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Mobile Hitachi Process Intelligence and UAV Control Centre Demonstration Unit

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Executive summary

MLA held its AGM from 20nd to 23rd November 2018 at Canberra and the inaugural digital forum day on the 22nd of November 2018 at Carwoola Pastoral Station. Several suppliers of agriculture sensing devices and solutions were given the opportunity to install their equipment at the properties of Carwoola, in order to demonstrate the current "state of the art" of these technologies. For these technologies to provide meaningful information and decision support to the management of Carwoola it was necessary to integrate the outputs of as many of these solutions as a possible into a central control centre.

Hitachi Consulting was requested to integrate these solutions on their Smart Agriculture platform. In order to effectively demonstrate the overall benefits of a digital farm to the 250 delegates expected to visit Carwoola Pastoral Company, a mobile control centre was required that could be located on the property and provide a base for the various communications, computer and display systems to demonstrate the integrated digital farm systems with live, actual data. A Smart Agriculture Control Centre was also installed in the property manager's office for ongoing management of the farm. As part of the overall digital forum display several drones (unmanned aerial vehicles) were also flown on the day and the mobile control centre served as a control centre for the drone operations.

The mobile control centre was required to be rugged and easily transportable to MLA and other red meat industry demonstration and field days, where the same integration of agriculture technology solutions could be demonstrated in real time, while also serving as a base for drone flight missions at such events. Hitachi Consulting developed a ruggedised mobile control centre which had off -road capabilities. The integration of the various solutions was carried out by Hitachi Consulting developers in collaboration with the technical teams of the third party solution providers. The Smart Agriculture Control Centre effectively integrated many of the solutions installed on the property as well as live imagery and analysis from the drone operations.
The control centre has been an effective showcase of the technologies to delegates who have attended MLA sponsored events in 2018-2020.

A video was produced of the Mobile Control Centre operating at the Carwoola event see:
https://youtu.be/J35EgJ_m8Uk

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1 Background

Over the past four years, Hitachi Consulting has run several co creation projects with MLA in the area of digital transformation. P.PSH. 0815, assessed the value chain improvements in processes, practices and technologies using optimised data capture and analytics. P.PSH. 0859 “Eagles Nest”, developed and assessed UAV supported technologies and data capture for extensive beef production across northern Australia and P.PSH.1077 established terrestrial based digital connectivity at Calliope Cattle Station. These projects required a robust data platform that was able to ingest data from the various sensors and solutions, process the data and provide information in a useful manner. In carrying out these projects Hitachi Consulting built a platform, presenting the data in a control centre format, allowing for further development of decision support algorithms from the data and information collected. As a result of this ongoing engagement MLA approached Hitachi Consulting to assist in providing an integrated platform and control centre for the RedMeat 2018 event - Carwoola Pastoral demonstration farm.

Carwoola Pastoral spans four properties with a total footprint of 16,000 acres. The properties are used primarily for mixed grazing purposes, with some winter fodder crop and irrigated crops. For the digital forum demonstration over 200 AgTech devices were installed, from 22 different service providers. Technologies included cattle tags, rain gauges, soil probes, electric fence monitoring, pump monitoring and aviary monitoring. To connect these devices across the properties four LoRaWAN gateways, Sigfox connectivity, Satellite IoT and on-farm WiFi were installed (Agtechfinder.com, Case Study published by Food Agility, June 28, 2019). The devices, solutions and connectivity systems are illustrated in Figure 1.

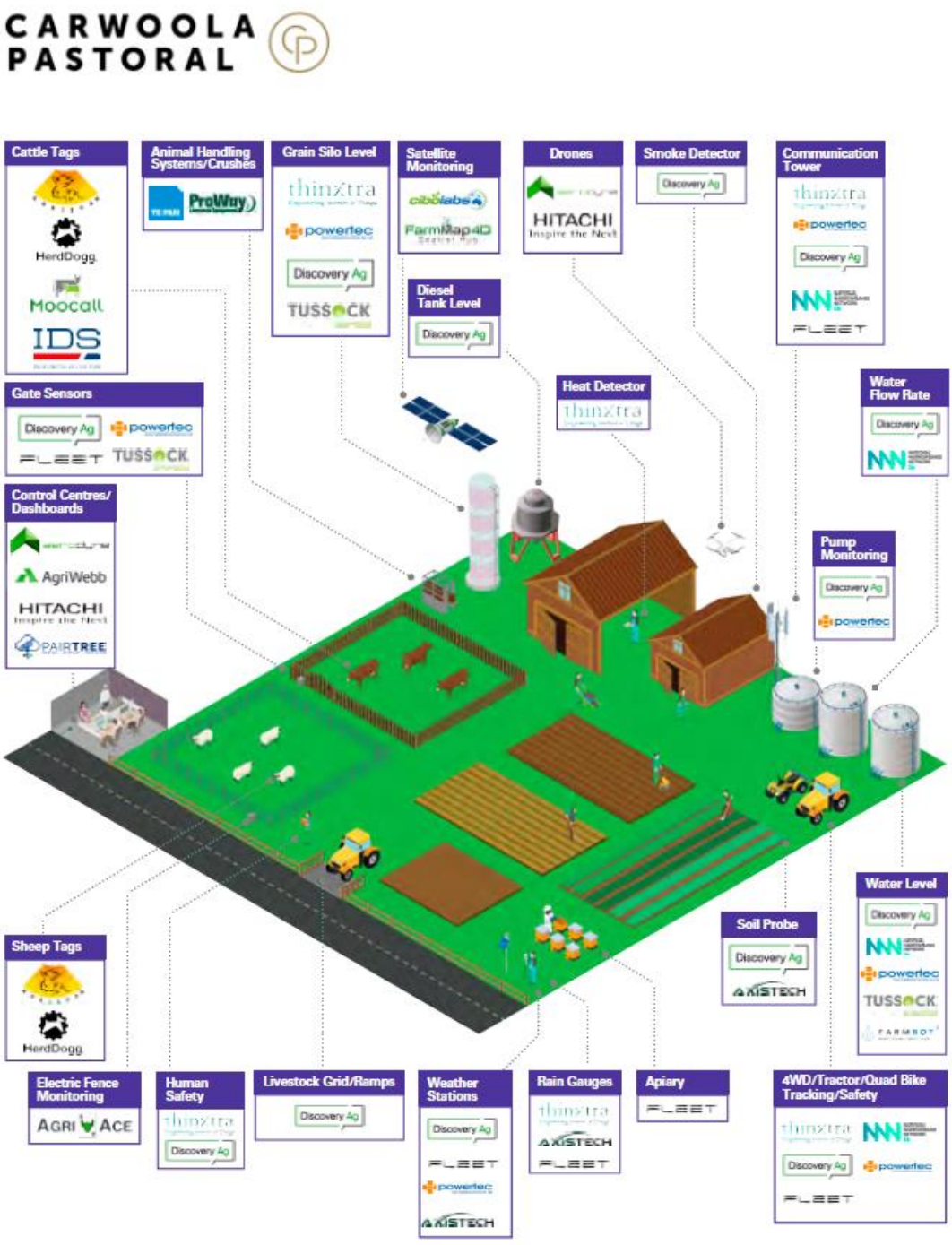

Figure 1: Sensors, solutions and connectivity sytems installed on Carwoola Pastroral (KPMG Agri 4.0 Connectivity at our fingertips report)

2 Project Objectives

The objective was to provide a mobile control centre that could provide the same information that was accessible to the property manager, at the farm office and on mobile devices, in real time, in a remote location. The control centre had to be accessible to groups of up to fifty delegates at a time. While all the sensors on each farm were connected as described in Section 1, it was also a requirement to have a real time communications link from the drones, one of which was providing multispectral imaging of the pastures for the purposes of providing biomass estimation while the

other was providing species recognition of the grass types for the purposes of calibration, a methodology developed for this event which was labelled as the digital botanal process. Figure 2 is an aerial view of Carwoola station, of note is the number of trees which had to be considered when planning drone flight operations.

Figure 2:Aerial view of Carwoola Pastoral from the Hitachi drone

Figure 3 shows the area allocated to the Mobile Control Centre; the main exhibition area was to the left of the road. Delegates had access to the Mobile Control Centre to the right of the road.

Figure 3: Location of the Mobile Control Centre in order to control drone operations

In addition to the specific objectives of the Carwoola Pastoral demonstration, the mobile control centre had to be capable of longer-term deployments in remote outback environments and be as self-contained as possible for these environments. These requirements included the ability to be used in off road conditions and have the ability to accommodate a crew of at least two persons for up to a week.

3 Methodology

3.1 Mobile Control Centre

After considering a number of options including converting a shipping container as well as a four wheel truck with a suitable compartment on the back tray, it was decided to purchase a second hand Jayco off road caravan and configure the internal layout for mounting the communications and computer systems. A major advantage of the Jayco caravan is the lifting rear door which not only allows for the large panel computer screens to be protected while still been visible to audiences, but also allows for visibility when the control centre is used for managing drone operations. The mobile control unit is built on a heavy-duty chassis with independent double axel suspension.

This mobile unit has off-road capabilities with storage space and facilities to accommodate equipment for the Smart Agriculture analytics and display as well as manage advanced UAV operations. The control centre is also able to accommodate two personnel allowing them to operate independently in remote circumstances.

The unit has a solar system and inverter electricity generating facilities as well as gas supply for the kitchen cook top, refrigerator and water heating. A total of 180 litres of water can be stored in 2 built-in tanks.

The storage and operational area can accommodate the following components (Figure 4):

- Volanti™ drone UAV Storage container: 1720 x 1140 x 435 mm
- Battery Charging Fridge for the Volanti drone UAV: 600 W x 450 D x 640 H mm
- Multiple Multirotor drone UAV's
- Sunbird Solar Powered drone UAV container: 1700 X 600 X 500mm
- Hitachi 65" Interactive Touch Screen TV on stand weighing 100kg
- Inverter generator: Adventure Kings 3.5kVA Open Generator | 212cc | 4-stroke
- Tables and chairs
- 3 x 3m Gazebo
- Solar panel system installed in mobile Control Centre
- Edge Computers as well as all UAV Control systems and radios and satellite transponders.

3.2 Installing Edge Computers and Visual Display system

A powerful computer capable of processing drone imagery on site has been installed in the Mobile Control Centre. This system is capable of onsite processing as well as displaying the Smart Agriculture Control Centre for any farm operation. Also included is a Hitachi 65 inch Interactive Touch Screen which has been used to demonstrate the Smart Agriculture Control Centre capability. All live data was accessible via the Interactive Touch Screen.

The mobile control centre contained: Edge Computer tower: Intel Core i7-8700K Hex Core Processor 3.7GHz (Turbo 4.7Ghz) LGA1151 CL No Heatsink WITH MOBO ONLY with Cooler Master Hyper 212X CPU Cooler 120mm fan. Asus PRIME Z370-P LGA1151 CL ATX Motherboard. Corsair Carbide 270R Solid ATX Mid-Tower Case. ASUS GeForce GTX 1050 TI PHOENIX PH-GTX1050TI-4G 4GB. Samsung 850 EVO 1TB SSD MZ-75E1T0BW. Microsoft Windows 10 Pro 64bit OEM DVD. 00. Cougar GX-S650 650W ATX 80+ Gold Power Supply. LG GH24NSD1 DL-DVD Writer Black Internal 24x OEM.

2 x 27” Computer monitors: 02LG 27MP48HQ-P Monitor 27", IPS, LED, 1920x1080, 5ms, 5M:1

3.3 Installing UAV Ground Control System

UAV Control Centre 875 X 680 X 600mm housing UAV system control. Inmarsat Satellite communications tower for autonomous communication operation.

3.4 Installing UAV radio and safety systems

Radios: 2 x 5 W handheld UHF radios with heavy duty magnetic base for extended communications reach. 1 X Airband Portable radio for communication with aircraft. Aerials for extended communication reach to aircraft. An additional installed unit in the Control Centre monitors the Aircraft ADSB (Automatic Dependent Surveillance Broadcast) system. This is an advanced safety feature that has been installed in the UAV and shows aircraft the position of the UAV. It also allows the crew of the Control Centre to monitor aircraft.

Figure 4: Equipment being prepared for transportation to Carwoola

3.5 Tow vehicle

The mobile control centre was towed with a rental Toyota Land Cruiser Trooper fitted with electric brakes and adequate towing capacity for the 3-ton mobile control centre (Figure 5).

Figure 5: Mobile Control Centre with Tow Vehicle

3.6 Integration of sensors and systems onto the Smart Ag Control Centre

The Smart Agriculture Control Centre was hosted on Google Cloud Platform in Sydney. The core components are all containerised which allows the Smart Ag Control Centre to be hosted on any cloud platform as well as on premise, it has been designed to be multi-tenanted, which allows many customers to use the same core infrastructure. Data were segregated tenant wise and there have been no data clash between multiple tenants. The Control Centre had inbuilt capability for integration of different kind of sensors such as weather stations, water level monitors, asset management through RFID or GPS, through a messaging protocol, message format and service endpoint for smooth integration. This architecture has provided a cost-effective solution for many farmers to adopt the Hitachi Smart Agriculture Control Centre. The solution architecture is illustrated in Figure 6 .

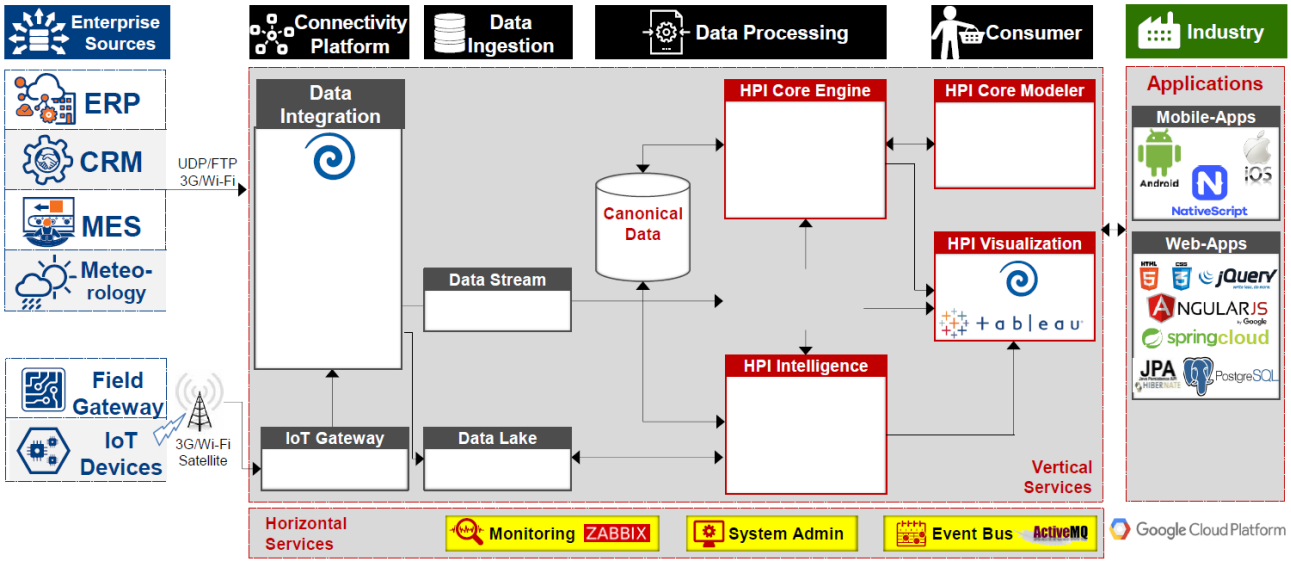

Figure 6: Solution Architecture of the Smart Agriculture Control Centre

3.7 Smart Agriculture Data and Application Security

The following protocols have been applied to the Smart Agriculture Control Centre to ensure the highest levels of security. Both data in transit and data in rest have been encrypted within Google Cloud Platform. Smart Agriculture Control Centre has used Google CloudSQL database to store application data. All data stored was encrypted by default by Google managed encryption/decryption key. Authentication and Authorization data was stored in CloudSQL database where user password is hashed before storing into the database. The password is doubly secured by hash and encryption on rest. Data in transition from the farm/property network to Google cloud was protected through a secured security layer to protect it from a so called “man in the middle attack”. The data in database is partitioned per tenant. Data was segregated tenant wise and provided no data clash between multiple tenants.

The Smart Ag Control centre has had its own security service which provides authentication, authorization and role-based access control implemented using OAuth 2.0. For each tenant a separate organizational structure has been created. Access to users has been restricted at property level. Users at one property can be restricted to access another property’s data. This rule is followed hierarchically to protect the data of each tenant.

As shown in Figure 7, the Service Gateway was connected to Security Service and Service Registry. Every API call was intercepted by the Gateway Service which checks caller identity and authority which is encrypted in a token. Consumers of API’s pass this token in every API call. If a token is not present, the Gateway redirects consumers to authenticate themselves followed by which consumers send authentication request with user identity and password in www-url-form-encoded request through secured socket layer. The Gateway service invokes the Security service to identify the consumer and validate the authenticity. Once authenticity is validated, the security service lists down allowed privileges of the consumer along with additional information, encrypt all information and converting that into a time bound security token. The consumer receives the security token and uses that to send in a request header of each request. All services and resources are secured through role-based access control so that consumer with specific privilege can access allowed resources for that particular role.

Token is valid for a specific period, after which the consumer can refresh token with required credentials. In case there is any change in the token, or its data gets compromised, the security service will block the consumer to any further access.

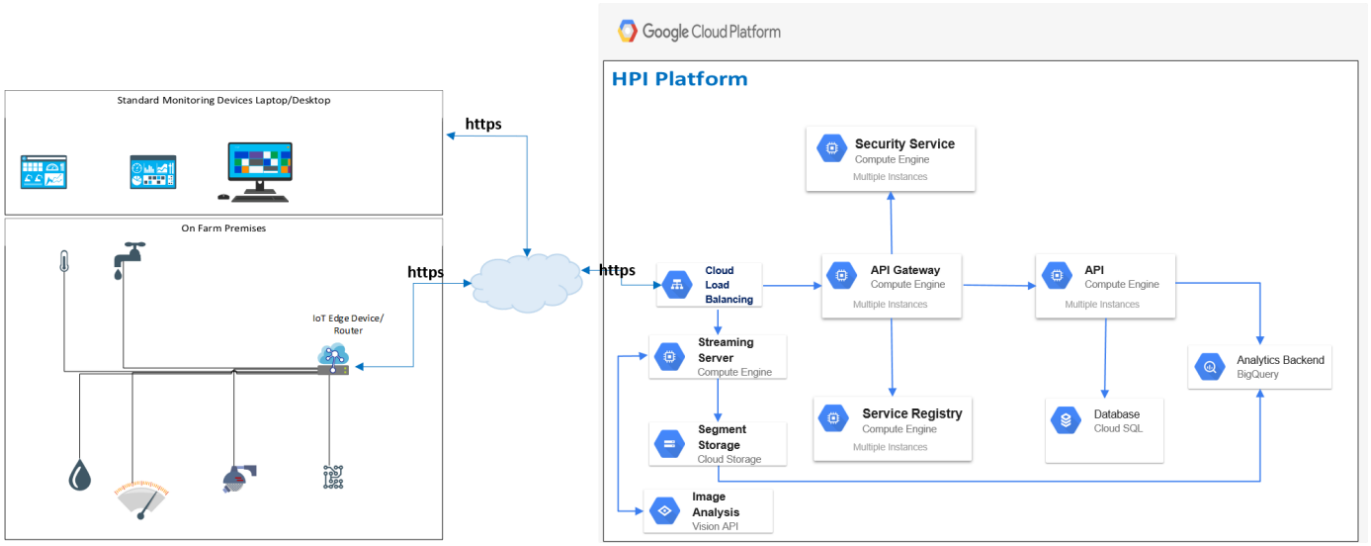

Figure 7: Smart Agriculture Data Security Architecture

4 Results

4.1 Integration of sensors and systems to the Smart Agriculture Control Centre

Figure 8 indicates screenshots of Carwoola Pastoral's Smart Agriculture Control Centre. These outputs were available from the Control Centre at the farm/property office and from the Mobile Control Centre. Figure 8 also shows the location of the sensors on the property.

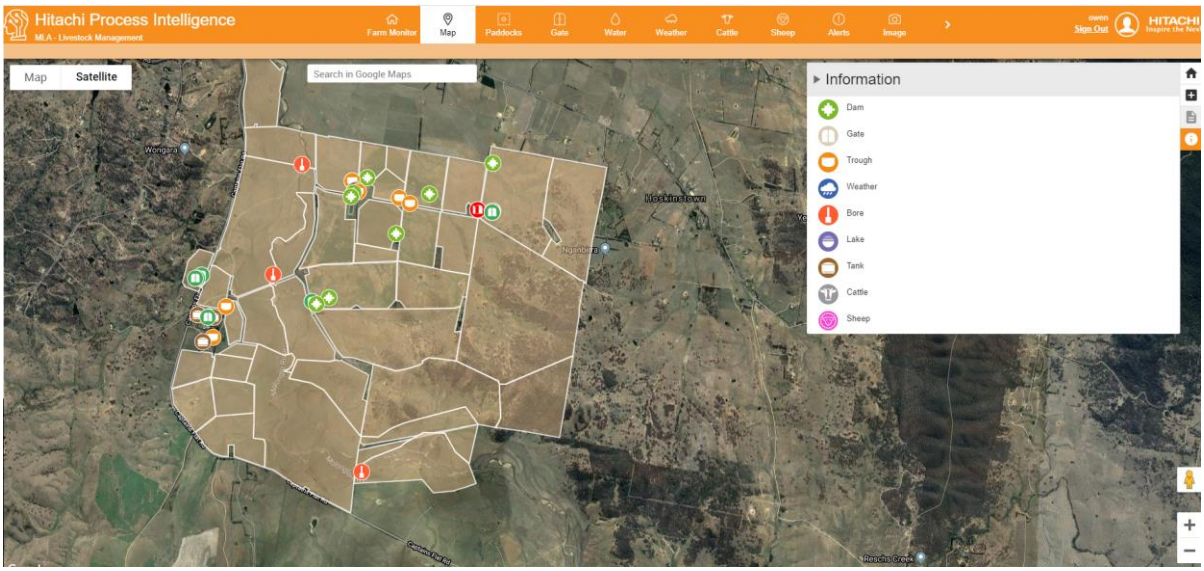

Figure 8: Location of sensors on the property

Figure 9 gives the weather station outputs from one of the weather stations

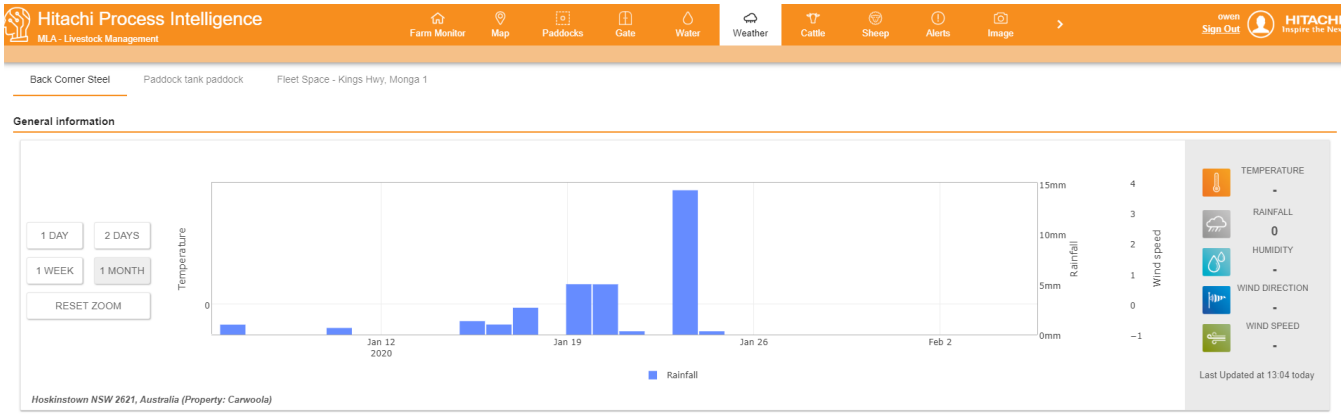

Figure 9: Weather station output

One of the more unique solutions installed at Carwoola was the gate monitoring system. From the control centre alerts could be set on gates to indicate when they were opened and closed within certain time periods (Figure 10).

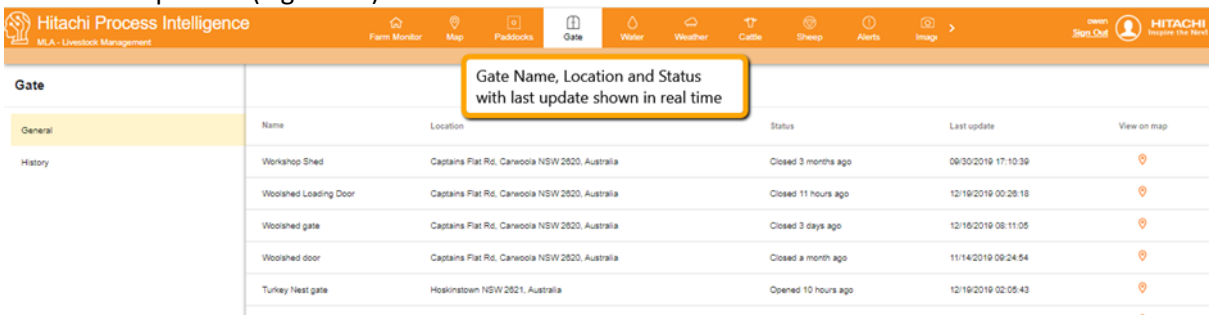

Figure 10: Gate monitoring system

A very key source of information was the water levels of tanks, troughs, bores and dams as well as river flood alerts. These monitors were consolidated into the screen (Figure 11).

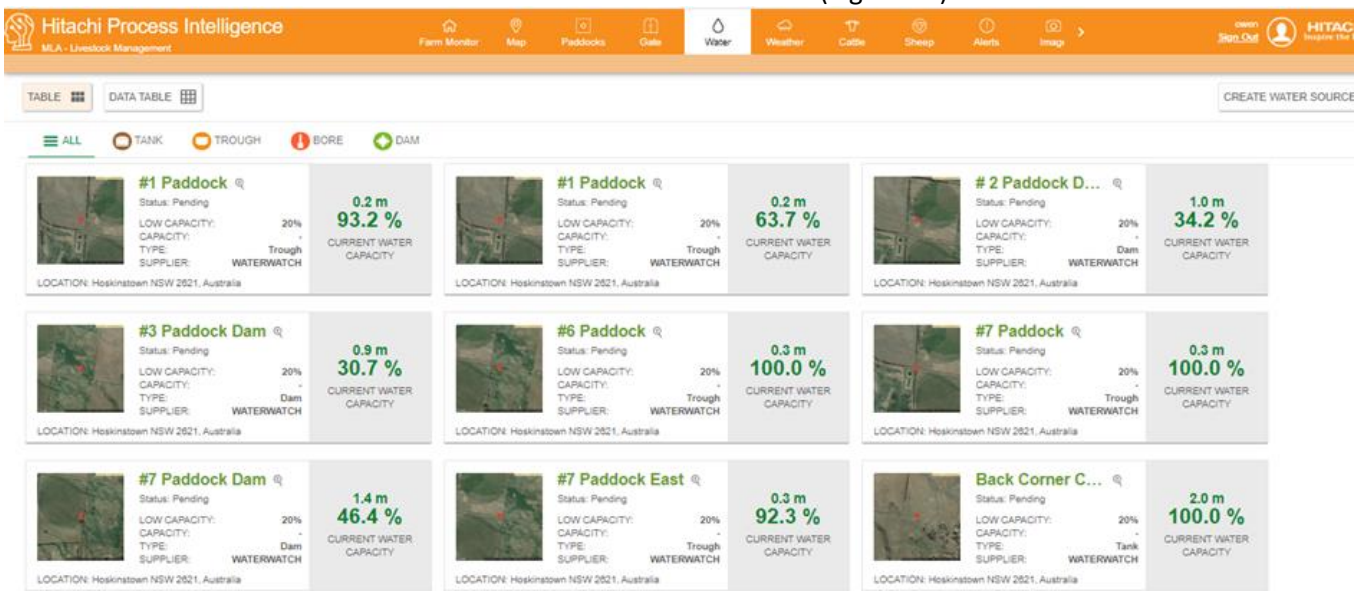

Figure 11: Water level monitoring systems

Cibolabs (https://www.cibolabs.com.au/) provided biomass information per paddock. This data was integrated into the paddock management screen which also included food on offer days (Figure 12).

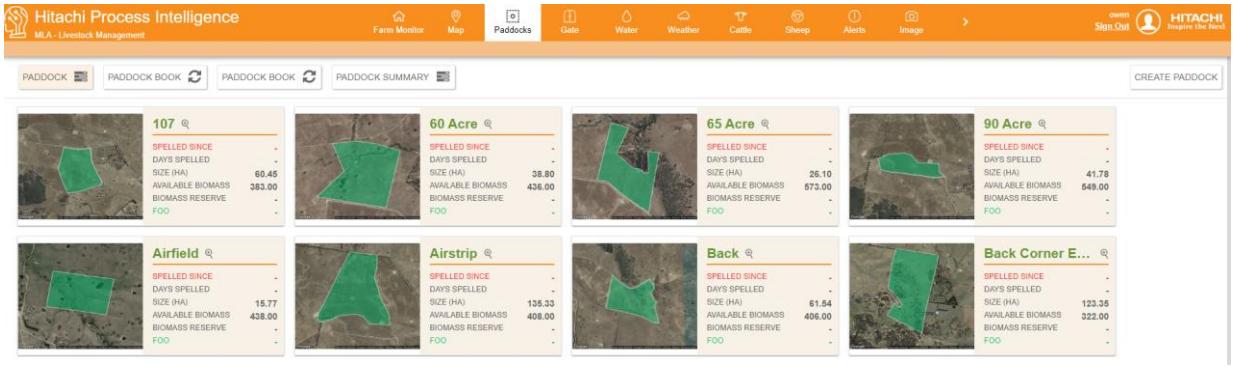

Figure 12: Paddock screen with paddock biomass data

4.2 Running the Mobile Control Centre at Carwoola

On the 22nd November 2018, there was an extreme weather event in the region, icy winds gusting up to 70 kph provided a challenge. The Mobile Control Centre provided a shelter from the elements and gave delegates an insight to how a farm can be managed with live data being integrated, aggregated and displayed in a single control centre (Figures 13 and 14)

Figure 13: Delegates enjoying a moment of sunshine

Figure 14: Delegates at the control centre, Carwoola before the high winds and rain returned

Inmarsat provided an Atom 65 Ka satellite transmitter which enabled high fidelity live video streaming of the drone images to the Smart Agriculture Control Centre (Figure 15).

Figure 15: Atom 65a Satellite Transmitter used at Carwoola

It took a large team to facilitate this demonstration**.** Inmarsat (https://www.inmarsat.com/) provided the satellite communications, Vodafone Business (https://www.vodafone.com/) provided the cellular communications, Carbonix (https://carbonix.com.au/) provided the Volanti™ drone, drone pilots and flight planning , Sunbirds™ (https://sunbirds.aero/) the solar powered drone, pilots and flight

planning, Risen Films (https://www.risenfilm.com/) produced video and photographs of the event and Hitachi Consulting Australia and India (Figure 16).

Figure 16: The extended team that ran the Mobile Control Centre and Drone Operations at Carwoola

5 Conclusions

5.1 Suitability for the application

The Mobile Control Centre proved to be the right equipment for the Carwoola Pastoral event. Easily transportable it had an ability to raise the entire back door enabling the demonstration of the Smart Agriculture Control Centre on a large flat screen television. Behind the television screen was sufficient space for the communication and computing systems as well as the for the drone control systems.

As a drone (UAV) control centre it was very practical. It provided adequate storage space for the transportation of the drones with effective dampening suspension to protect the equipment. The control centre also provided a secure base for the many communication systems required to run safe, efficient drone operations.

5.2 Future Applications

The Mobile Control Centre when deployed is an impressive system (Figure 17). Especially when showcasing the Smart Agriculture Control Centre live (Figure 18) as well as the large drone systems (Figure 19 and Figure 20) that were developed during the Eagles Nest project P.PSH.0859.

Figure 17: The Mobile Control Centre deployed at the RNA showgrounds for MLA's Beef Breakfast event

Figure 18: Demonstrating the Smart Agriculture Control Centre live

Figure 19: The Volanti™ with its 3.2 m wingspan and 2 h flight endurance

Figure 20: The Sunbird™ Solar Powered drone with 8 h endurance

6 Recommendations

It is highly recommended that the Mobile Control Centre and Drone Demonstration Unit be proactively marketed as a tool for enabling adoption of farm ready technologies.

It should be deployed at more field shows and red meat events; namely RedMeat 2020 in Toowoomba and BEEFWeek in Rockhampton. Similarly it is important to deploy this resource onto farms and enable the connection and integration of sensors and farm systems for improved decision support.