Department of Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

Murdoch University

Digital Agriculture (with drones)

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Digital Agriculture (background)

- Digital agriculture (smart farming, e-agriculture) is the use of technologies to collect, store, analyse, and share data and information for agricultural purposes.
  - Precision agriculture, IoT, Artificial intelligence (AI), Robotics
- Mobile phenotyping is the use of mobile devices to collect and analyse data related to the physical characteristics of plants, animals – all things agriculture)
- Australian Plant Phenomics Network (APPN); DPIRD is the WA-node
  - High-resolution aerial/ground imagery for precise analyses
  - Real-time data capture for time-sensitive research
  - Data packages from pipelines using advanced analytics

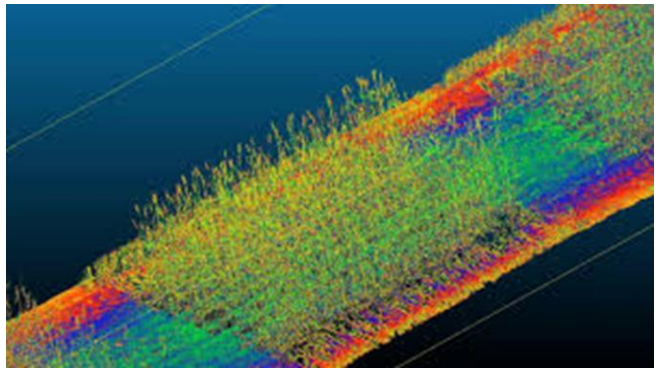
My background (with Pivotel)

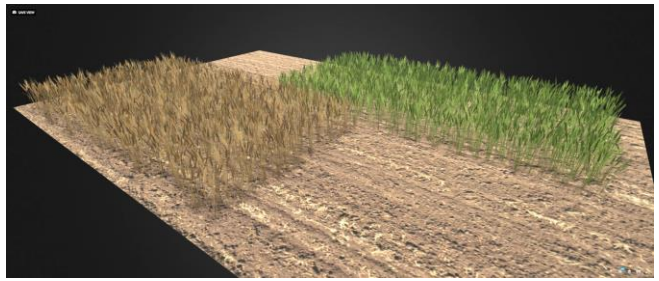
- Digital Agriculture Collaboration (2017-2021)
  - MOU with MU, DPIRD, others
  - 8 x PhD project/scholarships (two: livestream thermal for frost; IoT sensors)
- Katanning smart-farm (2021 – 2024)
  - LTE/4G network across farm; 2 towers; Starlink backhaul
- APPN/WA-node “mobile phenotyping” project (2024-2026)
  - Livestreaming drone imagery via Pivotel “Starlink-wifi-hub”

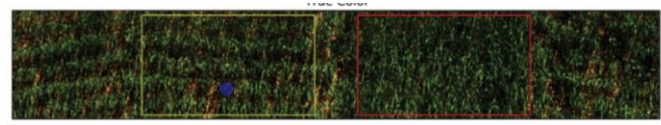
Data/images captured from these platforms produce GIS layers that are integrated with field-data enabling measurement of a range of otherwise difficult to measure traits related to plant performance

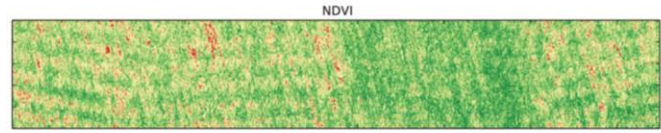
Our current projects (with Pivotel)

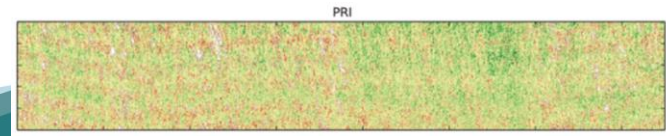
- Projects
  - 1: As part of a national pasture-nutrients project, we are looking at flying drones over trial sites to develop a calibration for identifying pasture species
  - 2: This research (grants APPN-SIF, AEA-ignite?) seeks to stitch imagery into 3D incrementally as the drone flies over a site
  - 3: This research uses UAVs to navigate obstacles and map the topography using RGB/Lidar
  - 4: This research builds off earlier DPIRD/GRDC research that measures the impact of frost on wheat/chickpeas
  - 5: This project utilises the digital-twin concept to monitor specific farm paddocks (or potentially whole farms) using routine UAV flights to monitor weed/crop health
  - 6: This project is a collaboration similar to Project 5 but involves the environmental monitoring of a specific area
  - 7: This project is a collaboration involving the facial recognition of sheep as they enter the shed.
  - 8: This project involves specialised methane-capture trailers that are networked via an onfarm private network







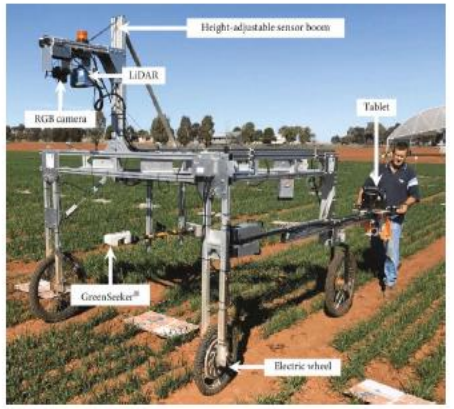




Reference: “White Paper: Unleashing Digital Agriculture with Private LTE Networks, IoT, and Edge Computing”, Pivotel, Mar-2024 [written by Dean…]

APPN “mobile phenotyping” project

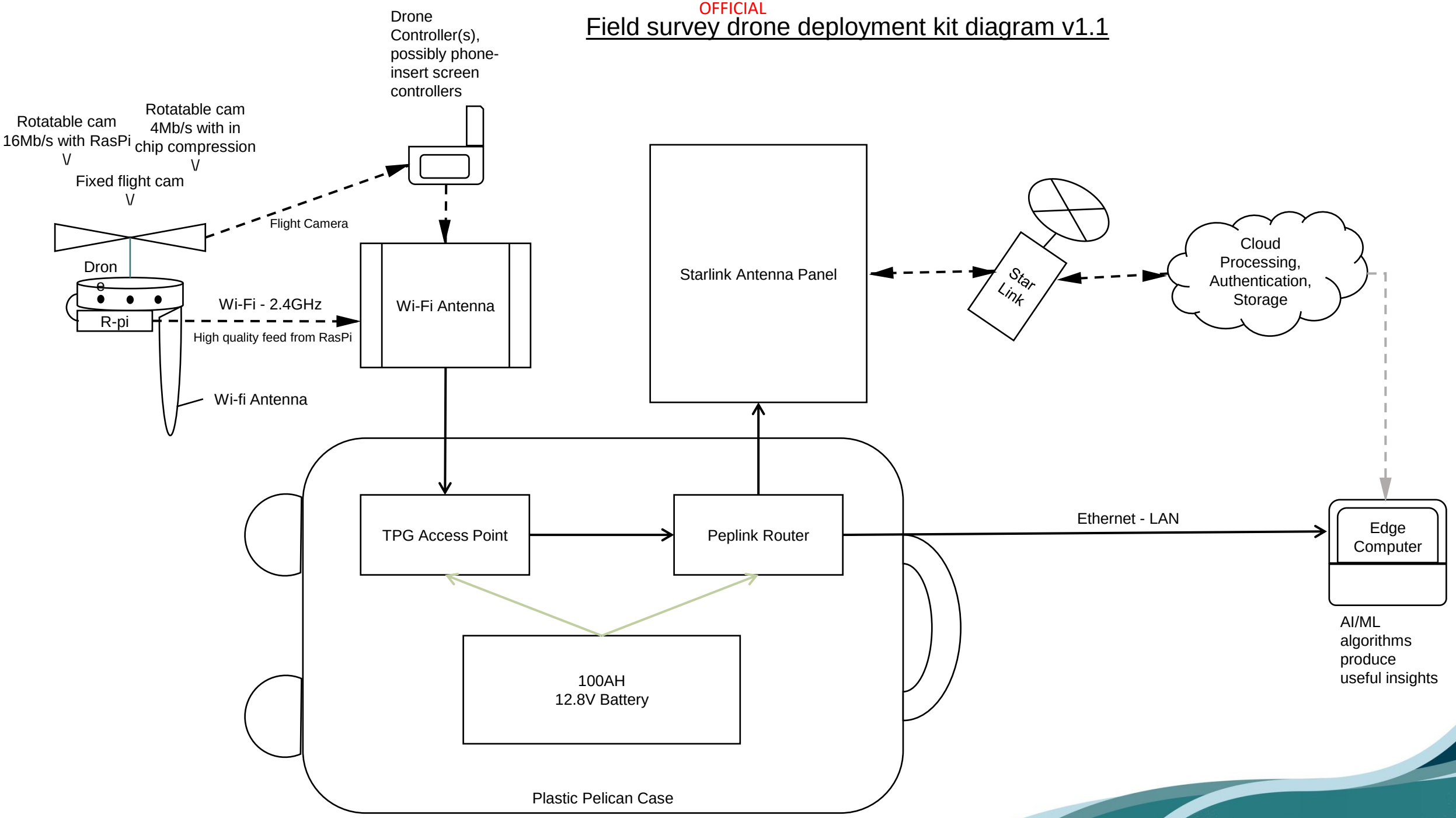
- Equipment
  - Drones (DJI M300/M350, DJI M3M, DJI mini-4, Gryfn)
    - Imagery(Gryfn) = RGB (61 MP); hyperspectal (340 bands); LIDAR (128 ch; 5.2 Mpoints/sec))
    - Imagery(M3M) = RGB (20MP); multispectral (4x5MP;G/R/RE/NIR) [simultaneous; not overlapping)
    - Imagery(mini-4) = RGB (48MP)
  - Robotics …
    - Similar as drones (but with lights…use remotely/at-night?)
  - Handheld (in field)
    - RGB, hyperspectral, thermal
  - Mobile/ute-based Starlink-wifi hub
    - Portable (< 32kg); batteries (>4hours); Starlink backhaul; wifi6/7; edge-computer; secure router/hub; plugins for: power (charge drone-batteries), internet-port, and chargeable/solar-panels; geotagged hea tolerance/lockable container (with some room to store stuff)
- Software
  - Livestreaming via DJI-customised-wifi = AVCRM-connect/live
  - Custom-build livestreaming = drone via wifi6+Pi-5 to starlink-wifi to cloud-server
    - Aim to provide more bandwidth from drone to Starlink-wifi-hub



Deery et al. 2021

	Drone - Lidar	Drone - multispectral	Drone - hyperspectral	Drone-RGB/SLR	Drone-Thermal	Drone-Diastatic-Lidar	Drone-Laser-induced-florescence
Plant-emergence	A	A	A	G	R	R	R
Ground cover	R	A	A	G	R	R	R
Plant biomass	G	R	R	A	R	A	A
Plant growth stages (Zadock)	G	R	R	A	R	R	R
Plant height	G	R	R	A	R	R	R
Stem strength	R	R	A	R	R	R	R
Flowering/head counts	A	R	R	A	R	R	R
Stay-green traits	R	G	G	G	R	R	R
Canopy architecture	G	R	R	A	R	R	R
Canopy temperature /moisture loss	R	R	R	R	G	R	R
Photosynthesis	R	G	G	R	R	R	R
Plant water stress	R	R	G	R	G	?	?
Frost damage	R	A	G	R	G	?	?
Heat damage	R	A	G	R	G	?	?

Field survey drone deployment kit diagram v1.1



Data

- APPN delivers a service using mobile equipment to collect field-based data

- Locations: research trials (~500m x 200m); paddocks/vineyards (~1.5km x 1.5km); transects/environment (several paddocks)

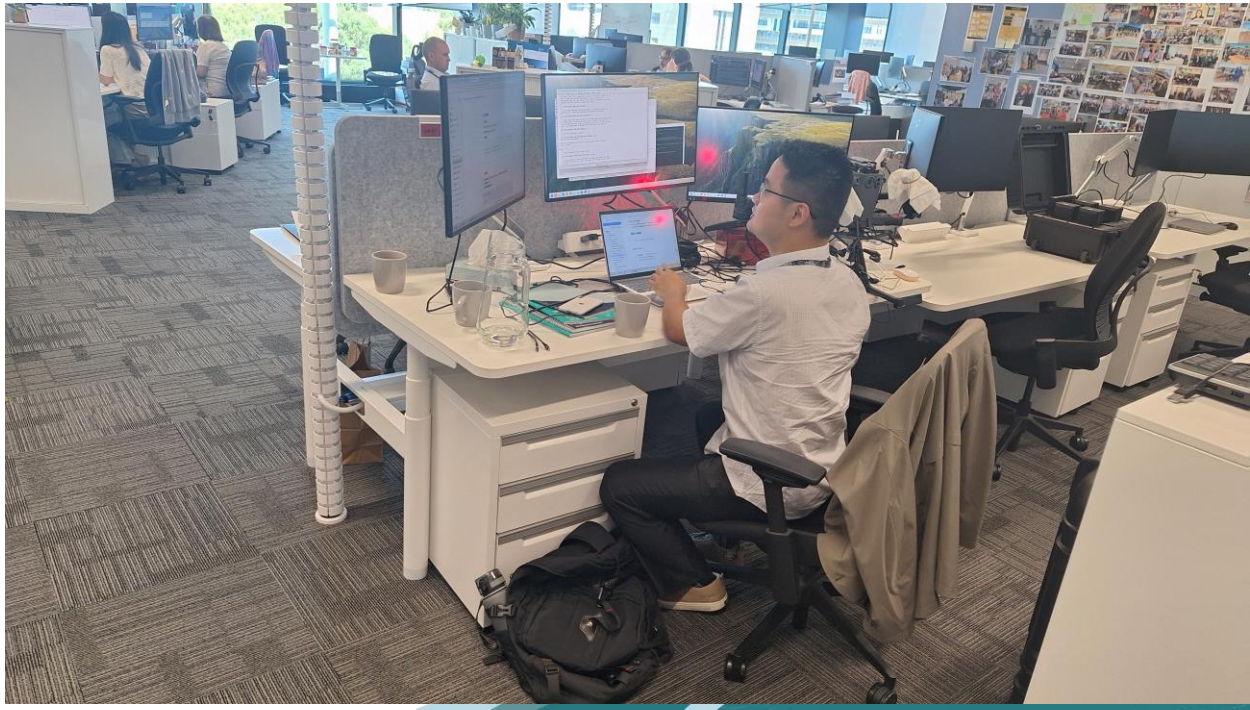
- Data at different resolutions (eg <0.2mm/pixel; 1-2cm/pixel); Higher-res data takes longer to collection (ie drone flies closer to ground); more throughput via wifi
  - RGB(low) = 200Mb [10cm resolution by 12MP camera]
  - RGB(high) = 50GB [1 cm resolution over 0.5 hectare by 42MP camera]
  - LIDAR = 1TB [high resolution, medium altitude; 30min flight]
  - Hyperspectral = 100GB [100 bands x 1000x1000 pixel image]
  - Thermal = 1TB [30fps at 640x480 for 10 min flight]
  - RGB + thermal/multispectral = 1.1TB (2 x cameras per flight)

Live-streaming

- APPN/WA-node is about delivering a mobile-phenotyping service, which includes data-design/equipment, data-collection/analyses and data-packaging/reporting.

- Locations: research trials (~500m x 500m); paddocks/vineyards (~1.5km x 1.5km); transects/environment (several paddocks)

- Issues
  - Signal range/interference
  - Bandwidth
  - Battery life
  - Image quality/stability
  - Environmental (weather, terrain/obstacles)
  - Operational (planning, equipment, CASA regulations)



Thank you

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