 dBi

### LoRa

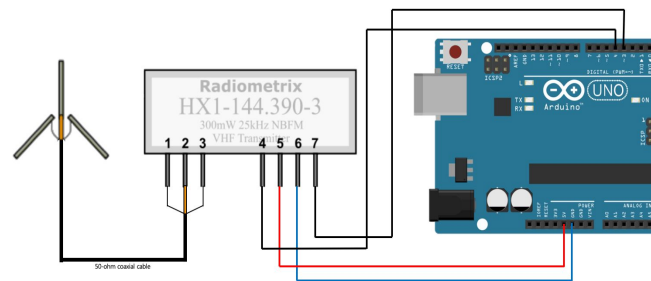
- Arduino Uno
- Arduino LoRa/GPS Shield v1.4
- wlaniot 900MHz Antenna
- 824-960 Mhz 6 dBi 900MHz Omni Antenna



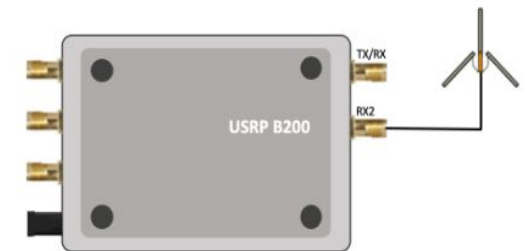
**Transmitter / Receiver**

### APRS

- Arduino Uno
- Radiometrix HX1-144.390-3
- USRP b200 USB Software Defined Radio
- X2200A Dualband Base/Repeater Genuine Nagoya UT-72

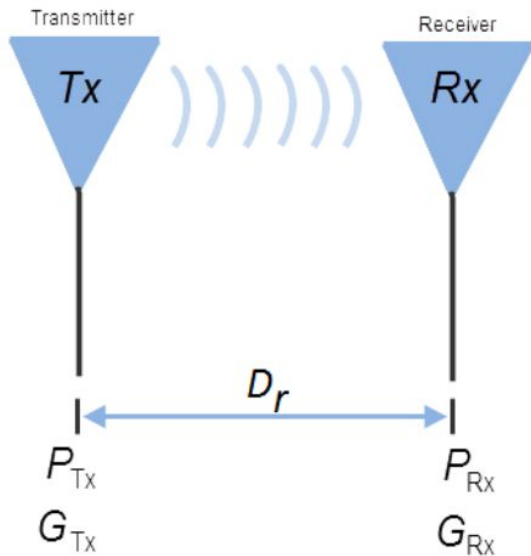


**Transmitter**



**Receiver**

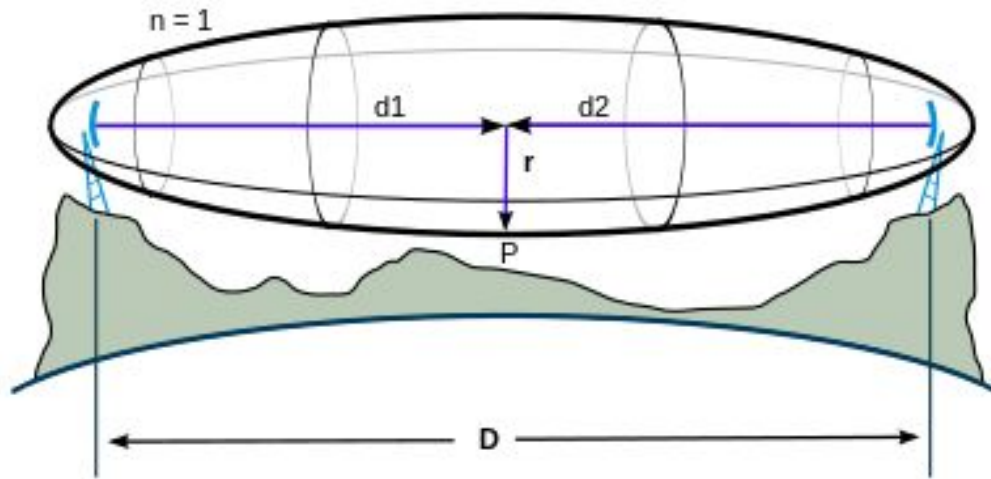
## Friis transmission equation



$$P_{rx} = P_{tx} G_{tx} G_{rx} \left( \frac{c}{4\pi D_r f_0} \right)^2$$

$$D_r = \frac{c \sqrt{P_{tx} G_{tx} G_{rx}}}{4\pi f_0 \sqrt{P_{rx}}}$$

## Fresnel Zone



$$r_n = \sqrt{n \frac{d_1 d_2}{d_1 + d_2} \lambda}$$

$$(d_1, d_2 \gg n\lambda)$$

**LoRa**

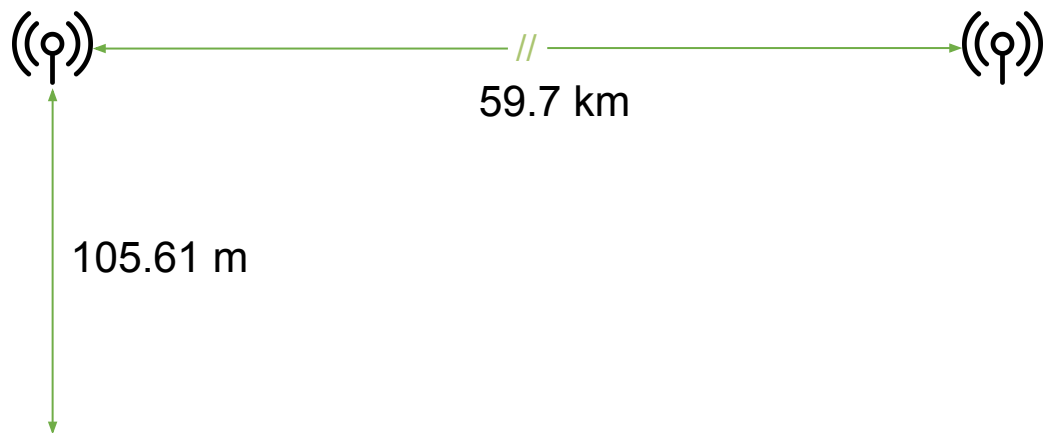
Transmitter Power	16 dBm
Transmitter Gain	9 dBi
Receiver Gain	6 dBi
Theoretical Distance	9.3 km (5.78 miles)
Height Needed	27.79 m (91.17 ft)
60% of Fresnel Zone Radius	16.67 m (54.69 ft)

Transmitter Antenna Height	2.35 m (7.71 ft)
Receiver Antenna Height	4.0 m (13.12 ft)
Tested Distance	4.2 km (2.61 miles)
Efficiency Constrained by Height	45.16%

**APRS**

Transmitter Power	24 dBm
Transmitter Gain	1.17 dBi
Receiver Gain	6 dBi
Theoretical Distance	59.7 km (37.10 miles)
Height Needed	176.02 m (577.49 ft)
60% of Fresnel Zone Radius	105.61 m (346.49 ft)

Transmitter Antenna Height	2.35 m (7.71 ft)
Receiver Antenna Height	6.4 m (21.00 ft)
Tested Distance	0.86km (0.53 miles)
Efficiency Constrained by Height	1.44%



Transmitter and Receiver place 106 m height for 60 km coverage distance  
by **Fresnel Zone**



**LoRa**





**Different antenna gain and Transmitted power**

**Crop canopies**

**Same antenna gain and transmitted power**

**Antennas at higher elevations**

# Q & A