econode

24th April 2020
Econode NZ Ltd
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RE: Predator Free 2050, LoRa repeater project update 24th April 2020
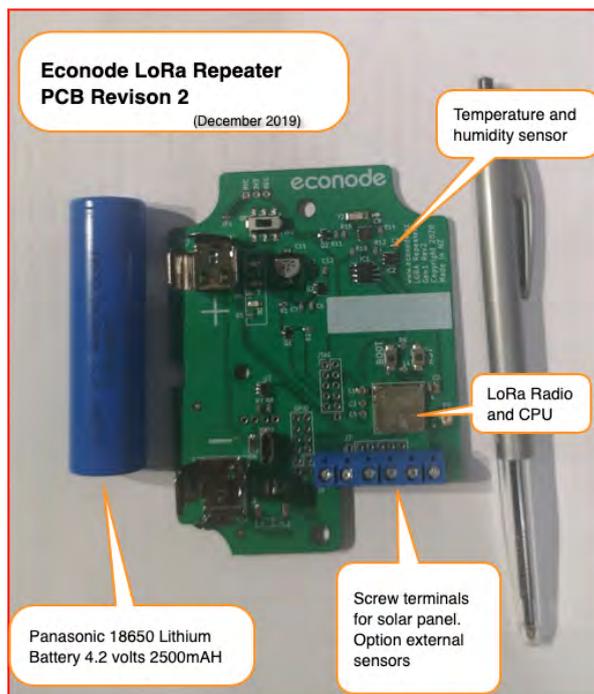
Field testing / Covid-19:
We have been unable to complete field testing due to Covid-19 travel restrictions. Tests have been done from our Avondale site. Likewise it will be some time that we can get additional parts before making the next production revision repeater PCB boards.

Repeater power:
The 18650 Lithium battery is working out well, the repeater will run for 7 - 10 days without any power. With the 5watt solar panel (29cm X 15cm) the battery will fully charge in 3 hours. IE we only need 3 hours direct sunlight per week.

Repeater circuit board:
We have made 5 revision 2 circuit boards (PCBs).

Econode LoRa Repeater
PCB Revison 2
(December 2019)

Temperature and humidity sensor

LoRa Radio and CPU

Panasonic 18650 Lithium Battery 4.2 volts 2500mAH

Screw terminals for solar panel. Option external sensors

Changes from Rev1 are;
#1 Alter battery clips
#2 Add temperature and humidity sensor
#3 Add eeprom
#4 Change screw terminals

Still to change (Rev3/Production)
#1 Reverse battery protection
#2 Undervoltage protection
#3 Cut out for pressure vent
#4 Integrate solar controller

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Repeater housing / Solar panel:

- 5 volt / 5 watt Solar Panel
- 3mm air gap between bracket and solar panel for cooling
- 5mm air gap between repeater node and bracket for cooling

Initial tests showed that heat and humidity were potential issues for the repeater battery and electronics. The repeater now has an internal temperature and humidity sensor with temperature and humidity reported back to the cloud server every hour.

A Goretex valve has been installed to equalize the pressure and keep humidity down.

There is an air gap between the solar panel and the bracket and another air gap between the bracket and repeater casing.

The 5W solar panel is capable of fully charging the battery in 3 hours of direct sunlight.

Pole mounting system:

The repeater can be mounted on a 2.4meter or 3.6meter mounting pole. The aluminium mounting pole is collapsible so that no piece is longer than 1.4meters. This allows sending the collapsed pole as normal freight with NZ Post, and will be easier to carry into remote locations.

Pictured to the left is the repeater running at the Avondale site.

*note NZ post max parcel length 1.5meters

3.6 Meter collapsable mounting pole. Largest part 1400mm long

Software:

Changes have been made to the mux/demuxing of the repeater packets, initially the repeater would only repeat for SmartTrap kill traps, the software will now work with 16 different distinct node types.

The demuxing software has been tested on The Things Network and Taranaki IoT network (ChripStack).

All three software components are at a functional beta stage and ready for field testing.

More work particularly around provisioning will need to be done before the software is ready for production.

Summary:

The problem;
While LoRaWAN has very good range it's limited to near line of sight, which creates issues in project areas that have hills / valleys and other objects which inhibit the LoRa radio signal.
The concept of the repeater was borne out of experience with Econode's projects on Great Barrier Island and Taranaki Mounga, particularly valleys which generally make good locations for trapping.

The solution;
To create a LoRa repeater which will relay signals from hard to reach places onto a standard LoRaWAN network. The repeater would need to be cost effective IE less than NZ $250, self powered so it could run for years without battery changes. Be light weight and small enough that the repeater can be mounted in a tree or on a fence post.
The solution is composed of four parts;
1 - Custom LoRa firmware (software) for nodes which are end points.
2 - Custom LoRa repeater hardware.
3 - Firmware (software) for the LoRa repeater.
4 - Demuxing software for the Cloud server which separates and routes messages.

Testing and findings so far; (24th April 2020)
Radio performance has exceeded expectations with tests up to 2km away in an urban environment through many buildings etc. Surprisingly the repeater gave good radio performance indoors, IE with the repeater on the workshop bench the signal could still be picked up 2km away non line of sight.
Battery endurance the repeater will run 7 - 10 days with the solar panel covered up. With direct sunlight it will fully charge in 3 - 4 hours. So it only needs 0.5 hrs sunlight per day on average.
While there are a few extra seconds of delay in the trap event being received by the cloud server to the end user there is no difference between a repeated node and a standard LoRaWAN node.
All the normal QR code / ArcGIS / TrapNZ events work just the same.

Current issues;
- With Covid-19 it may be some time before we can source parts to build more repeaters.
- Some messages are lost, as the repeater only has one radio when it's transmitting (uplinking) it can't receive messages from downstream nodes.

Overall;
Overall we are very happy how the project has gone. It's taken more time than anticipated as it's been more technically challenging than envisaged.
This is mainly due to the number of caveats involved in making sure the repeater is compatible with the LoRaWAN protocol. Specifically with the "The Things Network" which has some very restrictive fair use policies.
Without doubt this project will help with reach on both small and large monitored pest control projects.

Whats Next;
#1 Building off the LoRa repeater to make a LoRa to 3G repeater for small sites.
A full solar powered LoRa gateway can cost $3,000 to implement LoRa to 3G could do that for $300
#2 Econode are working with a satellite company with the idea of creating a LoRa to satellite repeater for less than $300.

Project milestone update.

Milestone No.	Milestone Description	Milestone Due Date	Status
Milestones are to be written as activities conducted rather than outcomes achieved. Critical achievements that are essential for Project progression will be included as Decision Points in the section below.			
Project Aim 1: LoRaWAN Repeater platform - first generation.			
Milestone 1.1	Preliminary software development and testing. - Power management / charging. - Develop underlying software to switch radio stacks. - Identify issues - scope/design SmartTrap node firmware changes. - scope/design Repeater firmware - scope/design Cloud server de-muxing software Brief verbal report to PF2050 Ltd Project Manager	31/1/2019	**All Completed**
Milestone 1.2	Software development (Alpha versions) - Write new SmartTrap firmware (Alpha version) - Write LoRaWAN repeater software (Alpha version) - Write Cloud Server demuxing software (Alpha version) Brief written report to PF2050 Ltd Project Manager	1/6/2019	SmartTrap firmware Alpha **completed**. Repeater firmware Alpha. **completed** Demuxing SW Alpha **completed**
Milestone 1.3	Hardware development - Identify specific hardware changes arising from initial firmware testing. - Design new printed circuit boards - Physically Make initial 3 repeaters for software development - Brief written report to PF2050 Ltd Project Manager	1/5/2019	Hardware changes identified - **Completed**. First of 3 handmade repeater. **Completed.** PCB design **Completed**.
Milestone 1.4	Pre Production run of repeater hardware. - Manufacture first 10 LoRaWAN repeaters for field testing.	1/8/2019	Production run of 5 Rev 2 PCBs **Completed.**

Milestone 1.5	Software development (Beta versions)
	- SmartTrap repeater firmware (Beta version)
	    - LoRaWAN repeater software (Beta version)
	    - Cloud Server demuxing software (Beta version)
		1/9/2019	Beta versions of LoRaWAN repeater and cloud software written.
			Completed.

Project Aim 2: Combined hardware/software platform field trial			
Milestone 2.1	Developmental trial Install first repeater Avondale / Auckland. Linked off Skytower / Public Network provider (KotahiNet) 10KM distant. Testing in urban environment with rat / kill traps	1/9/2019	Trial repeater installed at Avondale February 2020. Tested with Things Network and Taranaki IoT network **Completed.**
Milestone 2.2	Install at least 2 of the following 3 suggested trials (or other trials agreed with PF2050 Ltd): #1 DOC Great Barrier Island / Live cat trapping #2 Taranaki Regional Council / Stoat kill traps #3 DOC/Auckland council Glenfern (Great Barrier Island) Live cat trapping	1/10/2019	Unable to test at the moment due to Covid-19 restrictions. **Partly Completed.**
Milestone 2.3	Full written report on platform development and field trial performance submitted to PF2050 Ltd'	20/12/2019	This report on Platform development. Unable to complete field trials under Covid-19 **Completed.**

Regards

Matt Way