Final report

Review of Goanna Ag's low-cost sensors and connectivity to optimise water management across Romani Pastoral Co Windy station and significantly improve on-farm efficiencies

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Abstract

Digital farms are important for the longevity of Australian red meat supply chains, whether that be to inform consumers of our credentials such as the CN30 program or Beef Sustainability initiative or to improve production businesses. The Romani Pastoral Company project will demonstrate technology that was not available previously, or willing to be provided at the time, during a potential Carwoola Pastoral Company project- Phase 2.

In November 2018, Meat and Livestock Australia (MLA) hosted the inaugural Digital Forum, as a commercial testing ground for Agtech innovation. The Digital Forum was designed to push industry innovation providers to work together within networks and visualisation tools and also to commercially test the robustness of their devices and services.

Sensors are becoming more relevant to modern farming systems as agriculture, as an industry, becomes more data centric. The data from a collection of sensors can enhance the efficiency, safety and quality of a farming enterprise. This is achieved by gaining greater control and insight into on-farm assets, allowing producers to make better management decisions in a shorter amount of time.

Goanna Ag deployed a LoRaWAN telecommunications network as well as a range of sensor solutions across Romani Pastoral Company properties "Windy Station" and "Warrah Station" to assess this thesis. Overall, both the network and sensor solutions performed well. Third party sensor providers had varied results in connecting their solutions through a standardised telecommunication medium.

Executive summary

Background

Sensors are becoming more relevant to modern farming systems as agriculture, as an industry, becomes more data centric. The data from a collection of sensors can enhance the efficiency, safety and quality of a farming enterprise. This is achieved by gaining greater control and insight into on-farm assets, allowing producers to make better management decisions in a shorter amount of time. The purpose of this project is to assess the value of currently available sensor technology for the livestock sector to assist producers in decision making, and to potentially inform future R&D investment where gaps are identified.

Objectives

Supplied, install and made operate the following digital components:

1. 4 Solar powered, LoRaWAN base stations
2. 5 Water trough sensors
3. 5 Water tank sensors
4. 1 Diesel fuel tank sensors
5. 5 Gate and door sensors
6. 1 Asset tracker
7. 1 Weather stations
8. 2 Rain gauges; and
9. 3 Soil probes

Methodology

- Plan and install appropriate LoRaWAN infrastructure to provide farm wide sensor connectivity;

- Install and operate nominated sensor technology at client identified sites

- Train client staff in use of sensor technology

- Provide other sensor suppliers’ support for use of the LoRaWAN network

Results/key findings

Low powered sensor solutions can provide a number of benefits including labour efficiencies, risk mitigations and more informed decision making.

Sensor solutions have some way to go to be seamlessly compatible over third party supplied network infrastructure.

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1. Background

Digital farms are important for the longevity of Australian red meat supply chains, whether that be to inform consumers of our credentials such as the CN30 program or Beef Sustainability initiative or to improve production businesses. The Romani Pastoral Company project will demonstrate technology that was not available previously, or willing to be provided at the time, during a potential Carwoola Pastoral Company project- Phase 2.

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Sensors are becoming more relevant to modern farming systems as agriculture, as an industry, becomes more data centric. The data from a collection of sensors can enhance the efficiency, safety and quality of a farming enterprise. This is achieved by gaining greater control and insight into on-farm assets, allowing producers to make better management decisions in a shorter amount of time.

Goanna Ag has a fleet of hardware solutions that monitor; soil, water, weather and inventory. Goanna Ag solutions are connectivity agnostic and utilise LoRaWAN, 3G / 4G and Myriota protocols. For this project, we utilised LoRaWAN. The data collected our deployed sensors is directed to GoSat, a powerful platform that relays accuracy around irrigation scheduling, satellite imagery and benchmarking functionality, as well as yield forecasting. The GoApp, downloadable on smartphones, tablets and iPads, allows you to access your secure and reliable data at your convenience.

1. Objectives

Supply, installed and made operationalise the following digital components:

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3. 5 Water tank sensors;
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6. 1 Asset tracker;
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9. 3 Soil probes

All of the above network infrastructure and sensor solutions were installed. All objectives were completed.

2. Methodology

2.1 Site identification

The initial task of the project was to identify the most suitable sites for network base stations to be deployed to provide coverage across as much of the properties as possible, specifically ensuring that the sensor install locations were guaranteed coverage.

A visit to "Windy" and "Warrah Stations" occurred in early October 2019 to visually inspect the sites and to understand the terrain and property layouts. The ideal locations for gateway installations are determined by a number of factors, including:

- Pre-existing infrastructure that could be utilised for installation;
- Land height (the higher the install, the larger the coverage footprint generated);
- Surrounding infrastructure shadows; and
- Vegetation coverage.

It was determined that four network gateways would be required, with the most ideal locations sited at the following co-ordinates:

i) Sandy Ridge: -31.598227, 150.410553
ii) Brown's Ridge: -31.611937, 150.45047
iii) Warrah Station: -31.620945, 150.655533
iv) Colly Creek: -31.640844, 150.696701

The next step was the to conduct a radio-frequency (RF) network planning process to ensure that full coverage is achieved from those sites.

2.1.1 RF network planning

The network planning process involves assessment of the topography of the farm to identify the most appropriate location for a LoRaWAN network base station to be installed to provide maximum coverage both spatially and in terms of signal strength. A 20m digital elevation model of each property is combined with LiDAR imagery showing tree height, density and building dimensions as well as telecommunications coverage maps (3G, 4G and satellite) to create an anticipated coverage map known as an RF plan.

The outcome of the network planning process is a "coverage map" that shows anticipated coverage of the LoRaWAN network from the suggested installation point. If this step resulted in a coverage map with a poor footprint, alternative sites would be reviewed as alternatives.

2.1.2 Design most appropriate network installation

With gateway installation sites confirmed, the next step is to determine the most appropriate design and installation method for the LoRaWAN network base station depending on the structure the base station will be installed.

General components of a base station include a solar panel, an enclosure with the network hardware and battery array and an external antenna – all up weighing around 70kg.

In addition to the general componentry described above, there are a number of site-specific install requirements meaning that each base station installation is as a custom build depending on site specification.

2.1.3 Network operation

MLA requested that Goanna Ag provide the LoRaWAN network connectivity for all LoRaWAN sensor providers rather than have a everyone install their own network instances. Part of the driver for this was to reduce physical infrastructure installed across the properties, and a part was to assess the ability for different provider's technologies to work in a cooperative manner.

In preparation we documented the LoRaWAN requirements for devices to be permitted access to the network, all of which comply and reinforce the global LoRaWAN alliance operating standards. This document / process is known as the N-Tick process.

2.1.4 Sensor placement

Sensor installation points had been pre-selected by Romani Pastoral Co and MLA project officers. Other than understanding signal impact, there was no specific methodology employed for this process.

3. Results

Network and sensor installation and commissioning processes took place on both "Windy" and "Warrah Stations" on Monday 28th October – Tuesday 29th October by Dan McNaulty and David Ward from Goanna Ag. The following map shows the deployment locations for all network hardware and sensor devices across the property.

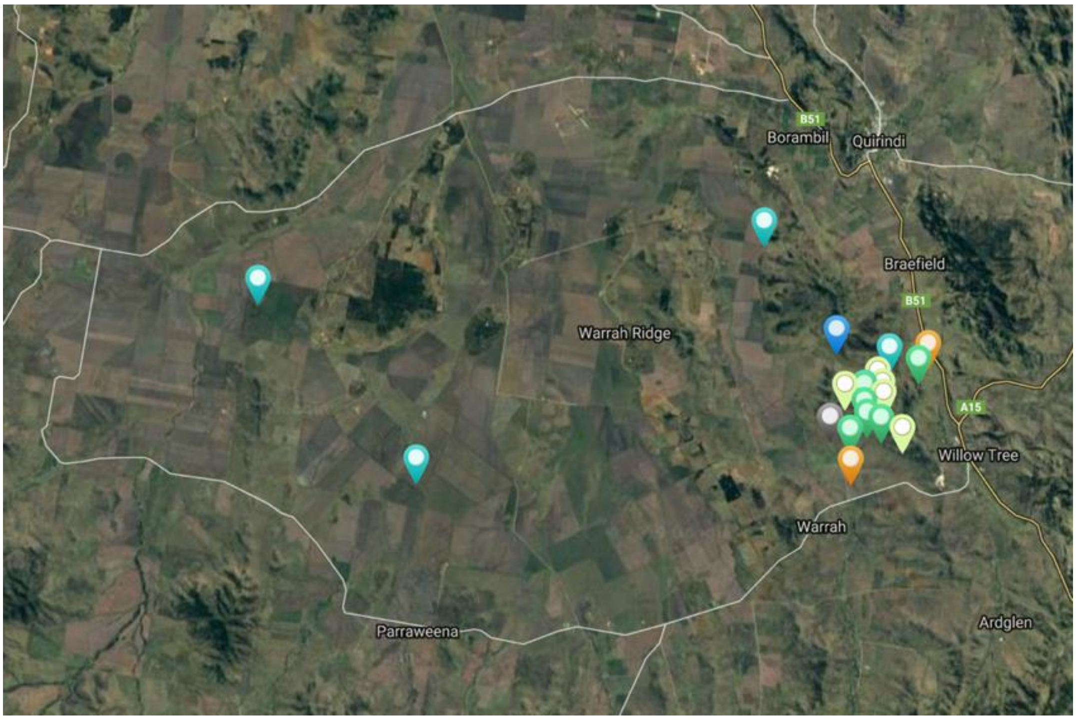

Figure 1: Network gateway and sensor locations across Windy & Warrah Stations

Key:

- LoRaWAN gateway installation
- Soil Moisture probe (1 is grey)
- Rain gauge
- Tanks – both water and diesel
- Trough monitors
- Weather station

The 4 network gateways were the first infrastructure deployed across both properties. This enabled installation and testing of devices to occur concurrently ensuring that all deployed assets were operational, with sensor data being received by the GoApp platform when Goanna Ag staff left the properties.

3.1Network installation and provisioning

3.1.1 Windy Station

4.1.1.1 RF Plan

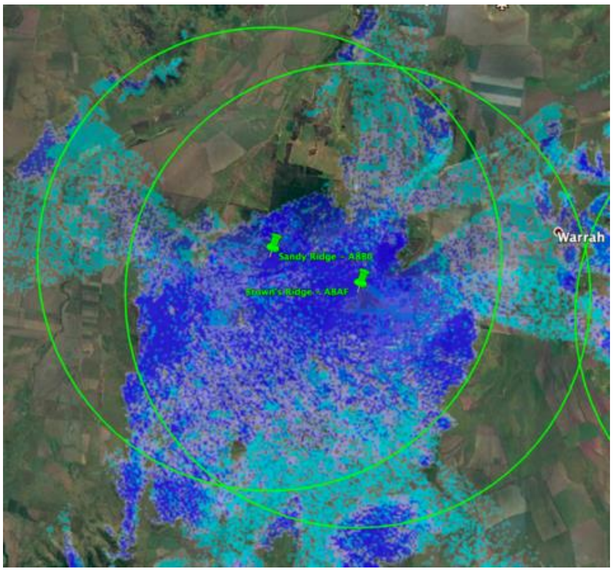

Figure 2: RF Plans for Windy Station gateway installation sites

The above picture outlines a conservative expectation of LoRaWAN network coverage from each of the gateways installs on "Windy" combined. The dark blue and light blue on the map is the result of different planning processes and do not demonstrate stronger or weaker signal. The green circle denotes a 10km radius which in flatter terrain is a reliable estimation of coverage.

4.1.1.2 Final site installation details

The two identified sites to provide best network coverage across the property were some distance from other significant infrastructure. It was therefore decided that the two gateways installed at "Windy Station" (site names are Brown's Ridge and Sandy Ridge) were to be ground mast installations with the network componentry, solar panel and battery enclosure installed at least 2m above the ground to remove any opportunity for interference by livestock. The ground mount for the pole was cemented 1.5m into the ground to ensure stability and rigidity of the structure.

Figure 3: Windy station gateway installation photos

3.1.2 Warrah Station

3.1.2.1 RF Plan

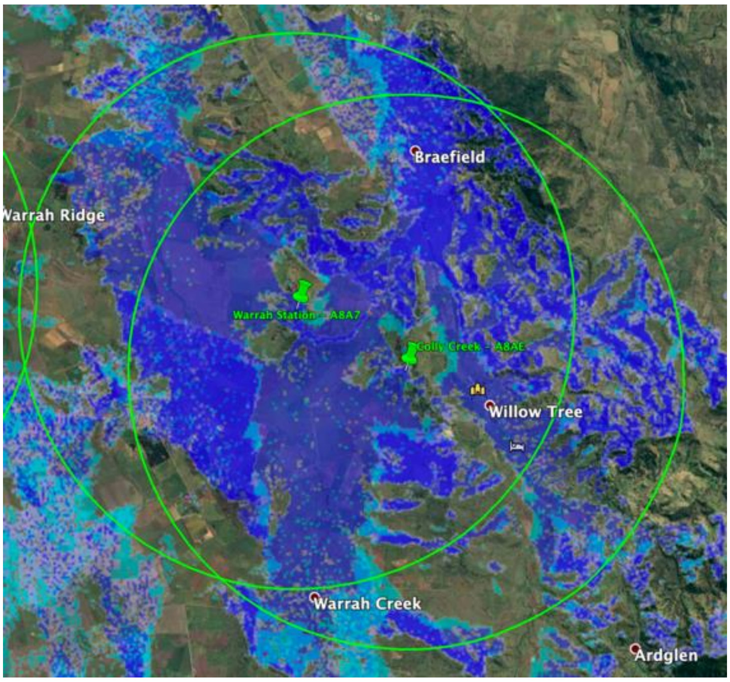

Figure 4: Warrah Station RF Plan

The above picture outlines a conservative expectation of LoRaWAN network coverage from each of the gateway installs on "Warrah" combined. The "Colly Creek" installation had a significant dead zone to the N/NW due to topography changes across the landscape. The "Warrah Station" gateway fills in that lack of coverage well, as demonstrated in the above map. The dark blue and light blue on the map is the result of different planning processes and do not demonstrate stronger or weaker signal. The green circle denotes a 10km radius which in flatter terrain is a reliable estimation of coverage provided by a single LoRaWAN gateway.

3.1.2.2 Final site installation details

As was the case with "Windy Station", the two identified sites to provide best network coverage across the property were some distance from other significant infrastructure on "Warrah Station". It was therefore decided that the two gateways installed at "Warrah Station" (site names are Warrah Station and Colly Creek) were to be ground mast installations with the network componentry, solar panel and battery enclosure installed at least 2m above the ground to remove any opportunity for interference by livestock. The ground mount for the pole was cemented 1.5m into the ground to ensure stability and rigidity of the structure.

Figure 6: Warrah Station RF Plan

3.2 Sensor installation and commissioning

The project contract specified the type and number of each sensor to be installed across Windy and Warrah Stations and were as follows:

1. 4 Solar powered, LoRaWAN base stations
2. 5 Water trough sensors;
3. 5 Water tank sensors;
4. 1 Diesel fuel tank sensors;
5. 5 Gate and door sensors;
6. 1 Asset Tracker;
7. 1 Weather station;
8. 2 Rain gauges; and
9. 3 Soil probes

The following sections contain photographs of some of the sensor installation across the properties, however photos of every sensor are not included due to report size implications.

3.2.1 Water trough sensors

Figure 7: Modified Water trough sensor

3.2.2 Water tank sensors

Figure 8: Water tank sensor

3.2.3 Diesel fuel tank sensors

Figure 9: Diesel fuel tank sensor

3.2.4 Gate and door sensors

Whilst 5 gate and door sensors were sourced for use in the project, they were not suitable for use on gates due to the distance between the edge of the gate and the fencepost in most scenarios. Three of the devices were subsequently used on doors across the property with the other 2 sensors not being deployed. Installation of these 3 devices did not occur until December 2019.

Figure 10: Chemical shed door

Figure 11: Grain silo door sensor

Figure 12: Office door sensor

3.2.5 Asset tracking

Installation of the asset tracking device did not occur until December 2019

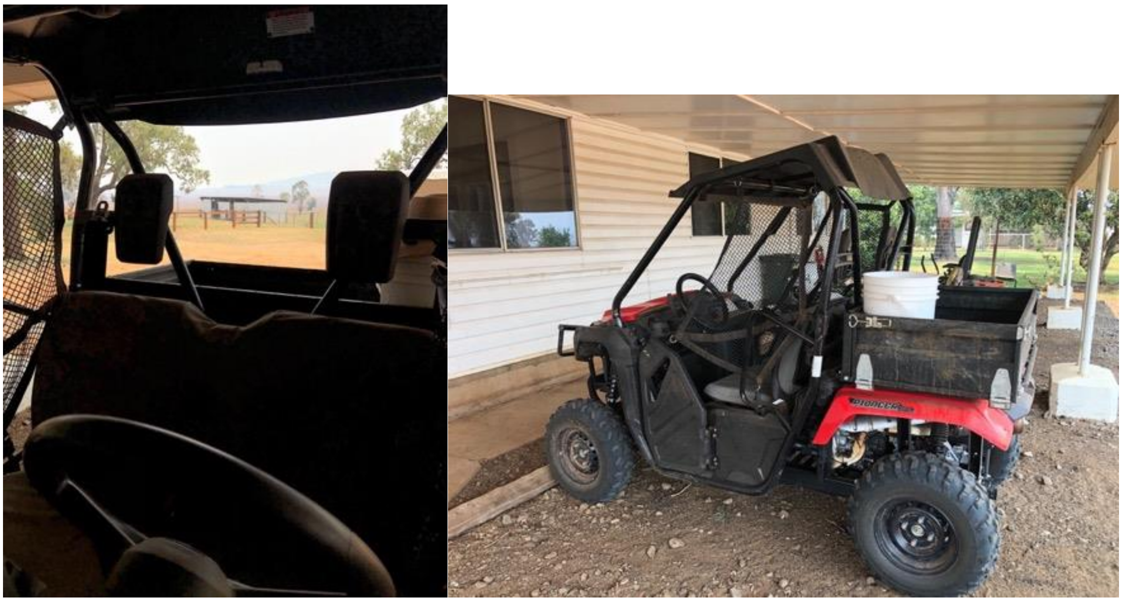

Figure 13: Asset tracker

3.2.6 Weather stations

Figure 14: Windy weather station photo

3.2.7 Rain gauges

Figure 15: Warrah rain gauges

3.2.8 Soil probes

Figure 16: Windy soil moisture probe

4. Key findings

4.1 Network Performance

Since installation, the four gateways deployed under this project have operated seamlessly with a total 0 minutes of downtime. This represents full availability of the network at all times (100%).

4.2 Network onboarding

Whilst base requirements to join the LoRaWAN network had been documented for other sensor providers, the reality of on-boarding other manufacturers proved challenging. All other sensor providers were at different points of development maturity and had implemented LoRaWAN with varying degrees of success.

Goanna Ag utilises services from the National Narrowband Network (NNNCo) to manage user authentication, device provisioning and general network management. Whilst this relationship brings the benefit of a telecommunications license for broad operation as well as being able to provide a Service Level Agreement of 99.7%, there are technical requirements imposed on any device on the network to ensure that no device can interfere with signal transmission of other devices.

There was a general misconception amongst other providers that the network would operate as a publicly available network in that any person could join any LoRa (Note not necessarily LoRaWAN sensor) on to the network.

Goanna Ag worked closely with each provider, and the network manager NNNCo, to assist with technical difficulties experienced. Goanna Ag provided separate LoRaWAN gateways to 4 of the providers to establish a test environment to assist with finalising development changes required prior to deployment at no charge.

This combination of issues proved a hurdle for a number of suppliers. Goanna worked with the other LoRaWAN sensor providers to onboard devices for the RPC project. As at the date of this report the other providers have now been successful with their implementation on the Goanna Ag network. It should be noted that there were broader technical issues than simply joining the network, at least two other providers did not have the software backend to handle and display data ready for implementation.

4.3 Sensor Performance

Since installation, all sensors have operated seamlessly with no lag or drop out of data provided. The improved ruggedization and installation of our sensors from previous livestock deployments has proved successful in all but 1 case – a soil moisture probe which came off second best to a cow as we had not fenced the device in a timely manner. This sensor has now been replaced.

4.4 Durability and Reliability of installation

Goanna Ag implemented a number of variations to our standard builds after initial deployment of our sensor solutions on to a livestock property through the MLA Carwoola Pastoral Company trial. These modifications were deployed on "Windy"and included:

- more ruggedized deployment of trough sensors, ensuring that the device was sufficiently far enough away from the reach of an animal with a cage enclosure; and

- different construction of the network gateways. We previously used guy-wire to stabilise a taller ground Telo-mast, however a combination of lengthy guy-wires and the resultant fence required to protect the gateway was unrealistic. We changed manufacturing to use a pole mast, which was cemented 1.5m into the ground, with the gateway enclosures deployed > 2m above ground height allowing cows to rub up against the mast without impact. Despite these modifications, RPC still felt that fencing was required around the installation.

We sourced gate sensors from a third-party supplier and found them to be unsatisfactory. We installed of these on door infrastructure rather than gate and requested the remainder be removed from the project.

4.5 Data provision

It was a noted requirement of the project to pass data on to centralised web applications for use by RPC. We have trained the RPC staff on use of our GoApp. We also provide data upon authentication into the Pairtree platform.

5. Conclusion and recommendations

Overall Goanna Ag's LoRaWAN network and sensor solution deployments are far more rigorous and stable in the Romni Pastoral Company when compared with twelve months ago after implementing a number of learnings from MLA's Carwoola Pastoral Company trial. We recognise that our traditional footprint is broadacre and irrigated cropping and the introduction of live animals into the operating environment increases the requirement for ruggedized and protected installations.

Whilst IoT devices will bring significant value pre-farm gate, the maturity of the IoT eco-system needs further refining and agreement on a standard to ensure one type of network infrastructure can support a broad range of solution providers. The current approach for providers to supply their own network installation will make the technology either too complex or too expensive for most producers to engage with.