FINAL REPORT

Integrating autonomous aircraft into the healthcare supply chain for remote communities in the Northern Territory.

PROJECT ID: 2-011

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Table of Contents

FINAL REPORT ---- 1

EXECUTIVE SUMMARY ---- 3

1. BACKGROUND ---- 5
2. SECTION 1: PROJECT MILESTONES AND ACHIEVEMENTS ---- 7

Reasons why Milestone 4 deliverables were not met: ---- 7

2.1. SUMMARY OF PROJECT SUCCESSES PER PROPOSED OBJECTIVE ---- 9

2.2. KEY PROJECT TAKEAWAYS ---- 11

2.3. OVERVIEW OF TRIALLED REMOTELY PILOTED AIRCRAFT ---- 13

2.3.1. PD-2 from UKRSpec Systems ---- 13

2.3.2. Mugin e350 UAV ---- 14

2.3.3. Carbonix Volanti ---- 16

2.3.4. Wingcopter 198 ---- 17

2.3.5. Rigi-tech Eiger UAV ---- 19

2.4. CHALLENGES ENCOUNTERED ---- 21

2.4.1. Regulatory challenges ---- 21

2.4.2. Technical challenges ---- 22

2.4.3. Logistical challenges ---- 24

3. SECTION 2: A SAFE, SUSTAINABLE, AND COST-EFFECTIVE RPAS HEALTH CARE DELIVERY NETWORK TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY ---- 26

3.1. THE INFRASTRUCTURE AND TECHNOLOGICAL REQUIREMENTS FOR RPA HEALTHCARE DELIVERY TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY ---- 26

3.2. APPROVALS REQUIRED FOR RPA HEALTHCARE DELIVERY TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY ---- 27

3.3. ESTIMATED COST FOR RPA HEALTHCARE DELIVERY TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY (TOP END ONLY) ---- 28

3.5 PROPOSED TRIAL FOR THE NORTHERN TERRITORY ---- 32

4. CONCLUSION ---- 33
5. REFERENCES ---- 34

APPENDIX A – ILLUSTRATIVE OUTPUT FROM THE SPATIAL DECISION SUPPORT TOOL ---- 35

APPENDIX B – TRAINING PATHWAYS ---- 36

Pathway 1 – Ground-crew training ---- 36

Pathway 2 – RPAS Familiarisation Accreditation ---- 37

Pathway 3 – Certified and Licenced RPAS pilot training ---- 38

APPENDIX C – THE LICENSING REQUIREMENTS FOR OPERATING RPAS IN AUSTRALIA COMMERCIALLY. ---- 39

EXECUTIVE SUMMARY

This report presents the findings and outcomes of a 3 year research project funded by the iMOVE Cooperative Research Centre in collaboration with the NT Department of Health and Charles Darwin University. The project received $1,186,840 in research funding from the CRC with NT Health providing a 60% contribution. The project objective was to investigate the technological, budgetary, and regulatory obstacles associated with flying Remotely Piloted Aircraft System (RPAS) Beyond-visual-line-of-sight (BVLOS) in the Northern Territory and using them to transport medical items between remote communities.

This initiative marked the first application of RPAS for healthcare delivery in Australia, the inaugural trial of freight delivery via RPAS outside of an urban centre in Australia, and the first attempt to operate RPAS in and around Aboriginal land and communities. There was no blueprint or guidelines from which the research team could work in developing this project. This report comprises our learnings and findings from extensive consultations with Aboriginal Corporations, Traditional Owners, Healthcare professionals, Technologists, RPAS Manufacturers, and Australia's Civil Aviation Safety Authority (CASA), as well as the results of field trials using several different RPAS types.

This Final Report offers a high-level summary of significant project accomplishments, challenges encountered, and potential solutions. It outlines future directions to enable a safe and reliable RPAS integration into health care delivery for remote communities in the Northern Territory. The critical take-home finding was that the technology and protocols used for RPAS healthcare delivery operations in developing countries could not be readily integrated into the healthcare delivery supply chains for remote communities in the Northern Territory due to the broad distances the RPAS needed to travel, the poor mobile network coverage, and strict Australian aviation regulation. This project developed bespoke infrastructure and protocols to overcome these hurdles and the findings generated from this project will inform the advancement of remote community RPAS healthcare delivery operations in the NT and streamline the process for future initiatives nationwide. Offering a transformative, low-emissions approach to healthcare access in remote regions across Australia.

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- ***Glossary***

  CASA – Civil Aviation Safety Authority

  CASR – Civil Aviation Safety Regulation

  BVLOS – Beyond Visual Line of Sight

  LTE – Long-Term Evolution (mobile phone network)

  RF – Radio Frequency

  ROIP – Radio Over Internet Protocols

  RPA – Remotely Piloted Aircraft

  RPAS – Remotely Piloted Aircraft Systems

  NT – Northern Territory

  VHF – Very High-Frequency Radio

  VTOL – Vertical Take-Off and Landing

  ELoS – Electronic Line of Sight

1. BACKGROUND

Since the early inception of medical RPAS technology in 2016, the potential for integrating RPAS technology into global health care supply chains has been of great interest to governments and health organisations (Marks 2021; Poiesz, Wagelmans, and Bouman 2020). This includes interest in the technology's ability to improve the timeliness and cost efficiency of supply chain operations in regions where poor road infrastructure, increasing remoteness and logistical complexities create limitation to supply chain efficiency, while increasing operational and labour costs (Hundal and Laux 2020; Wang 2020).

RPAS delivery of health care has been operating in some African nations for over 7 years, providing sufficiently long data-sets from which health metrics can be determined. Haidari et al. (2016) estimated the operational and economic value of using RPAS for the delivery of vaccines, resulted in a 20% cost saving ($0.08 USD) per vaccine. It also highlighted UAV establishment and operation costs could be easily recuperated in scenarios where there were cold-chain supply chains exceeded 50 km.). According to independent studies of Zipline RPAS health care delivery in Rwanda and Ghana, RPAS logistics has significantly improved cold-chain supply chains (Ersson and Olsson 2020; Ackerman and Koziol 2019), which has led to a 51% reduction in hospital mortality rate from Potentially Preventable Hospitalisations (Ackerman et al, 2019; Joen et al 2022).

Australia is among the top ranked countries in the world for life expectancy (Mathers et al. 2001), however there are significant inequalities in health outcomes between remote populations and those living in urban environments (Dobson et al. 2010; Wakerman and Humphreys 2019). Rates of mortality and disease burden increase with increasing remoteness from major cities (Health and Welfare 2018). Additionally, remote communities are characterised by higher rates of hospitalisation and other health risk factors, in comparison to their metropolitan counterparts (Health and Welfare 2019). Such communities are further disadvantaged by reduced access to primary health care services, directly contributing to low health care utilisation and poor health status (McGrail and Humphreys 2014; Careyet al. 2013; Gruen, Weeramanthri, and Bailie 2002).

The Northern Territory is the most remote jurisdiction of Australia, with an overall population of over 240,000 (Statistics 2020); of which approximately 102,000 people occupy a remote hinterland of 1,345,000 km2 (Markham and Doran 2015). Remote populations in the Northern Territory experience poorer health outcomes in comparison to their southern counterparts across a range of health measures, including life expectancy, potentially preventable hospitalizations, avoidable deaths, and chronic disease risk factors (Zhao et al. 2013). Access to medical commodities is an important factor in the provision of timely and effective healthcare services in remote regions of northern Australia. Cold chains are particularly susceptible to bottlenecks and breakdowns due to increasing travel time and operational handling of time-critical and temperature-sensitive medical commodities from urban suppliers and remote end-users (personal communication with Top-End Health staff).

Against this backdrop The Northern Territory Department of Health approached Charles Darwin University to investigate the potential for RPAS to improve supply chain efficiency and effectiveness to remote communities in the Northern Territory.

2. SECTION 1: PROJECT MILESTONES AND ACHIEVEMENTS

Milestone	Description	Delivered
1	• Contract signed	Yes
2	• Pilot and maintenance controller recruited Aviation consultants contracted.	Yes
	• Take-off, landing locations, and flight paths planned, and permissions obtained.	Yes
	• Airframes decided upon, and agreements in place with manufacturers.	Yes
	• Safety and flight procedures developed.	Yes
	• Beyond visual line of sight requests submitted to CASA.	Yes
	• Development of spatial prioritisation tool for flight path designation.	Yes
3	• Establishment of regular RPAS flights occurring up to 100 km in the Northern Territory.	Yes
4	• Establishment of regular RPAS flights occurring up to 200 km in the Northern Territory.	Adjusted
	• Regular transport of medical items to and from remote communities using autonomous aircraft.	Adjusted
	• Development of training materials to build capacity in local communities to receive autonomous aircraft medical delivery.	Yes
5	• Final Report Submitted	Present document

Reasons why Milestone 4 deliverables were not met:

The two components of Milestone 4 that were not met were:

a*) Establishment of regular RPAS flights occurring up to a distance of 200 km in the Northern Territory.*

The reason that the 200 km distance milestone was not met was due to a combination of technological and regulatory constraints. CASA will only allow electric RPA (powered by batteries) less than 25 kg in maximum take-off weight to operate in and over urbanised areas in Australia, and there is currently no electric RPA of this weight class that can travel further than 100 km. Consequently, at the time of writing the report, only RPAS systems that are battery-powered and weigh less than 25 kg can operate around medical Centres located in remote communities, and will be restricted to a range from the take-off to landing point of less than 100km.

b) Regular transport of medical items to and from remote communities using autonomous aircraft.

While the project successfully established a regular transport system for medical items within a remote community, we faced challenges in transporting these items between different remote communities. The real potential of RPAS (Remotely Piloted Aircraft Systems) in enhancing health delivery lies in connecting remote communities. The primary issue was that mobile phone coverage is severely limited in many areas between communities in the Northern Territory, leaving pilots unable to communicate with the RPAS during flights.

In developing countries, RPAS operations often mitigate this issue by allowing extended flight periods on autopilot without requiring continuous communication with the pilot. However, Australian aviation law prohibits this approach. Since existing off-the-shelf healthcare delivery RPAs are designed for use in developing countries, we needed a novel, purpose-built RPAS to facilitate flights between remote communities in Australia. This requirement emerged only after initial workshops with CASA inspectors in the first year of the project, revealing critical insights that were not known at the project's outset.

The project dedicated substantial resources and time to address this challenge. We integrated three communication methods into the RPAS: LTE, RF, and Satellite. The aircraft can seamlessly switch between these methods based on the coverage available. Developing this technological solution took over 18 months, and it was not until November 2023 that the CDU research team received CASA approval for conducting RPAS BVLOS (Beyond Visual Line of Sight) flights between over large expanses of areas in the NT, where mobile phone coverage is not available. We are currently testing these flights at our CASA-approved test facilities, with plans to initiate remote community medical delivery flights by mid-2025.

However, since the primary goal of this project was to explore the logistical, regulatory, and cost implications of establishing a drone delivery system rather than to implement an operational model, NTG (Northern Territory Government) approved adjustments to the milestone deliverables to reflect this focus.

A. Report the technological, budgetary, and regulatory challenges in achieving long-range drone flights in the Northern Territory, with solutions and costings.

B. Undertake medical delivery drone take-off and landing in a remote Indigenous community and report upon the infrastructural, budgetary, and regulatory requirements to achieve regular transport.

The Project Milestone 4 report contains in-depth detail of the technical, regulatory and logistical challenges the team encountered trying to achieve RPAS flights between remote communities in the Northern Territory. The Milestone 4 report can be viewed here.

2.1. SUMMARY OF PROJECT SUCCESSES PER PROPOSED OBJECTIVE

Objective 1: Foster and grow local capacity to enable project deliverables

- Established a team of locally based qualified and experienced RPA pilots for safe and compliant long-distance flights to facilitate medical deliveries in remote communities.
- Assembled a team of locally based engineers for RPA fleet maintenance.
- Created a local RPA flight testing facility to trial new RPA technologies and operations.
- Developed Vocational Education qualification (CERT III aviation Remote pilot) to enable the training of new pilots
- CASA approved the research team to undertake accredited RPAS training in the Northern Territory.

Objective 2: Develop decision support tool to prioritise flight path selection

- Developed a spatial decision support tool and collected data on remote community health logistics for prioritising medical delivery routes.
- Used this tool to prioritise flight planning and shared with Stakeholders
- Used this tool to undertake assessment of the impact of community remoteness on the efficiency of Hepatitis B vaccine delivery.

Objective 3: Undertake regular RPAS flights up to a distance of 250 km along specified flight path

- Conducted trials with five RPAS from Australian and international manufacturers and tested different features and configurations for operations within remote areas of the NT.
- Developed and built two RPAS that can travel up to 100 km with 3 kg of cargo in weight and 15 Litres in mass and have the appropriate safety features for operating in and around build-up areas.
- Solved communication challenges over distances greater than 30km (maximum distance of VHF Radio communication) and poor network coverage in remote areas.
- Implemented real-time communication technologies for pilots with air traffic and ground crews.

Objective 4: Deliver some medical items by RPAS to remote communities.

- Run a local community information campaign in West Arnhem using posters, school, talks, and flyers.
- Engaged directly with Traditional Owners, Aboriginal Corporations, and other air users in West Arnhem.
- Interacted with health providers in remote communities, visited medical centres and consulted with staff and doctors.
- Developed an educational animation video for public awareness and schools, incorporating feedback from NT Health representatives.
- Demonstrated equipment to the NT Minister for Health and other relevant stakeholders.

- Established Specific Operations Risk Assessment (SORA), Standard Operating Procedures, and Emergency protocols for safe RPA flights between remote communities.
- CASA has approved the research team to transport cargo by RPA, undertake beyond visual line of sight flights in the NT, and land beyond the visual sight of the pilot.
- Secured permits for operating RPAs over West Arnhem
- Delivered medical items by RPA in and around sites within the remote West Arnhem community of Jabiru

Objective 5: Develop logistical framework to undertake emergency response flights.

- Consulted with CareFlight, NT Emergency Services, and Royal Flying Doctor Service to assess the role of RPA in emergency response flights
- Consultation with CASA revealed that RPA would need to follow designated flight routes and could not deviate from these in an ad-hoc manner. Thus, using RPA for emergency response could only occur if it was along existing flight routes.

Objective 6: Ensure sustainability of RPAS operations for medical delivery in the Northern Territory beyond the lifetime of this project.

- Secured sufficient funding from the Commonwealth Government to instigate a three-month RPA medical delivery program in West Arnhem in 2025.
- Developed a collaboration with West Arnhem-based Aboriginal Corporation (Red Lily), which will deliver health care across West Arnhem from 2025 onwards.
- Developed accredited training courses for future pilots, engineers, and ground crew.

2.2. KEY PROJECT TAKEAWAYS

I) The current technology and operational strategy used for delivering medical items by RPAS (Zipline, Swoop Aero) in developing countries is not directly transferrable for application in Australia. This is because of a requirement in Australia for the pilot to be able to communicate and deliver a command to the RPA at any point along its flight path. This is not a requirement for the RPAS currently delivering medical items in Africa.

II) The current technology and operational strategy used for delivering food by RPAS in urban areas of Australia (Wing) is not directly transferrable for remote community medical delivery. This is because the range of the Wing RPA is only 7 km from the Central Command Centre, and they only use mobile network coverage (LTE) for communication. This range will not be viable for remote community healthcare delivery, and large areas of the NT have poor or no LTE coverage (Fig. 1).

III) Whilst Radio Frequency can communicate with RPA up to 150 km from the pilot, this is only possible if the RPA is above 1000 feet. In a medical delivery program, the RPA needs to come close to the ground or land to deliver cargo, and it is at this low altitude the RPA will lose the line-of-sight connection with the pilot due to the curvature of the earth. Therefore, a bespoke solution that uses multiple forms of communication between the pilot and the RPA is required for operations in the NT.

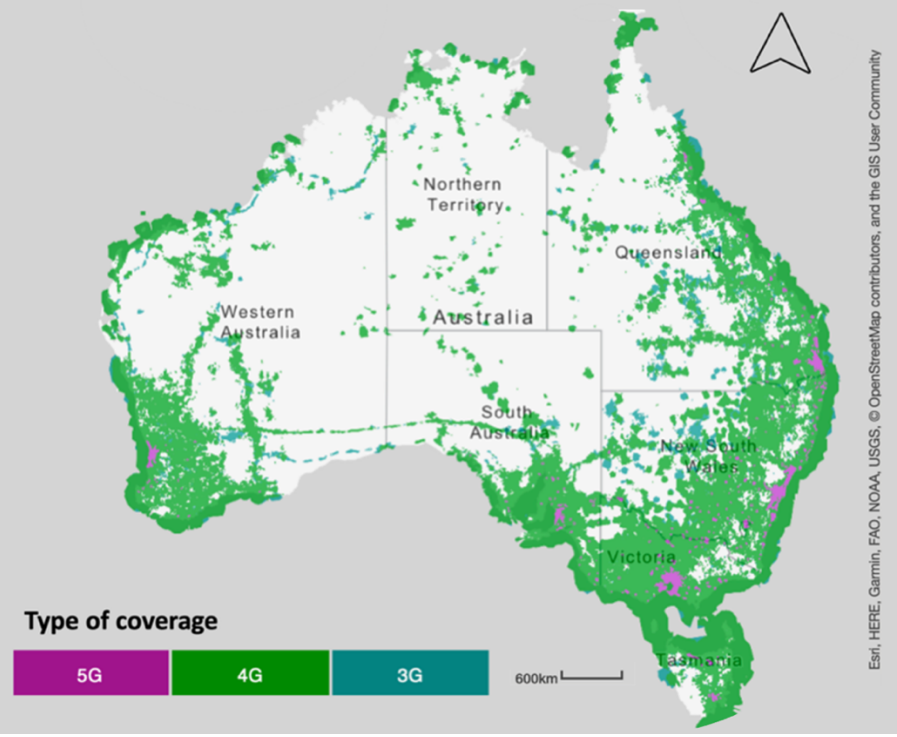

Figure 1: Mobile network coverage across Australia shows limited Northern Territory coverage.

IV) The mobile network in remote north Australia uses a particular bandwidth (band 28) not commonly used in other countries or urban and regional areas of Australia. Thus, the specific modem to communicate through band 28 is not generally incorporated into RPA.

V) RPA medical delivery to remote communities requires the RPA to fly and land beyond the pilot's visual line of sight. This requires preapproval by the Civil Aviation Safety Authority using the Specific Operations Risk Assessment. A new approval needs to be obtained for every flight area, and each requires in-depth consultation with landholders and air users and evaluation of the local air and ground risk. This process can take between 12 and 18 months to obtain.

VI) Aboriginal communities are suspicious of new technologies and are particularly wary of any sort of surveillance or spying on their lands or activities. RPA must carry cameras for safety reasons, and lengthy community engagement is needed to alleviate concerns.

VII) RPAS is still a relatively new technology, with many manufacturers and consultants vying to sell their hardware and expertise to a small group of users. Consequently, there is a lot of overstating and mistruths about the reliance and capacity of the technology.

VIII) It is a big leap between having an RPA that can transport cargo over long distances and having a safe, reliable, and commercially viable medical delivery service between remote communities. Each stage of the development of operations needs to be fully tested to ensure safety and reliability. Reputational risk needs to be considered.

2.3. OVERVIEW OF TRIALLED REMOTELY PILOTED AIRCRAFT

2.3.1. PD-2 from UKRSpec Systems



A public tender process was initiated to determine the airframe for our project, attracting applications from seven companies. These applicants were required to present to a selection committee the suitability of their RPAs for long-range medical delivery drone operations in the Northern Territory. The PD-2 UKspec Systems RPA was selected for the project following thorough evaluations. This RPA was powered by a 2-stroke petrol engine, had an impressive 8-hour endurance, and flew a range of 450 kilometres with 11 kg of cargo. Manufactured in Ukraine, the airframe was sourced through the Sydney-based supplier, DOVE AIR, for $1.2 million. However, due to budget constraints limiting the airframe expenditure to $210,000, a leasing arrangement was secured for the project's duration.

Upon finalising the RPAS selection, the research team engaged in a two-day workshop with the Civil Aviation Safety Authority (CASA) to establish safe operational protocols. Following this workshop, CASA stipulated that a fuel-powered aircraft with over 45 kg maximum take-off weight could only operate out of a designated aerodrome. Consultation with medical centre staff at Jabiru and Gunbalanya reported logistical challenges if the RPA landed at the community aerodrome because these aerodromes were often approximately ten kilometres from the Medical Centre. Recognising the impracticality of this setup for remote community RPA medical delivery, a decision was made to opt for a battery-powered RPA weighing less than 25 kg to ensure safe and compliant operations in and around remote communities.

Number of test flights in the NT = 0	
Pros	**Cons**
Over 450 km endurance	Very high cost (+$1 million)
Cargo limit of 11 kg	Petrol engine
	Communicates via Radio Frequency out to 150 km but would lose connectivity with the pilot when landing
	Requires opening of aircraft to remove cargo

2.3.2. Mugin e350 UAV



The Mugin e350 UAV, an electric fixed-wing vertical take-off and landing (VTOL) aircraft, emerged as the second-placed RPA from the Tender process, weighing less than 25 kg. This RPA featured components manufactured in China, with assembly and modification carried out by the Australian company BRALCA from NSW for long-range drone operations in Australia. Two aircraft were acquired, and trials were conducted in the Northern Territory.

Field trials demonstrated that these RPAs could cover distances over 100 km. However, our investigation revealed limitations under the Australian Communications and Media Authority (ACMA), restricting Radio Frequency (RF) communication to 915 MHz or 2.4 GHz at a power output of 0.5 Watts. Due to these constraints, effective pilot-to-RPA communication was feasible only up to a range of approximately 30 km. Furthermore, when the RPA landed at a distance from the pilot, RF transmission was hindered by the earth's curvature. This highlighted the unsuitability of RF as a source of pilot to RPA communication for remote community healthcare delivery.

Additionally, logistical challenges emerged with this airframe concerning battery and cargo exchange, necessitating intricate fuselage manipulation and Centre of Gravity rebalancing after the cargo had been offloaded. The operational complexity of these procedures made them unsuitable for personnel with limited aviation experience and training. Consequently, the research team recommended against utilising this type of RPA for medical deliveries in remote communities.

The Mugin eVTO3500 was under a long endurance flight test on Wednesday 6th July, 2022. The airframe had flown 132 km on a right-hand circuit, and as it was coming into land the aircraft went in to an uncontrolled spin and crashed. The crash investigation showed that considerable structural change in the horizontal positioning of the right wing and right prop strut resulted in a dramatic change in aircraft aerodynamics mid-flight. This caused the aircraft to yaw right and then go into a spin before impacting the ground. The aircraft was under warranty and the full amount was refunded from the company back to the project.

Number of test flights in the NT = 34	
Pros	**Cons**
135 km range	Complex to remove cargo and refuel
Cargo limit of 5 kg	Unreliable
Low cost (~$60,000)	Radio Frequency, losing connectivity on landing > 30 km

Electric	

2.3.3. Carbonix Volanti



In pursuing an Australian solution, we also tested the leading Australian RPA available in 2023, the Carbonix Volanti manufactured in NSW. Trials of this RPA were conducted in the Northern Territory alongside the Carbonix flight team. Despite performing satisfactorily in the NT, this RPA faced similar constraints to the Mugin e350 VTOL. These limitations included reliance on Radio Frequency for pilot-to-RPA communication and the necessity for skilled personnel to manage battery and cargo exchanges. Consequently, we do not advocate using the Carbonix Volanti or this type of airframe fuselage for medical deliveries in remote community healthcare settings.

Number of test flights in the NT = 12	
Pros	**Cons**
+100 km range	Complex to remove and replace cargo and batteries
Cargo limit of 3 kg	High cost to purchase
Australian Made	Radio Frequency communication
Electric powered	GPS-controlled landing with 2-4 meters error

2.3.4. Wingcopter 198



The team tested two Wingcopter 198s as potential medical delivery RPAs in the Northern Territory. These aircraft had a proven track record in Europe and the US for delivering medical supplies up to 100 km. The Wingcopter 198's specifications indicated it could transport up to 5 kg over 100 km and utilised LTE (3G or 4G mobile network) for pilot communication, addressing CASA requirements. Moreover, the design allowed easy battery replacement and cargo handling without affecting the aircraft's centre of gravity, satisfying two problems that had arisen with previous aircraft.

Multiple trials of the Wingcopter 198 were conducted at our NT flight test range, which revealed limitations that would hinder the aircraft's application as a medical delivery RPAS to remote communities in the NT. Firstly, there were intermittent failures between the Ground Control Station (GCS) during start-up and flight. This resulted in either the drone not taking off or the flight prematurely terminating and the RPA returning to landing. Secondly, the region's high temperatures and humidity affected the tilt motors and servos, impacting endurance and reliability. Thirdly, the dusty environment adversely affected the LiDAR landing system. These challenges would be inherent to remote community operations in the NT.

Further examination uncovered that poor LTE connectivity was linked to Telstra's operation of band 28, peculiar to remote areas of northern Australia. Unlike in Europe or urban Australian settings, Telstra utilises this band in remote regions to enhance signal attenuation between towers. Further, transitioning from LTE to satellite communication in the NT resulted in up to 30-second latency, surpassing Australian aviation regulations' acceptable limits. Consequently, despite successes in the US and Europe as a medical delivery RPA, the LTE communication system, and the ease of battery and cargo exchange, our trials found the Wingcopter 198 was unsuitable for reliable medical delivery RPAs in remote NT communities.

Number of test flights in the NT = 48	
Pros	**Cons**

100 km range	LTE (mobile network) communication so drops out along flight routes in the Northern Territory due to black spots
Cargo limit of 6 kg	Tilt motors and servos are sensitive to high temperatures and humidity
medium cost (~$150,000)	Non-modular airframe, so challenging to transport by vehicles
Electric power source	Single-piece airframe, so challenging to repair when in remote locations.
Easy to exchange batteries	Lands using GNSS only, which can vary by 2 to 4 meters in north Australia.
Easy to remove and load cargo without affecting RPA centre of gravity	LiDAR affected by dust upon landing
LTE (mobile network) communication with Satellite Comm redundancy	

2.3.5. Rigi-tech Eiger UAV



Based on the findings from previous trials, we engaged in an extensive assessment with manufacturers worldwide to identify airframes capable of meeting the stringent requirements for safe and dependable long-range RPA flights in remote regions of the Northern Territory. Subsequently, we opted for an electric eVTOL delivery RPA, the Rigi-Tech Eiger, originating from Switzerland. This selection was driven by the aircraft's ability to seamlessly switch between 3 different modes of communication with the GCS (RF, LTE, and satellite communication), offering versatility that we deemed essential for remote community healthcare delivery in the NT. The company also devised remote RF transmitters for pilot communication in LTE black spots and designed the RPA for easy cargo and battery exchanges by minimally trained personnel. The Rigi-Tech Eiger ensured accurate landings even in high dust environments by utilising visual QR code recognition for precise landings rather than the LiDAR system used by the Wingcopter 198. The RPA was also fitted with a modem and comms system suitable for Telstra band 28.

Initial trials to evaluate the RPA's performance in the NT's conditions and communication via the band 28 mobile network yielded successful outcomes. Subsequently, two aircraft were procured from external funding sources and outfitted with added safety features to comply with Australian regulations. These enhancements included the capability to detect and respond to other aircraft's ADSB transponders, enabling avoidance manoeuvres like altitude adjustments or altering course, and incorporating a parachute deployment system in scenarios where connection with the pilot is lost, preventing a high-speed descent to the ground.

Extensive testing has demonstrated the suitability of the modified Rigi-Tech RPA for medical deliveries in remote NT communities. These aircraft have now undergone repeated flights at our Darwin Test Flight Range, and we recommend them for further remote community medical delivery trials in West Arnhem.

Number of test flights in the NT = 94	
Pros	**Cons**
+100 km range	Piloted through a cloud, which relies upon a good internet connection, which remains a

	challenge in remote locations of the Northern Territory
Cargo limit of 3 kg, but large cargo bay	Requires cloud subscription to operate, increasing flight operational costs
Reasonable cost (~$150,000)	
Battery powered	
Easy to exchange batteries	
Multiple modes of pilot-to-drone communication LTE, RF, Sat Comm	
Easy to remove and load cargo by personnel with limited training	
Performs well in high heat and humidity	
Precision landing using a visual cue and thus not impacted by dusty environments	

2.4. CHALLENGES ENCOUNTERED

2.4.1. Regulatory challenges

In Australia, obtaining approval for flying drones beyond visual line of sight (BVLOS) entails following the Specific Operations Risk Assessment (SORA) process. Established by the Joint Authorities for Rulemaking on Unmanned Systems (JARUS), this procedure evaluates the unique air and ground risks associated with BVLOS operations. Given the pioneering nature of this project, the research team hired the assistance of aviation consultants and undertook a two-day workshop with CASA inspectors in 2020. This workshop provided a list of regulatory requirements to enable safe and compliant RPA operations between remote communities in the Northern Territory (see table below). Many of these requirements were unknown when the project proposal was submitted, and they provided a new direction for the research. The Research team worked on meeting these regulatory requirements, and a submission was made to CASA in mid-2023. The research team worked with CASA to achieve RPAS cargo delivery under Australian Aviation Regulation, and a BVLOS training instrument was awarded to CDU in December 2023. This training instrument enabled the team to conduct test flights in over 350 km^2 of the Northern Territory. The maximum distance an RPAS could be located from the pilot within this approved air envelope would be 78 km.

In July 2024, CASA undertook an inspection of the research team's RPAS operations and deemed that the research team were able to undertake safe and compliant RPA operations beyond the visual line of sight of the pilot in the Northern Territory. These operations can be conducted with the Rig-Tech airframe and can undertake cargo delivery and point to point delivery flights within the current training area. We are currently conducting BLVOS RPA flights and delivering cargo between sites within the training area envelope. Our aim is to translocate these operations to West Arnhem in 2025.

Challenge	**Solution**
Pilot must be able to communicate and interject into RPA operations throughout the entire flight.	Development of LTE–RF mesh network. This combines the mobile network, and transmitters deployed every 10 km along the drone flight paths (Fig. 2).
RPA operations into and around communities must be safe and have redundancy in case of technical failures	• RPA will communicate and send real-time video through the local mobile phone network when near a community and restrict flights to communities with mobile towers. Radio Frequency and satellite comm backup for pilot-to-drone communication in the event of a mobile network outage. • Geofence so RPA does not fly over houses and other inhabited areas.

	• RPA initiates rotor copter landing procedures in the event of loss of communication and uses a ground-facing camera for safety. Parachute deployment is available as last line of defence if RPA is uncontrolled descent. • Operations can only take off and land in communities with 4G mobile coverage. • Starlink satellite link - to act as a backup in case of network outage.
Pilot must have a real-time video link of the landing site at the freight delivery end.	RPA to be operated through a cloud that can stream over LTE, Wi-fi streaming camera at the landing site.
Pilot must have real-time communication with the Ground Crew at the freight delivery end.	Radio of Internal Protocols, with mobile phone connectivity as a backup. Live streaming of flight to tablet open by the observer
Pilot must be able to see and communicate with other aircraft by VHF Airband	RPA must have a live streaming forward-facing camera, and the ability to relay VHF Airband calls from the pilot
Must have redundancy for all of these if any failures	
RPA flights into and around urban areas are limited to aircraft below 25 kg maximum take-off weight	Electric (battery-powered) aircraft.

2.4.2. Technical challenges

Many of the regulatory challenges for RPA medical delivery in the NT can be solved by technology. However, the remoteness and environment of the Northern Territory produce its unique technical challenges. These are discussed in the table below.

Challenge	Solution
Curvature of the earth limits the range of Radio Frequency control to less than 30km.	• Development of LTE–RF mesh network. This combines the mobile network and transmitters deployed every 10 km along the drone flight paths (Fig. 2).
Poor mobile network coverage and large areas with no coverage outside of urban areas in the Northern Territory.	• Radio Over Internet Protocols (ROIP) – where the pilot relays a command by radio that is converted into a digital signal transmitted over the internet and then relayed from antennae placed at the start, midway and end of the flight path.
Ensuring the safety of other aircraft along the flight route	• Ability of drone to detect the ADSB signal from other aircraft during flight and take aversive action
Ensure safety on the ground when the drone is departing and arriving.	• RPA will land and take off from within a fenced area. • Ground crew to be able to communicate with the pilot by radio. • Pilot to have a live video feed of the take-off area, as well as aircraft and weather observations.

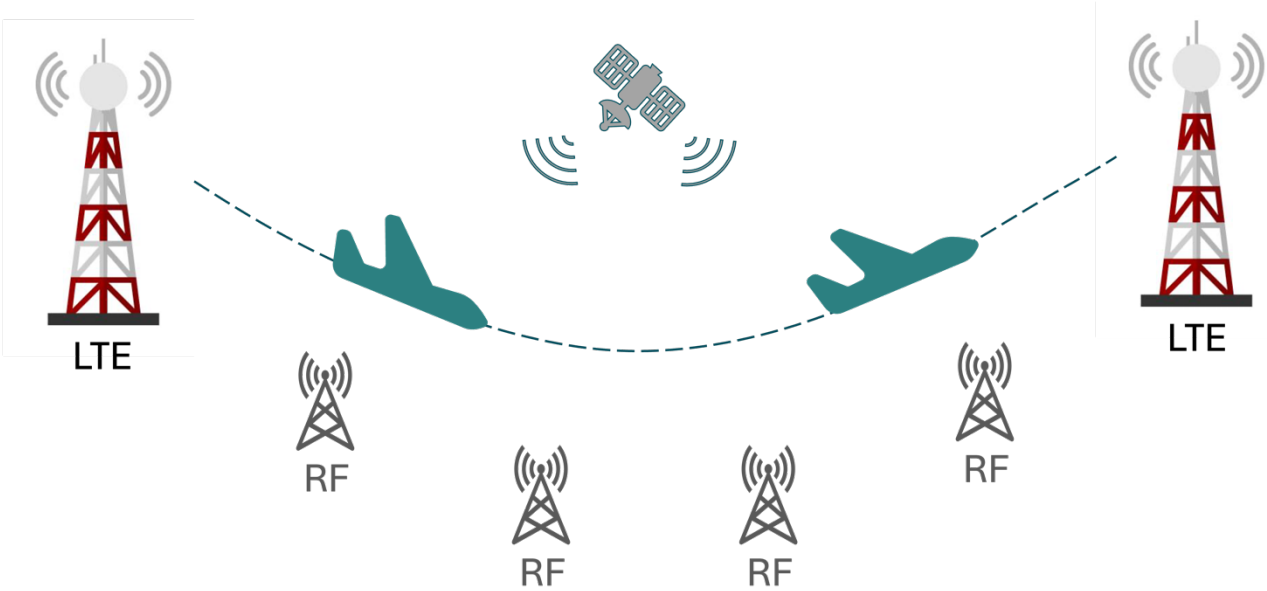

Figure 2: Schematic LTE–RF mesh network diagram with Satellite Communication.

2.4.3. Logistical challenges

Our research uncovered several logistical challenges associated with RPA medical delivery between remote communities in the NT that we were unaware of at the commencement of the project. These challenges are listed below, with solutions developed during this project for safe and reliable operations.

Challenge	**Solution**
Flights between communities will be restricted to under 100 km.	• Build shorter routes or daisy chain operations. Longer routes with heavier fuel-driven RPAs could be an option once a safety record has been established.
Radiofrequency and wattage output in Australia is regulated to a maximum range of ~30 km, and remote areas of the NT have poor or no mobile network connectivity.	• RPA must use a combination of RF, LTE, and satellite communication to enable BVLOS travel in the NT. • Install other contingencies into the airframe to reduce risk when RPA has limited connectivity (i.e., automatic detect-and-avoid geofence).
VHF air-band radio for pilots to talk with other aircraft has a limited range of around ~30 km from the ground.	• Use Starlink to route VHF calls to remote site repeaters via ROIP or have a VHF air-band output in the RPA.
Internet connectivity can be poor and unstable in remote regions of the NT.	• Use Starlink to generate a remote communication hub and plan for all RPAS to fly from an urban centre.
The link between the pilot and RPA could be lost because of poor mobile coverage in the NT.	• Use RPA with dual redundancies and additional satellite count and accuracy.
The pilot will be a considerable distance from where the RPA is taking off and landing but must have full control and be able to abort the landing if required.	• RPAs must undertake vertical take-off. • RPAs require precision landing technology. • Use a physical fenced take-off and landing pad. • Pilots and ground crew must be able to communicate effectively. • LTE at landing and live video feed from landing location. • Having an observer maintaining communication with the pilot. • Source several alternative landing areas accessible to the observer and with sufficient and adequate communication options.

RPA will require battery change and cargo offloading at the end of the flight route. Challenging and not cost-effective to have paid NACAS staff in every remote community.	• Ensure cargo and battery swaps are simple. • Develop appropriate ground crew training courses for community and Centre staff. • NACAS has developed training pathways for medical workers and the community.
RPAS must land near medical Centres to be valuable, and Centres tend to be located in the centre of the community.	• Careful planning of approach and departing flight routes in consolation with local TOs. • Ensure that RPAS does not fly over culturally sensitive areas.
LiPO batteries are flammable and can explode if not handled and stored correctly.	• Fly routes that do not necessitate a battery change in the community. • Have a central hub where flights are conducted, and battery and equipment can be stored. • Develop training courses for community ground crew support.
Observer must ensure the road is clear from vehicular traffic on the Jabiru and Civic Drive before we launch.	• RPA must have sufficient redundancies to allow overflying the road without waiting for cars to pass when near the take-off path and on approach to land. • Observer must be positioned adequately to have full sight of the flight path.
Ability for cargo and batteries to be uploaded or exchanged by personnel with limited aviation training.	• Cargo bay with outside access, foolproof mechanisms, and fault detection sensors. • Easy battery change mechanism.

3. SECTION 2: A SAFE, SUSTAINABLE, AND COST-EFFECTIVE RPAS HEALTH CARE DELIVERY NETWORK TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY

3.1. THE INFRASTRUCTURE AND TECHNOLOGICAL REQUIREMENTS FOR RPA HEALTHCARE DELIVERY TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY

- For remote community health care in the Northern Territory, we recommend the Eiger RPAS by Rigi-tech from Switzerland. This electric eVTOL RPAS can transport cargo weighing 3 kg with a volume of 15 litres up to 100 km range, undertake vertical take-off, and land close to medical centres. It is also below 25 kg and has the appropriate features for delivering medical items directly to health Centres in the urban fabric of Aboriginal communities. More suitable RPAS will become available in the future, but this is currently the most suitable RPAS for remote community health care delivery in the NT on the global market.
- The RPAS must be piloted from a centralised facility in a commercial hub, such as Darwin, to make delivery sustainable and cost-effective. We do not think having pilots within the communities will be sustainable. Therefore, the RPAS for remote community health care in the Northern Territory must be able to communicate with the pilot via cloud-based software. This will enable a single pilot to simultaneously fly multiple RPAs, significantly reducing costs through economy of scale.
- Given the limited coverage and unstable mobile network coverage in the NT, the RPA needs to have the ability to communicate with the pilot via Radio Frequency (RF), Mobile Network (LTE), and Satellite communication (Iridium). The RPA needs to be able to seamlessly switch between these modes of communication during flight and landing.
- The RPA must utilise LTE comms during take-off and landing in communities, switch to RF at altitude and when outside of the urban area and use a network of remote RF stations along the flight path (refer to Fig. 2). CASA requires operation to have redundancy for pilot-to-RPA comms and the RPA must be able to automatically switch to satellite communication if RF or LTE communication fail.
- The pilot needs to be able to communicate with other aircraft within the vicinity through Airband VHF radio. To overcome the distance, we suggest radio over internet protocols (ROIP) with RF repeaters located at the take-off and landing areas and along the flight path if required.
- The RPA must be able to geofence the flight route, so it does not fly over urban areas, airfields, or sacred sites and initiate landing if the geofence is broken.

- Aircraft must be able to detect and autonomously change direction or height to avoid other aircraft along the flight route if required.
- The RPA take-off and landing areas must be physically fenced to enable safe operations in remote communities. An area of 15m x 15 m should be sufficient, and it needs to be located at least 30 meters from inhabited buildings.
- The take-off pad requires a live video stream to the pilot and has the facilitates to enable real-time verbal communication between the pilot and ground crew. Thus, RPA medical deliveries can only be conducted in communities with the 4G mobile network connectivity capability. Starlink can also be used as backup communication.
- The take-off and landing areas also need an ADSB antenna and receiver for local aircraft detection and a weather station for real-time wind speed, wind direction, and pressure measurements. These data need to be fed to the pilot in real-time, who may be located a considerable distance away.
- Sustainable RPA operations for remote community healthcare will necessitate medical centre staff or community members' capability to load cargo, replace batteries, adhere to checklists, and communicate with pilots via radio.
- Initially led by research team members, the transition from research to the operational phase demands the education and upskilling of remote community residents and healthcare workers, all warranting certification by CASA.
- Full details of the proposed training pathways can be found in Appendix B.

3.2. APPROVALS REQUIRED FOR RPA HEALTHCARE DELIVERY TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY

RPAS operations require a Specific Operational Risk Assessment for each new medical delivery hub. We recommend that the following approvals be sought before operations commence. We have provided a rough estimate of the timeline required to obtain these (Table 1). A comprehensive list detailing aviation compliance and necessary permits and approvals to enable Beyond Visual line of sight RPAS Operations in Australia can be found in Appendix C.

Table 1. *Recommended approvals to* undertake RPAS operations in and around remote communities in West Arnhem in the Northern Territory.

Approval	**Estimated time to completion**
CASA Specific Operation Risk Assessment	12 months
Approval from Other Air users	3-6 months
Permit to fly over National Parks	~9 months, depending on location

Territorial Owner approval for all flight areas	6-12 months
Aboriginal Areas Protection Authority	1-12 months, depending on location
Land Council approval	1-6 months
Department of Foreign Affairs & Trade	3-5 months

3.3. ESTIMATED COST FOR RPA HEALTHCARE DELIVERY TO REMOTE COMMUNITIES IN THE NORTHERN TERRITORY (TOP END ONLY)

Based on financial estimates per drone hub, the cost of setting up medical drone delivery for seven drone hubs across the Darwin, East Arnhem and Katherine regions would be $7,782,000. These seven hubs would have the potential to serve 287 remote communities. The current estimates assume one delivery site (or community) per hub. Set up costs would require an additional ~ $40,000 for each additional community to be added to the network, covering infrastructure costs and two ground crew (cost could be subsidised through NTG skill development fund). Although costs will vary depending on the distance of the community from an urban area and costs of local materials and services.

The annual running cost of the seven drone hubs would be ~$6,391,000, with an additional $7,400 required for each additional ground crew member trained and accredited. As more flight routes are added to a drone hub the running costs will decrease due to shared equipment and staffing.

A full breakdown of these costs can be found in Table 2.

Table 2: *Initial cost to set up one 100km* radius flight hub RPAS medical delivery flight route in a remote community in the Northern Territory.

ITEM	**COSTS**
Salaries	
Community and stakeholder liaison Officer (1 FTE; 12 months, oncosts)	$170,000
Aviation Compliance & Safety Officer (0.5 FTE 12 months, oncosts)	$,90,000
RPA Engineer (0.5 FTE 12 months, oncosts)	$90,000
Project management (0.5 FTE 12 months, oncosts)	$105,000
Equipment	
Remotely Piloted Aircraft ($150,000 each)	$450,000
Batteries plus charging and powering facilities	$45,000
Remote site command station (could function for more than one hub)	$110,000
Community communication system	$30,000
Infrastructure for take-off and landing pad ($25,000 per pad)	$50,000 (2)
Other	
CASA fees	$12,000
Travel and accommodation costs in community	$35,000
Ground Crew training and accreditation ($7,400 per person)	$14,800 (2)

Total	***$1,111,800***

Once the RPAS hub has been set up, we estimate the annual cost to operate the hub to be around $913,000 per year. However, economy of scale will be significant and operating costs of additional hubs may be as little as 25% of running the first hub. A full breakdown of these costs can be found in Table 3.

Table 3: Annual cost to sustain a daily 100km RPAS medical delivery flight hub Northern Territory.

ITEM	**COSTS**
Salaries	
Community and stakeholder liaison Officer (0.2 FTE)	$40,000
Aviation Compliance & Safety Officer (0.1 FTE)	$14,000
RPA Engineer (1 FTE, oncosts)	$180,000
Project management (0.5 FTE 12 months, oncosts)	$105,000
RPA Pilots (2 FTE, oncosts)	$360,000
Other	
Equipment maintenance and service	$150,000
Cloud data subscription	$5,000
Travel and accommodation in remote community	$10,000
Additional Ground crew ($7,400 each)	$14,800 (2)
Third-party liability insurance	$35,000
Total	***$913,000***

3.4 THE FUTURE OF RPAS HEALTH CARE DELIVERY IN THE NT

A key finding from this project was that RPAS healthcare delivery operations currently being undertaken in developing countries were not directly transferable to remote community healthcare in the Northern Territory. This is because i) there already exists a well-financed and long-serving health care delivery service to remote communities in the NT from which any RPAS operation needs to be integrated, ii) the distances that RPAS are required to fly to be of value for remote community health care in the NT are considerably greater than required in developing country where RPAS operations are occurring, iii) mobile network coverage between remote communities in the NT is absence, and iv) aviation regulations in Australia are far more stringent than in developing countries where health care delivery RPAS are currently operating. Regardless of these challenges, our research found five scenarios where RPAS could contribute to improving the efficiency and effectiveness and reducing the cost of healthcare supply chains to remote communities in the Northern Territory. These are discussed below.

I) Scheduled RPAS delivery services (pharmaceuticals and pathology) for remote communities with a Health Centre

We believe that RPAS operations could be implemented relatively quickly between remote communities in the NT that have an existing Health Centre. RPAS operations may not be valuable for every remote community but for some communities it has the potential to significantly enhance healthcare supply chain efficiencies and reduce costs. For instance, the new Jabiru Health Centre benefits from year-round road access, while the Gunbalanya Health Centre (a 48 km RPAS flight away) faces limited access due to seasonal flooding and tidal cycles along the East Alligator River. As a result, healthcare services to Gunbalanya are delivered by manned aircraft directly from Darwin. Further, the air service to Gunbalanya lands at Oenpelli Airfield, which is approximately 12 kilometres from the health centre, and Jabiru Airfield is similarly 10 km distance from the Health Centre. An RPAS flight could transport medications and pathology samples directly between these Health Centres in less than 40 minutes door-to-door. This would dramatically reduce the opportunity for cold-chain breaches, and offers the potential to streamline and share services between the two communities

Health centres are generally located in larger remote communities. Under the Commonwealth Government's 2023 Digital Connectivity Project, most of these communities now enjoy reliable mobile network connectivity. This improved communication infrastructure, combined with Starlink technology, can address many of the regulatory requirements for RPAS operations when pilots operate beyond the visual line of sight of the aircraft, and provides a value add for the high costs involved in government schemes to improve mobile network coverage across remote regions of the Northern Territory

II) Ad-hoc RPAS delivery of time-critical items (blood, snake venom, painkillers, medications) for remote communities with a Health Centre.

Emergencies can arise unpredictably in both time and location, which means RPAS flights to address these situations cannot be pre-scheduled and must be launched on an ad-hoc basis within a short timeframe. While under this scenario, emergency flights may follow the same routes as the scheduled RPAS flights, they will require greater stakeholder engagement and enhanced safety protocols to ensure safe operations, minimise conflicts with other aircraft, and guarantee that trained personnel are prepared to receive and manage the RPAS upon arrival.

Using RPAS to deliver time-critical medical items between Health Centres will be feasible with the existing infrastructure described in Scenario I. However, we recommend initial trials use scheduled flights for supply chain restocking to assess infrastructure needs and ensure safe deconfliction with other airspace users.

III) Scheduled RPAS delivery service between outstations or remote communities without a Health Centre

The use of RPAS for healthcare delivery to outstations and communities without a Health Centre holds significant potential to reduce wait times for medications among community members. Many of these communities are located tens or hundreds of kilometres away from the nearest Health Centre and are typically connected by unsealed roads that can be impassable during the wet season. Further, if these communities have an airfield the runways are generally unsealed and not usable for many months of the year.

Whilst community members have informed us that the advantages of having RPAS delivery to these communities would be substantial, considerable challenges remain that will constrain these operations initially. These are: poor or non-existent mobile network connectivity hampers the pilot's ability to maintain real-time video and telemetry of the RPAS during landing, and lack of appropriately trained personnel available to maintain landing infrastructure, receive the RPAS, communicate with the pilot, make any required amendments to the RPAS, remove and administer the medical items on board.

One proposed solution from the staff at Gunbalanya Medical Centre was to synchronise RPAS flights to these outstations with doctor visits. These typically occur every four to six weeks to conduct patient health assessment and undertake diagnosis. If patients need to change their medication or require new medication, the doctors generally do not have these, and the patient needs to wait until the doctor’s next visit for administration. If it was possible for doctors to place phone orders for pharmaceutical requirements to the nearest Health Centre, and for these orders to be delivered by RPAS. Then medications could be administered by the doctor, reducing wait times for medication from 4 to 6 weeks to less than an hour. This RPAS scenario would also help minimise wastage, as doctors often carry excess supplies when visiting outstations or communities without a Health Centre, and these

require disposal due to the inadequate thermal conditions they are stored (personal communication with Gunbalanya Health Centre doctors).

IV) Ad-hoc delivery of emergency items between outstations and remote communities with no existing Health Centre

This RPAS scenario would have the same challenges discussed in II) and III), and for the majority of emergencies would also require medical staff to be in attendance. Value for this scenario may be for the RPAS to provide video conferencing facilities to the community or patient, temporary pain relief or first aid until trained medical staff arrived.

V) *RPAS cargo deliveries from the NT primary pharmaceutical warehouses to remote community Health Centres.*

For this scenario to add value to existing healthcare infrastructure, the RPAS would need to fly long distances (+ 300 km), and the cargo to be of sufficient size (+ 100 kg). To achieve these distances and transport this weight of cargo, the RPAS would need to be very large (exceeding 500 kg) and powered by hydrocarbon fuel. Although RPAS of this type rating being produced by numerous companies around the world, all are still in the prototype and testing phase. To our knowledge, no RPAS of this size class are engaged in commercially viable cargo delivery operations.

The Civil Aviation Safety Authority (CASA) has established a maximum take-off weight limit of 25 kg for RPAS operating in and around communities beyond the visual line of sight of the pilot. According to CASA's regulatory road map, operations involving larger RPAS are 3 to 5 years away from being approved (Civil Aviation Safety Authority, 2022), and only once safety records have been established and there is a unified national traffic management system for manned and unmanned aircraft.

3.5 PROPOSED TRIAL FOR THE NORTHERN TERRITORY

To better understand how RPAS can improve the efficiency and effectiveness of remote community healthcare delivery in the Northern Territory and provide a better estimate of costs, we propose to undertake a 3-month medical item delivery trial between the remote communities of Jabiru and Gunbalanya, in West Arnhem. This is an ideal test case for location because Jabiru maintains year-round road access with Darwin, whilst Gunbalanya, located only 48 km away, has severe road disruption due to the East Alligator River. Despite their proximity these clinics do not share facilities or supply chains, with Gunbalanya receiving all its supplies by manned aircraft from Darwin.

The proposed trial will be funded through an award from the Commonwealth's Emerging Aviation Technology Partnership (EATP) program and has approval from West Arnhem Council, Kakadu National Park, Gundjeihmi Aboriginal Corporation and Red Lily Health Board. While the project is fully funded and does not necessitate financial resources from NT Health, collaboration with existing Community Health Services and Traditional Owners is crucial. We will, therefore, establish an Advisory Board with key stakeholders to guide the project's delivery.

The trial will commence in July 2025 to align with Red Lily Health Board taking over the provision of services from the Gunbalanya Health Centre from the NT Department of Health. The trial will run as a daily service for three months. After the trial, surveys of remote communities, participants, and medical centre staff will be undertaken, as well as calculations of operating costs and improved efficiencies. These data will be used to advise upon the suitability and sustainability of RPAS integration for remote community healthcare delivery in the Northern Territory.

During the wet season, Cahills crossing and many unsealed roads in West Arnhem are impassible. Consequently, it is during the wet season, when RPAS health delivery will likely provide the most benefit. Whilst our selected RPA (Rigi-tech) can fly in rain, the wet season will bring additional complexities to operations due to high humidity and electrical storms and the inability for project staff to move between RPAS facilities and infrastructure. The first trial is proposed to occur in the dry season to make things easier, with a second trial proposed for the wet season in 2026.

4. CONCLUSION

The age demographic in Aboriginal remote communities is increasing (Statistics 2020), and with the desire by the government and Traditional Owners to support Aboriginal people to remain on their traditional lands (Australian Institute for Health and Welfare, 2020), providing effective first-world healthcare to these populations will require higher costs. This project highlighted that operating RPAS over distances sufficient to benefit remote community healthcare in the Northern Territory is technically and regulatory challenging. Whilst most of these can be addressed with existing technology, ensuring safe and reliable RPAS operations will be initially expensive. However, economies of scale will be significant as more remote communities join the network. For instance, Wing pilots in South-East Queensland manage to operate up to 30 RPAs simultaneously for food delivery over short distances. While the specific health benefits and cost savings of integrating RPAS into healthcare delivery in the Northern Territory remain unclear, the documented benefits to community health provided by RPAS operations in developing countries should not be overlooked.

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APPENDIX A – ILLUSTRATIVE OUTPUT FROM THE SPATIAL DECISION SUPPORT TOOL

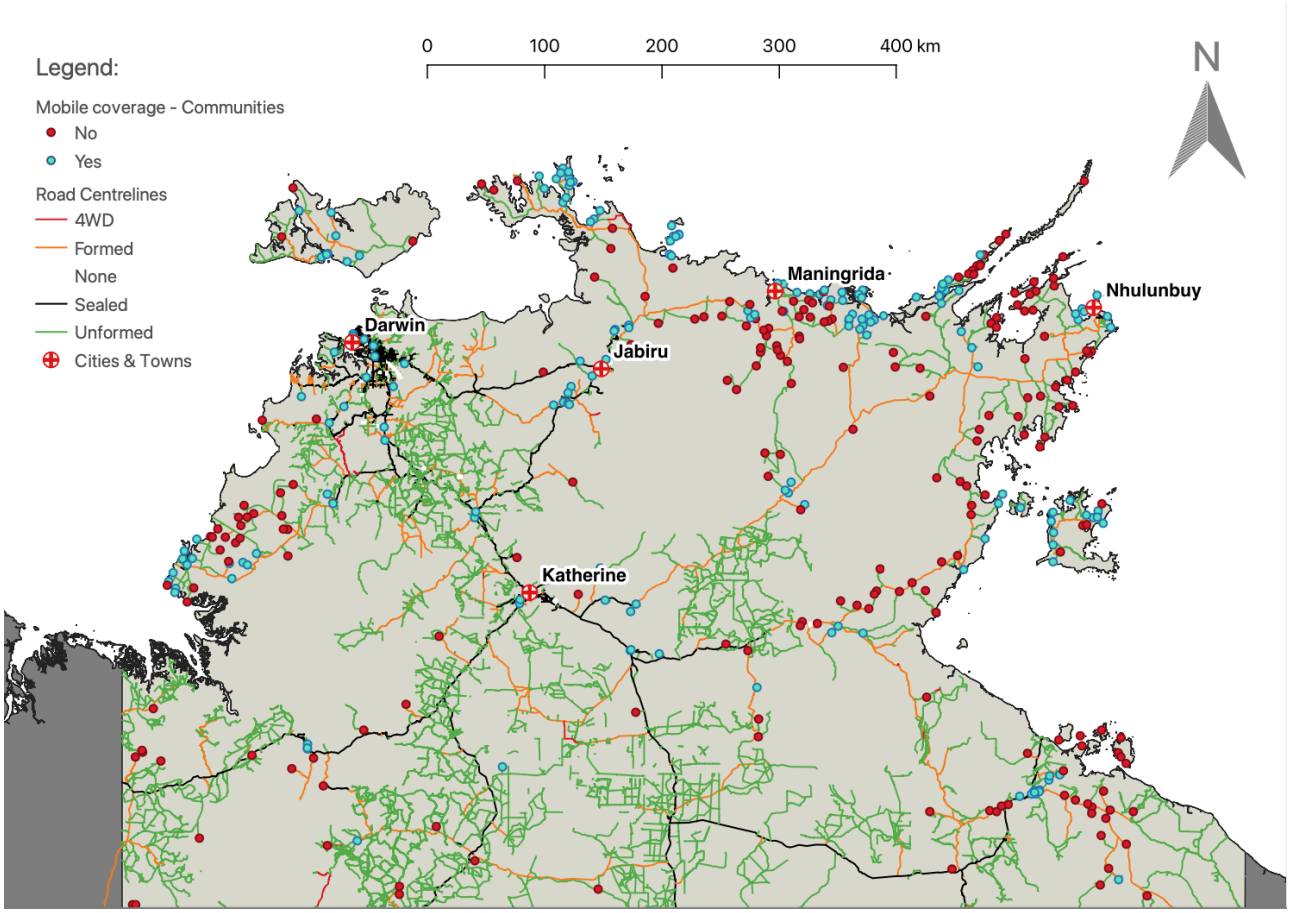

Figure A1: Map of the top-end of the Northern Territory highlighting the spatial arrangement of communities, health centres, mobile network connectivity and road infrastructure.

APPENDIX B – TRAINING PATHWAYS

Pathway 1 – Ground-crew training

This pathway will include informal training the CDU-TAFE delivers on receiving medical delivery of autonomous aircraft using RPA safely. The training will teach how to load and unload deliveries, communicate with the operator, and conduct pre- and post-flight checks.

Students will also be required to complete the following VET (Vocational Education Training) units:

Outcome: Certificate of completion of the following units

AVIW0004	Perform operational inspections on remotely operated systems.
AVIW0009	Conduct aerial delivery retrieval using remote pilot aircraft systems.

Course Description:

AVIW0004 - Perform operational inspections on remotely operated systems.

ELEMENTS Elements describe the essential outcomes.		**PERFORMANCE CRITERIA** Performance criteria describe the performance needed to demonstrate achievement of the element.
1. Prepare charts and operational plan	1.1	Suitable maps, charts, and weather briefings for intended remote operations are selected, and an operations plan and geofencing set, if required, are prepared
	1.2	Pre-operational information and Notice to Airmen (NOTAM), or industry equivalent, is accessed, analysed and applied to the operational plan
	1.3	Hazards are clearly indicated on charts, and risk controls are implemented
	1.4	Effects of wind velocity, adverse environmental conditions and contingency actions are planned for
	1.5	Lost link profile and routing are prepared and validated
	1.6	Awareness of current and forecast weather conditions is maintained
2. Complete operational inspection administration	2.1	Information about remotely operated systems is obtained, read and used to guide work as required
	2.2	Pre- and post-operational planning and documentation is completed
	2.3	Remote system operating weight and configuration are confirmed
	2.4	Pre- and post-operation technical release and remote system operation administration documentation is completed
	2.5	System serviceability is determined by approved technical inspection
	2.6	Certification of inspection for technical release is completed
3. Perform operational actions/inspection	3.1	Equipment and documentation are identified and accessible following regulatory requirements
	3.2	Internal and external checks are completed following the approved system checklist
	3.3	Deployment administration tasks and communications are conducted

	3.4	The remotely operated system is secured following manufacturer specifications and organisational procedures
4. Perform and record operational inspection	4.1	Pre-operating inspection of the remotely operated system and ancillary equipment is performed following original equipment manufacturer (OEM) documentation and operations manual
	4.2	Appropriate actions are undertaken to rectify discrepancies and are recorded
	4.3	Pre-operating inspection is recorded following the operations manual

AVIW0009 - Conduct aerial delivery/retrieval operations using remotely piloted aircraft systems.

ELEMENTS Elements describe the essential outcomes.		**PERFORMANCE CRITERIA** Performance criteria describe the performance needed to demonstrate achievement of the element.
1. Prepare for delivery and retrieval	1.1	External load characteristics and dimensions are determined and calculated
	1.2	Aerial delivery equipment is prepared and checked as required following equipment manuals and publications
	1.3	Remote pilot aircraft connection system is prepared and checked
	1.4	Safety hazards are identified and addressed using established procedures
	1.5	Remote pilot aircraft power availability is calculated to transport load effectively
	1.6	Wind speed and direction are determined, which may affect the operation
	1.7	Load-lifting location and surrounds are checked for suitability
	1.8	Plan for delivery/retrieval is followed
2. Perform load delivery/retrieval operation	2.1	Remote piloted aircraft operational checks are conducted
	2.2	Load is connected/released to/from remote pilot aircraft using the appropriate operational method
	2.3	Situational awareness of RPAS load stability and aircraft flight performance is maintained
	2.4	External load is delivered/retrieved at the nominated delivery point
	2.5	Operation documentation is completed to organisational standards
3. Respond to external load operational emergencies and abnormal situations	3.1	External load operational emergencies are identified, diagnosed and communicated
	3.2	External load operational emergency or remedial actions are undertaken to maintain flight safety

Pathway 2 – RPAS Familiarisation Accreditation

This pathway is a short course on conducting site surveys using RPAS. This micro-credential will give students a basic introduction to RPAS regulations and operations. The program has been designed to collect data on the country, so it also includes learning about collaborating with traditional owners to ensure appropriate approvals are gained. The CDU-CSIRO-NAILSMA Healthy Country digital training program supports this introductory badge.

Outcomes: Micro-credential with the digital badge.

Course outline:

Elements
Culturally safe RPAS use
Launch and land an RPAS
Fly RPAS in a controlled way
Take photos of Country from the air with the RPAS
Set up survey area in RPAS control app to work offline
Collect monitoring data of the site using RPAS



Pathway 3 – Certified and Licenced RPAS pilot training

This pathway is a full Certificate III qualification (including licencing) that will provide students with in-depth knowledge and skills required to operate multi-rotor (< 7kg) RPAS. Although this qualification will not allow individuals to pilot medical delivery RPAS, it will give them the more profound knowledge and skills required to provide higher-level support to the operations team.

Outcomes: AVI30419 - Certificate III in Aviation (Remote Pilot) + Remote Pilot Licence (RePL) - Multi-rotor < 7kg + Aeronautical Radio Operator's Certificate (AROC)

Co-requirements: North Australia Centre for Autonomous Systems (NACAS) ground-crew training.

Qualification description: This qualification aligns with Remote Pilot Licensing requirements described in Civil Aviation Safety Regulation (CASR) Part 101 — Unmanned Aircraft and Rockets and Part 101 Manual of Standards.

Remote pilots at this level will apply non-technical and technical knowledge and skills to demonstrate autonomy and judgment. They will take limited responsibility in known and stable operational contexts within established regulatory parameters.

Course outline:

Unit code	Unit name
AVIF0021	Manage human factors in remote pilot aircraft systems operations
AVIH0006	Navigate remote pilot aircraft systems
AVIW0028	Operate and manage remote pilot aircraft systems
AVIW0004	Perform operational inspections on remotely operated systems
AVIY0052	Control remote pilot aircraft systems on the ground
AVIY0023	Launch, control and recover a remotely piloted aircraft
AVIY0053	Manage remote pilot aircraft systems' energy source requirements
AVIY0031	Apply the principles of air law to remote pilot aircraft systems operations
AVIZ0005	Apply situational awareness in remote pilot aircraft systems operations
AVIE0003	Operate aeronautical radio
AVIE0005	Complete a Notice to Airmen (NOTAM)
AVIY0027	Operate multi-rotor remote pilot aircraft systems
AVIY0032	Apply RPAS payload and configuration management principles
AVIW0009	Conduct aerial delivery retrieval using remote pilot aircraft systems

Pathways 2 and 3 are currently being delivered to the public by CDU-TAFE. Therefore, we are confident they provide introductory and in-depth training on RPAS operations and management for ground crew.

APPENDIX C – THE LICENSING REQUIREMENTS FOR OPERATING RPAS IN AUSTRALIA COMMERCIALLY.

- ReOC – A Remote Operator's Certificate, which is a company certification for commercial RPAS operations issued by CASA.
- Appointed Chief Remote Pilot, whom CASA must approve after completing a CASA CRP (Chief Remote Pilot) exam.
- RePL (Remote Pilot's Licence) for all remote pilots.
- All pilots must also hold an Aeronautical Radio Operator's Certificate (AROC).
- CASA approved Operations Manual for the company, which follows CASA procedures for RPAS rules and regulations and Part 101 of the CASA Manual of Standards,

- Registration. All RPAs in the company's fleet must be registered via the CASA website.
- Public liability insurance.
- Remote pilots are licenced to operate the aircraft category type. So, for BLVOS RPA operations, each pilot must possess the following: RePL, power-lift < 25 kg rating, AROC, pass the instrument rating (IREX) exam or the BVLOS OCTA (Outside Controlled Airspace) theory exam.
- Approval from CASA is needed for the specific BVLOS operations, including the RPA model used and the flight area.
- Approval from landowners for launch and landing sites.
- Engagement with other air users.