USDOT/FAA
BROAD AGENCY ANNOUNCEMENT: 692M15-19-R-00020-02 CALL 003
Contract No. 697DCK-22-C-00269

Incorporation of Broadcast Based Remote ID (BRID) into the USS Network to Achieve Combined Broadcast and Network RID (B+N RID)

Final Report (V3)

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Executive Summary

Beginning September 16, 2023, all drone pilots who are required to register their Uncrewed Aircraft System (UAS) in the United States (US) must operate in accordance with the rule (14 CFR Part 89) on Remote ID. Safety and security are top priorities for the Federal Aviation Administration (FAA) and Remote ID for drones is crucial to integration efforts. Remote ID is the ability of a drone in flight to provide identification and location information that can be received by other parties through a broadcast signal using WIFI or Bluetooth.

However, what has not been addressed is aggregating and then re-transmitting Broadcast Remote ID (BRID) messages by converting them to Network RID (NRID) messages that can be shared in the envisioned UAS Service Supplier (USS) Network[1]. For widespread and scalable UAS Traffic Management (UTM) deployment, USS's will need the ability to track their own vehicles and other participating UAS to better manage drone operations and prevent drone collisions. With BRID information in the cloud, new use cases emerge to support public safety and law enforcement stakeholders.

Increasing the collection and dissemination of BRID information will result in several important benefits and enhancements to support safety and security in the airspace. As uncrewed aircraft operations increase, so does the risk of uncrewed aircraft being operated near crewed aircraft, or people and property on the ground, or in airspace unsuitable for these operations.

Expanding Remote ID data collection and dissemination provides increased means to identify these aircraft and locate the person who controls them (e.g., operators, pilots in command). It allows the FAA, law enforcement, and national security agencies to distinguish compliant airspace users from those potentially posing a safety or security risk. It permits the FAA and law enforcement to conduct oversight of persons operating UAS and to determine whether compliance actions, enforcement, educational, training, or other types of actions are needed to mitigate safety or security risks and foster increased compliance with regulations. Remote ID data also informs the public and users of the airspace of the US of the local operations that are being conducted at any given moment.

However, the foregone network concept was interesting for several reasons, but primarily because of the ability to receive Remote ID information through existing infrastructure without having to deploy equipment to "listen" for a radio frequency broadcast. The primary challenge with this concept is its reliance on Wi-Fi or cellular network service being available where an aircraft is flying; the concept would not work in areas lacking cellular telephone coverage.

This project successfully demonstrated the capability to convert BRID messages into NRID messages and then share that data within a USS network. In addition, this test served as a valuable mechanism to further explore crewed aircraft operator utilization of BRID messages for increased situational awareness.

[1] FAA UTM CONOPs Version 2.0, https://www.faa.gov/sites/faa.gov/files/2022-08/UTM_ConOps_v2.pdf

1. Background

This document is being submitted for Broad Agency Announcement 692M15-19-R-00020-02; Call 03 in support of the FAA Unmanned Aircraft Systems Integration Office (UASIO), UAS Program and Data Management Branch (AUS-410) requirements for a commercial entity to demonstrate or validate technologies the FAA considers essential to the safe integration of UAS in the National Airspace System (NAS). ANRA Technologies was awarded Contract No. 697DCK-22-C-00269 and this document fulfills the deliverable of the Final Report.

In partnership with the University of Nevada Reno, Nevada Autonomous and uAvionix, ANRA demonstrated the ability to collect, aggregate and re-transmit Broadcast Remote Identification (BRID) messages by converting them to Network Remote ID (NRID) messages that were shared in its Unmanned Aircraft Systems (UAS) Service Supplier (USS) Network.

The Remote ID rule (14 CFR Part 89) requires most drones operating in US airspace to have Remote ID capability. Remote ID will provide information about drones in flight, such as the identity, location, and altitude of the drone and its control station or take-off location. Authorized individuals from public safety organizations will be able to request the identity of the drone's owner from the FAA. All drone pilots required to register, including those who fly for fun, for business, or for public safety, must operate their drone in accordance with the final rule on remote ID beginning September 16, 2023.

There are three ways to comply with the operational requirements for Remote ID. The first way is to operate a Standard Remote Identification uncrewed aircraft that broadcasts identification, location, and performance information of the uncrewed aircraft and control station. The second way to comply is by operating an uncrewed aircraft with a Remote ID broadcast module. The broadcast module, which broadcasts identification, location, and take-off information, may be a separate device that is attached to an uncrewed aircraft, or a feature built into the aircraft. The third way to comply allows for the operation of uncrewed aircraft without any Remote ID equipment, where the UAS is operated at specific FAA-recognized identification areas. The requirements for all three of these paths to compliance are specified in the Remote ID rule.

During the Remote ID Notice of Proposed Rulemaking (NPRM) process, the FAA received significant feedback about the network requirement identifying both public opposition to, and technical challenges with, implementing the network requirements. The FAA had not foreseen or accounted for many of these challenges when it proposed using the network solution and USS framework. After careful consideration of these challenges, informed by public comment, the FAA decided to eliminate the requirement in this rulemaking to transmit Remote ID messages through an Internet connection to a Remote ID USS.

Without the requirement to transmit Remote ID through the Internet, limited remote identification UAS as proposed is no longer a viable concept. In its place, the FAA is incorporating a regulatory framework under which persons can retrofit an uncrewed aircraft with a remote identification broadcast module to satisfy the remote identification requirements of this rule. Though the FAA recognized during rulemaking there are potential benefits associated with establishing a network of Remote ID USS, the FAA believed for the time being and given the types of uncrewed aircraft operations that are currently allowed, the BRID solution fulfills agency and law enforcement needs to maintain the safety and security of the airspace of the US.

However, the foregone network concept was interesting for several reasons, but primarily because of the ability to receive Remote ID information through existing infrastructure without having to deploy equipment to “listen” for a radio frequency broadcast. The primary challenge with this concept is its reliance on Wi-Fi or cellular network service being available where an aircraft is flying; the concept would not work in areas lacking cellular telephone coverage. This project was intended to bridge that network capability gap until such time future rulemaking considers expanding NRID capabilities and this document offers use cases that addresses the same concept of network RID capability.

American Society for Testing and Materials (ASTM) international F3411-19 Standard Specification for Remote ID and Tracking is a means of compliance for 14 CFR Part 89. For widespread and scalable UTM deployment, USS’s will need the ability to track their own vehicles and other participating UAS to better manage drone operations and prevent drone to drone collisions. This project is foundational to enabling more advanced UTM and other third-party services.

With BRID information in the cloud, new use cases emerge to support historical, real-time and predictive uses from public safety and law enforcement stakeholders. In addition, this test bed can serve as a valuable mechanism to further explore crewed aircraft operator utilization of BRID messages for increased situational awareness.

2. Project Objective

Remote ID of uncrewed aircraft is important to address safety, security, and law enforcement concerns regarding the further integration of these aircraft into the airspace of the US. Remote ID promotes compliance by operators of unmanned aircraft by providing UAS-specific data, which may be used in tandem with new technologies and infrastructure to provide airspace awareness to the FAA, national security agencies, law enforcement entities, and other government officials which can use the data to discern compliant airspace users from those potentially posing a safety or security risk.

However, BRID information is ephemeral and proximate to the UAS, meaning the identification of the drone is only feasible if the receiver is within the WiFi or Bluetooth range of the drone. Additionally, this information is not available to the broader UTM network. Strategically deployed receivers that can transmit Remote ID messages to a USS offer the opportunity to ingest this information into the cloud. With BRID information in the cloud, new use cases emerge to support historical, real-time and predictive uses from public safety and law enforcement stakeholders. In addition, this test bed served as a valuable mechanism to further explore crewed aircraft operator utilization of BRID messages for increased situational awareness.

As the FAA builds the regulatory constructs that support increasingly advanced concepts, such as BVLOS and UTM, the US Government will need to be prepared to solve safety and security issues related to those concepts based on more mature understandings. Increasing the collection and dissemination of BRID information will result in several important benefits and enhancements to support safety and security in the airspace of the US. As unmanned aircraft operations increase, so does the risk of unmanned aircraft being operated near crewed aircraft, or people and property on the ground, or in airspace unsuitable for these operations.

Expanding remote identification data collection and dissemination provides increased means to identify these aircraft and locate the person who controls them (e.g., operators, pilots in command). It allows the FAA, law enforcement, and national security agencies to distinguish compliant airspace users from those potentially posing a safety or security risk. It permits the FAA and law enforcement to conduct oversight of persons operating UAS and to determine whether compliance actions, enforcement, educational, training, or other types of actions are needed to mitigate safety or security risks and foster increased compliance with regulations. Remote ID data also informs the public and users of the airspace of the US of the local operations that are being conducted at any given moment.

This project sought to prepare for the future by:

- USS will need the ability to track their own UAS and other UAS to better manage drone operations and prevent drone-to-drone collisions. This project was foundational to enabling more advanced UTM functions.
- With BRID information in the cloud, new use cases emerge to support public safety and law enforcement stakeholders. This project helped to advance these concepts.
- This project served as a valuable mechanism to further explore crewed aircraft operator utilization of BRID messages for increased situational awareness.
- Improving data distribution will accelerate the path to full operational NRID deployment.
- Improving ability to miniaturize, broadcast and receive modules to function on drones of all sizes and weight categories.
- Informing rule making and further integration concepts.

To do achieve these goals, the project sought to:

- Determine methods for combining the BRID messages with NRID messages using cloud-based software application as well as purpose-built BRID Nodes that are deployed in the localized area.
- Demonstrate new use cases for public safety, law enforcement, and crewed aircraft entities enabled through aggregated Remote ID information that can be shared on the USS network.
- Explore crewed aircraft operator utilization of BRID messages for increased situational awareness.
- Support the direct receipt of BRID on a smartphone application without the need for a network as a basic capability.

Ultimately, the project demonstrated a Remote ID solution, composed of a BRID module mounted on a drone and a network of ground-based receivers, designed to communicate broadcasted messages within a UTM network.

3. Approach

This project conducted an end-to-end demonstration of an architecture designed to communicate BRID messages within a UTM Network. UASs were equipped with BRID modules that met the requirements as set in the FAA's Remote ID rule. A series of ground receiver modules were deployed that received BRID messages and communicated them to the USS. The USS processed these messages in a manner that made them discoverable within the USS network. Also, the project explored the utilization of BRID messages by crewed aircraft to increase total situational awareness in the NAS.

This one-year in duration project began in August 2022 with the development of a Concept of Operations (CONOPs) followed by software and hardware development that culminated in two live flight test periods.

- Phase 1 was June 19-23, 2023, and was a UAS-only flight operation that resulted in a written report.
- Phase 2 was July 10-14, 2023, and was a joint UAS and general aircraft flight operation that resulted in a written report.

Both Phase 1 and 2 tests conducted tests using various Remote ID configurations and modalities possible with the equipment per the Remote ID rule.

3.1. Tasks

High-level tasks, milestones and deliverables for the project are listed below and depicted in a high-level schedule in Table 1.

Tasks

1. Integration and Development
2. Develop Concept of Operations
3. Design, Development, and Integration
4. Test Plan Development
5. Conduct Test and Demonstration
6. Reporting to AUS

Project Milestones

- Kickoff Meeting (Task 1.1)
- ConOps Complete (Task 2.6)
- Test Plan Complete (Task 4.1)
- SITL/HITL Bench Testing (Task 5.1)
- Phase 1 Demo: Drones (Task 5.2)

- Phase 2 Demo: Crewed Aircraft (Task 5.3)
- Final Report Complete (Task 6.2)
- Final Presentation (Task 5.4)

Project Deliverables

- Kickoff Meeting Slides (Task 1.1)
- Integrated MS (Task 1.2)
- Use Case and Scenarios (Task 2.1)
- CONOPs (Task 2.6)
- Architecture (Task 3.1)
- Interface Control Document (Task 3.2)
- Test Plan (Task 4.1)
- Bench Test Report (Task 5.1)
- Phase 1 Report (Task 5.2)
- Phase 2 Report (Task 5.3)
- Final Presentation Briefing (Task 5.4)
- Final Report (Task 6.2)

		Preparation									Test/Report				
	Task	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Deliverables
1	Integration and Development														
1.1	Kickoff Meeting		M1.1												Kickoff Meeting Slides (Task 1.1), Sep 19, 2022
1.2	Integrated Master Schedule		M1.2												Integrated MS (Task 1.2), Sep 19, 2022
2.1	Use Case and Scenarios			M2.1											Use Case and Scenarios (Task 2.1), Oct 19, 2022
2.6	CONOPs			M2.6											CONOPs (Task 2.6), Oct 19, 2022
3.1	Architecture				M3.1										Architecture (Task 3.1), Nov 19, 2022
3.2	Interface Control Document					M3.2									Interface Control Document (Task 3.2), Dec 19, 2022
4.1	Test Plan										M4.1				Test Plan (Task 4.1), May 19, 2023
5.1.5	Report											M5.1			Bench Test Report (Task 5.1), Jun 19, 2023
5.3	Phase 1 Demo Report												M5.2		Phase 1 Report (Task 5.2), Jul 19, 2023
5.5	Phase 2 Demo Report													M5.3	Phase 2 Report (Task 5.3), Aug 18, 2023
6.2.1	Monthly Reports		M6.2	M6.2	M6.2	M6.2	M6.2	M6.2	M6.2	M6.2	M6.2	M6.2	M6.2		Monthly Status Report (Task 6.2), month + 15 days
6.2.2	Quarterly Reports			M6.2			M6.2			M6.2			M6.2		Quarterly Project Management Review Brief (Task 6.2), quarter + 30 days
6.2.3	Final Reports													M6.2	Final Report (Task 6.2), 18 Aug 2023
6.2.4	Final Brief													M6.2	Final Presentation Briefing (Task 5.4), 18 Aug 2023

Table 1: High level project schedule

See Appendix A for a detailed Integrated Master Schedule.

3.2. Equipment

Demonstration tests were conducted using hardware and software components with associated supporting networks. A description of test elements used during tests included and used for Phase 1 and 2 unless otherwise noted.

- **Crewed Aircraft**
  - **CC-19-180 xCub**. (Phase 2 only) V-strut-braced high-wing, a two-seats-in-tandem enclosed cockpit accessed via doors, fixed aluminum sprung conventional landing gear and a single engine in tractor configuration, see Figure 1.
    - The aircraft has an empty weight of 1,216 lbs. and a gross weight of 2,300 lbs.
    - Take-off and landing distance required at maximum gross weight has been demonstrated as 170 ft
    - Cruise speed is 145 mph
    - Endurance is 6 hours
  - xCub was hangared at Reno Tahoe International Airport (KRNO), a 30-minute flight to the test area.
  - All flights were conducted with one pilot and one technician onboard while in VFR conditions, using air-to-ground radio communications with the Test Director. Daily safety briefs were conducted before every test day and debriefs at the conclusion of daily test activities.
  - Aircraft conducted takeoff and landings in a dry salt lake bed located approximately one mile from test location to facilitate BRID equipment checks and personnel swaps.

Figure 1: xCub aircraft flown during test

- **Hardware**

- **BRID Module** – uAvionix module broadcasts BRID signals and complies with ASTM F3411-22a Remote ID and Tracking standard.
    - Broadcast Remote ID modules typically choose a single technology as described in ASTM F3411-22a. As defined in the project proposal, Bluetooth 5 was selected as the only broadcast method. uAvionix did not support transmission of WiFi BRID data on the current product that was used for this test.
    - Size: 4.3cm(L) x 2.5cm(W) x 1.7cm(H)
    - Weight: 21gms
    - Power: internal rechargeable battery powered, USB-C charging and optional power, green light illuminates when switched on, approximate 2 hour internal battery life
    - Operation: Toggle switch on, modules acquire GPS for position, then transmits BRID messages. See Figures 2 and 3 for images of modules.
    - Quantity. There were four modules available for testing with unique IDs, see Table 2.

Figure 2: BRID module

Figure 3: BRID module with Velcro tape to fasten to UAS

BRID #	Unique ID
03	1792C000000000003
04	1792C000000000004
08	1792C000000000008
09	1792C000000000009

Table 2: BRID Module with associated Unique ID information

- **BRID Ground Receiver –** uAvionix pingRID Ground Receiver
  - LTE/Ethernet
  - Size: 11cm(L) x 6.5cm(W) x 4cm(H) (without battery)
  - Weight: 30gms
  - Power: 20 Vdc COTS battery with observed endurance of greater than 8 hours
  - Operation: Activated when battery connected and for test, mounted on tripod, see Figures 4 and 5.
  - Quantity: two

Figure 4: BRID ground receiver connected to its battery

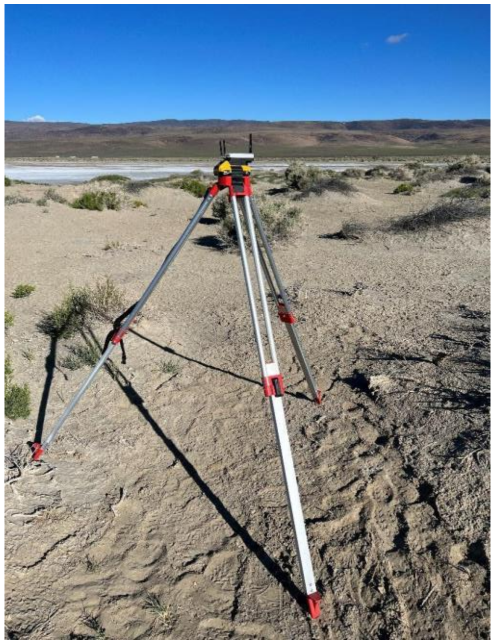

Figure 5: BRID ground receiver mounted on tripod

- **Electronic Flight Bag Receiver (EFB) -** uAvionix SkyRID
    - The EFB module creates its own personal WIFI to which the iPad gets connected, whereupon it displays the BRID module data.
    - Size: 10cm(L) x 7cm(W) x 3cm(H)
    - Weight: 50gms
    - Power: Internal battery with USB-C charging and power
    - See Figure 6 for image of EFB receiver
    - Quantity: Two

Figure 6: SkyRid EFB receiver

- One SkyRid EFB receiver was mounted on the right-wing strut and the other inside the cabin on the left window, see Figure 7.

Figure 7: Externally mounted EFB receiver on the right-wing strut and the other EFB receiver mounted inside the cabin.

- **Android Phone –** Hosted ANRA Remote ID software app.

- **iPad –** Hosted ForeFlight software app.

- **Laptop** – Hosted ANRA CTR software app.

- **Software**
  - **ANRA CTR** – Mobile and Web based software app that provides UAS Traffic Management (UTM) services and complies with ASTM F3548-21 standard on UTM USS Interoperability. Capable of providing NRID data.
  - **ANRA Remote ID** - Mobile and Web app that provides Remote ID Display Client per ASTM F3411-22a Remote ID and Tracking standard. For the remainder of this document the app is referred to as the "BRID app."
  - **ForeFlight** – Software app used for displaying BRID information for crewed aviation situational awareness. ForeFlight is an electronic flight bag for iOS and iPad OS devices designed to assist pilots and corporate flight departments with flight planning. It includes information about facilities such as airports, NAVAIDs, and air traffic control facilities. It also aids pilots in tasks including flight planning, weather monitoring, and document management, as well as an electronic logbook to help pilots record flight time.

- **Networks**: internet and cellular.

- **UAS**
  - **Censys Sentaero 5** (Phase 1 only)
    - VTOL fixed wing V-Tail
    - Electric quad motor tilt rotor system powered by a lithium polymer battery
    - Wingspan of 91 inches and is made of EPO foam.
    - Nominal flight time of 1.5 hours
    - Cruise speed of 40 mph
    - Ground Control Station and software
    - BRID module was mounted on underside of fuselage hatch, see Figures 8 and 9

Figure 8: Sentaero 5 with fuselage hatch removed

Figure 9: Sentaero hatch with BRID module mounted
on underside of hatch

  - **3DR Solo** (Phase 2 only)

- Multi-rotor quadcopter powered by a lithium polymer battery
- Dimensions are 18 x 18 x 10 inches and is made of carbon fiber and plastic.
- Nominal flight time of 20 min
- Cruise speed of 20 mph
- Ground Control Station and software
- BRID module was mounted on a pole attached to the airframe, see Figure 10.

Figure 10: Solo with BRID module mounted on pole.

- **Endurance Quad**
  - Multi-rotor quadcopter powered by a lithium polymer battery
  - Dimension of less than 0.4m and is made of carbon fiber and plastic.
  - Nominal flight time of 20 min
  - Cruise speed of 20 mph
  - Ground Control Station and software
  - BRID module was mounted to the airframe and enclosed with a cover, see Figures 11 and 12.

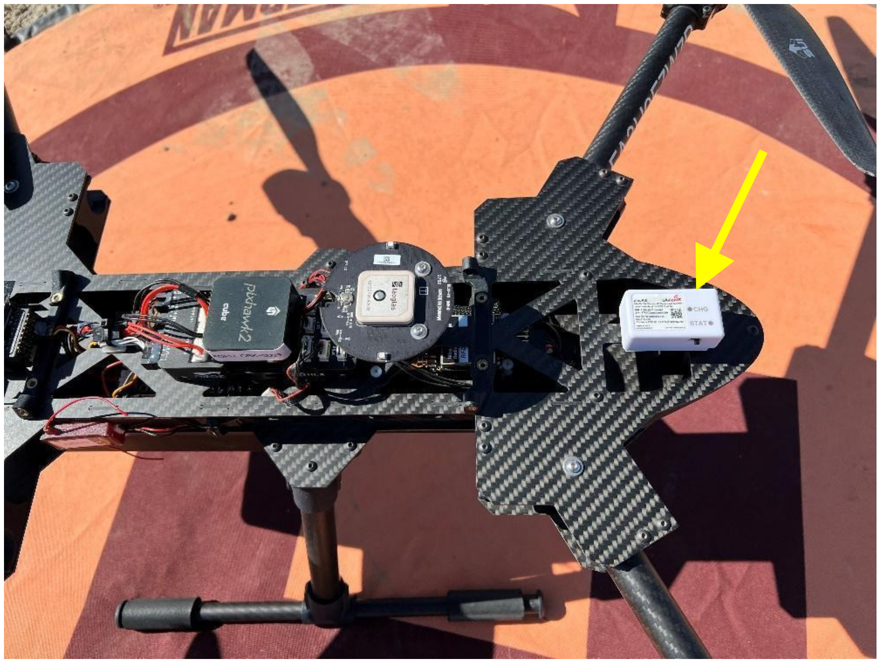

Figure 11: Endurance Quad with fuselage cover removed and BRID module

Figure12: Endurance Quad with white fuselage cover installed

3.3. Test Area

Testing occurred at an austere site located approximately 13 miles northeast of Fernley, Nevada. The site is at the north end of a salt flat that is accessible via dirt roads. The local field elevation is 4,050 feet MSL. Images of test location are depicted in Figures 13-16. This location was used for Phase 1 and 2 testing.

Figure 13: Satellite view of test area

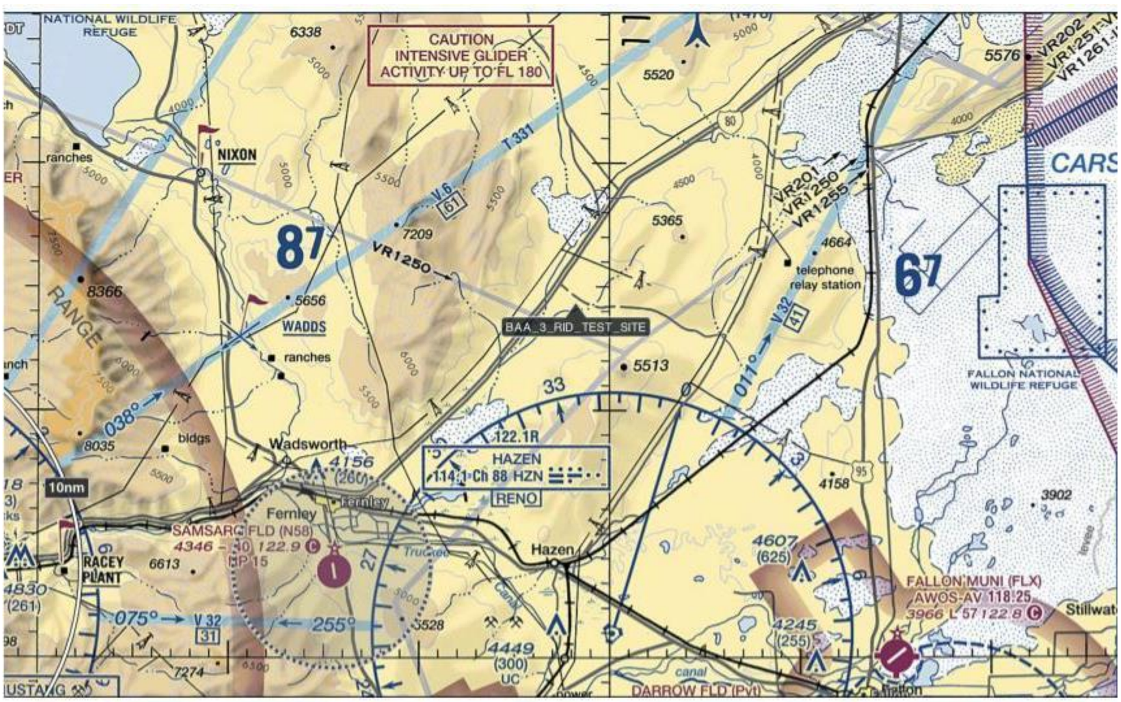

Figure 14: Test area identified on VFR Sectional chart

Figure 15: Flight test area and equipment

Figure 16: UAS landing and takeoff area

3.4. Test Organizations

Test included three organizations.

- **ANRA Technologies.** Provisioned UTM/USS and Remote ID related software and architecture that enabled the BRID technology featuring:
  - Software that shares BRID messages over a USS network.
  - BRID gateway that converted BRID message data into NRID messages.
  - Deployed USS services to include Remote ID gateway, Remote ID Service Provider, Remote ID Display Client and Remote ID Display Provider

- Deployed UTM
- Deployed cloud services

- **uAvionix.** Provisioned BRID related hardware and associated software featuring:
  - Developed Bluetooth BRID modules
  - Developed a prototype specialized networkable ground receiver to receive BRID messages and convert them into an industry standard format for ingestion into the ANRA environment.
  - Developed a BRID receiver that has Wi-Fi hotspot capability that will convert BRID messages received into GDL90 standard protocol for ingestion into Electronic Flight Bag applications.

- **University of Nevada Reno, Nevada Autonomous.** Provided safety of flight to include planning, operations, and test range management. Provisioned UAS, support equipment, and 14 CFR Part 107 and 91 operators for flight operations to include:
  - Crewed and uncrewed aircraft and support equipment
  - One tow vehicle (F-150) and 6'x10' Trailer
  - One large awning for ANRA/uAvionix Team
  - One Small Awning for Flight Operations
  - Coolers/Ice/Water (All)
  - 2x Generators
  - Fire extinguishers
  - Electrical Extension Cords
  - Four Tables
  - Four Folding Chairs
  - Several Canvas Chairs
  - Toilet paper

3.5. Roles and Responsibilities

List of personnel that supported testing identified in Table 3.

Organization	Role	Name
ANRA Technologies	Test Director	Brent Klavon
	Field Engineer	Ashish Nair
University of Nevada Reno, Nevada Autonomous	Flight Director / ASO	Mark Genung
	Support (Phase 1)	Carlos Cadillo
	VTOL RPIC/xCub Observer	Matt Bonini
	VTOL RPIC (Phase 2)	Richard Kelley

	VTOL Tech Support (Phase 2)	Cheryl Contreras
	xCub Pilot (Phase 2)	Ryan McMaster
uAvionix (Phase 1)	Field Engineer	Nick Inocencio
Police Department A (Phase 1)	Sargeant	
	Motor Officer	
Police Department B (Phase 1)	Police Officer 2	

Table 3: Test personnel

3.6. Safety Review Board

UNR conducted a Safety Review Board with test participants prior to each phase. The Operation Risk Matrix provided in Tables 4 and 5 for Phase 1 and 2 respectively.

		Probability				
		Frequent	Likely	Occasion al	Seldom	Unlikely
	Catastrop hic					Environm ent Hazards
	Critical					Drone (Ground)
	Moderate				Flight Crew sAUV Failure	Drone (Mid-Air)
	Negligible					

Table 4: Phase 1 Operational Risk Matrix

		Probability				
		Frequent	Likely	Occasional	Seldom	Unlikely
Consequence	Catastrophic				GA Operations	Environment Hazards
	Critical					Drone (Ground)
	Moderate				Flight Crew sAUV Failure	Drone (Mid-Air)
	Negligible					

Table 5: Phase 2 Operational Risk Matrix

All areas of risk were deemed to be mitigated to acceptable levels of risk.

4. Demonstration / Verification Results

Demonstration tests were designed to validate the functionality of all Remote ID system components. Testing was conducted with project partners in Reno, NV., and followed Test Plan guidance unless otherwise stated.

All flight operations were conducted under 14 CFR Part 107 and Part 91 and did not require a waiver or exemption from the FAA. The test site was located at an austere location - a salt flat located in Class G airspace. During multi-UAS operations, separate airspace volumes were assigned to uncrewed aircraft to deconflict flight operations. During xCub flight operations, 14 CFR Part 91 criteria were maintained. Demonstration flight data is summarized in Table 6

<table>
<tr><th>Phase</th><th>Date</th><th># of Mission</th><th>UAS</th><th># of Sorties</th><th>Flight Duration (HH:MM)</th></tr>
<tr><td rowspan="6">1</td><td rowspan="2">June 20</td><td rowspan="2">2</td><td>Sentaero</td><td>2</td><td>00:26</td></tr>
<tr><td>Endurance</td><td>1</td><td>00:12</td></tr>
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<tr><td>Endurance</td><td>6</td><td>01:13</td></tr>
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<tr><td>Endurance</td><td>2</td><td>00:37</td></tr>
<tr><td rowspan="9">2</td><td rowspan="3">July 11</td><td rowspan="2">3</td><td>Solo</td><td>3</td><td>00:40</td></tr>
<tr><td>Endurance</td><td>3</td><td>00:35</td></tr>
<tr><td>1</td><td>xCub</td><td>1</td><td>02:22</td></tr>
<tr><td rowspan="3">July 12</td><td rowspan="2">7</td><td>Solo</td><td>7</td><td>01:24</td></tr>
<tr><td>Endurance</td><td>6</td><td>00:47</td></tr>
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<tr><td>Endurance</td><td>3</td><td>00:51</td></tr>
<tr><td>1</td><td>xCub</td><td>1</td><td>02:16</td></tr>
<tr><td colspan="3"></td><td>Total</td><td>50</td><td>18:17</td></tr>
</table>

Table 6: Summary of operational live flight data

4.1. Verification Summary

Demonstration followed the Test Plan (separate document) and achieved the successful demonstration of converting BRID message data into NRID messages that were shared in a UTM environment. Other high-level results include:

- **BRID-NRID.** BRID module mounted on board an airborne UAS transmitted messages via Bluetooth to a ground receiver that then transmitted BRID data via a cellular connection to a dedicated URL that was converted into NRID message using a BRID Gateway, then subsequently displayed in a USS.
- **BRID app (mobile device)**. BRID module on board an airborne UAS transmitted messages via Bluetooth and received on a mobile phone device and then displayed using a Remote ID Display Client app.
- **BRID app (mobile device)**. Remote ID Display Client on a mobile phone device allowed authorized users (law enforcement) using a password to access a mock FAA database to correlate received BRID messages with a unique identification number to gain additional information about the registered operator.
- **BRID and NRID switching.** BRID module mounted on board an airborne UAS that is also connected to a USS for UTM, successfully switched to NRID when the BRID signal was no longer available.
- **Crewed aircraft situational awareness.** In-cockpit crewed aircraft EFBs provided situational awareness of the location for nearby BRID equipped drones.
- **Public Safety/Law Enforcement.** Police saw value in BRID but desired to see BRID information being networked as NRID for the long-term solution.
- **BRID Signal Range**. BRID module signal strength and associated reception range assessment are not in scope for this project. However, due to the elevated level of FAA interest expressed on this topic, we did conduct ad hoc tests that observed the following BRID Bluetooth 5 signal ranges:
    - Distance for ground-based, handheld BRID module transmitting to the prototype ground-based receiver: 800-900 feet.
    - Distance for BRID module mounted on flying drone transmitting to a mobile device with BRID app: 1,850 feet.

The remaining sections provide more details about results.

4.2. Architecture

Demonstration tests were conducted using the architecture depicted in Figure 17.

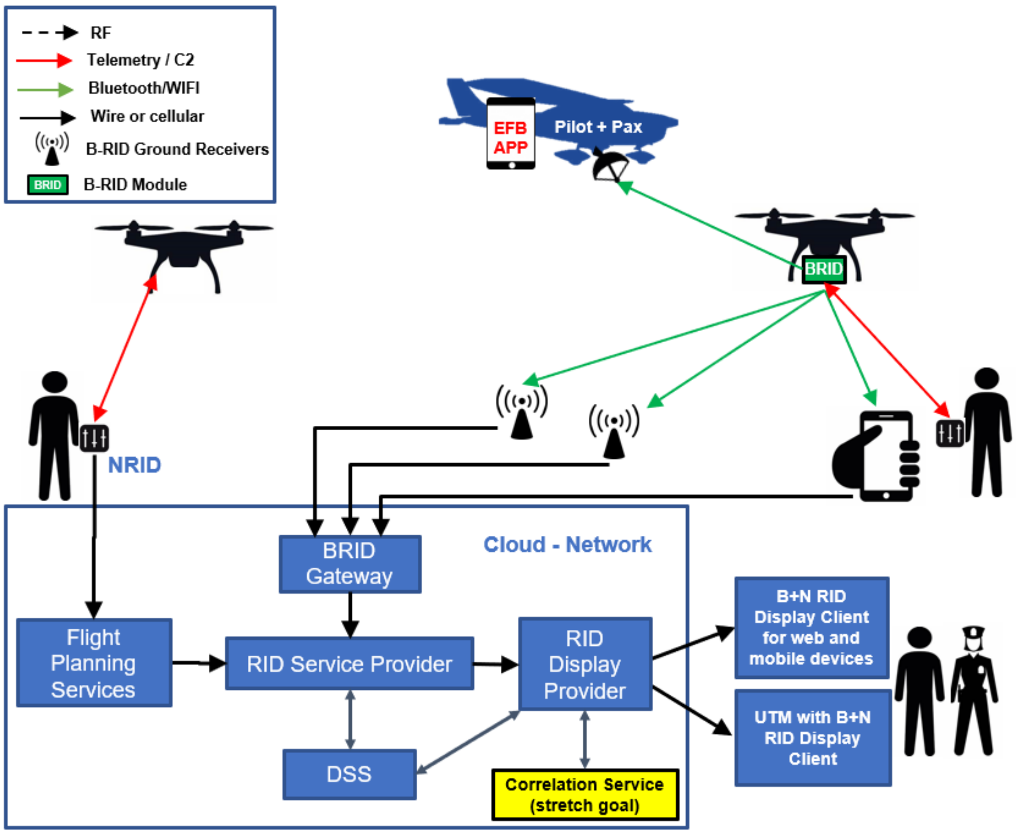

Figure 17: Test architecture

4.3. Verification of Nominal BRID

Purpose: Tested nominal direct BRID to mobile device receiver and display application.

Description: Direct method of a mobile device receiving a BRID transmission directly from a BRID equipped UAS. See Figure 18 that depicts the functional test areas.

Figure 18: Functional area for test

Test Objectives

- BRID messages are received by a mobile device
- BRID data is displayed on BRID app
- BRID information displayed per Remote ID standard
- Show location of launch point for aircraft on app
- Show flight path for UAS with attached module

Equipment Requirements

- (3) BRID modules deployed
- (1) BRID app installed on mobile device
- Cellular connection for mobile device

Results
Successfully achieved all objectives.

In Figure 19, the app screenshot depicts:
- The two teal-colored icons identify the launch locations for each UAS.
- The single, blue dot depicts the current location of the mobile device on which the BRID app is operating and receiving BRID messages.
- The three drone icons identify the locations of three BRID modules.
    - The red lines show the flight path for each drone.
    - The northernmost drone icon correlates to a ground based, stationary BRID module, see Figure 20.

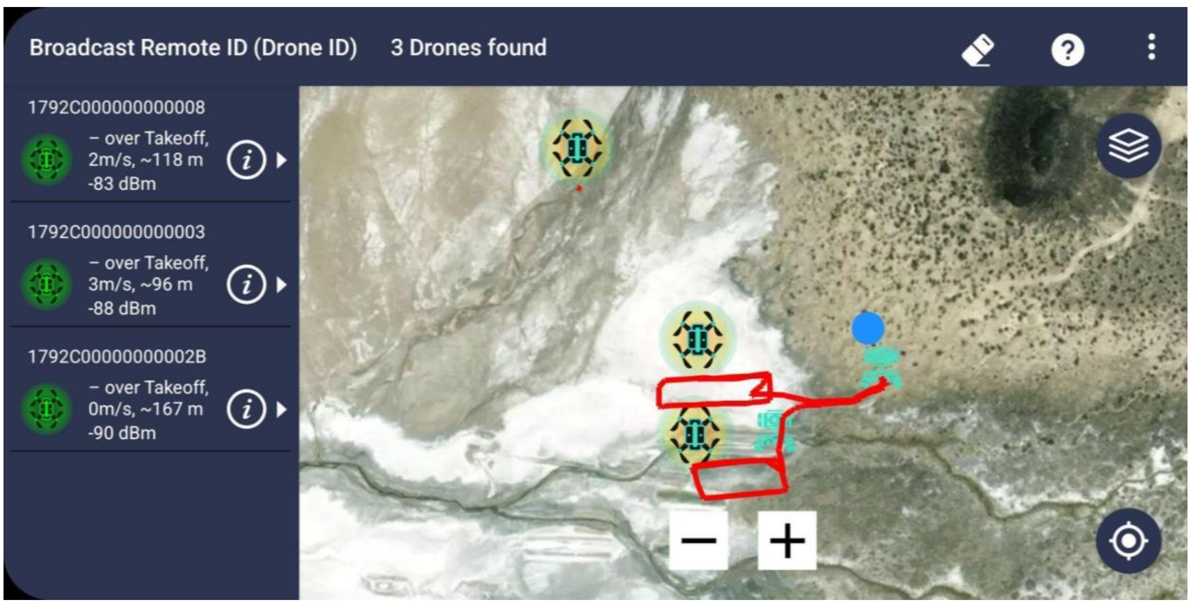

Figure 19: Screenshot of BRID app (mobile) depicting BRID modules, takeoff locations, and mobile device location.

Figure 20: Ground based, stationary BRID module with attached battery pack

BRID app (mobile) permitted users to select a drone and obtain details per the standard, see Figure 21.

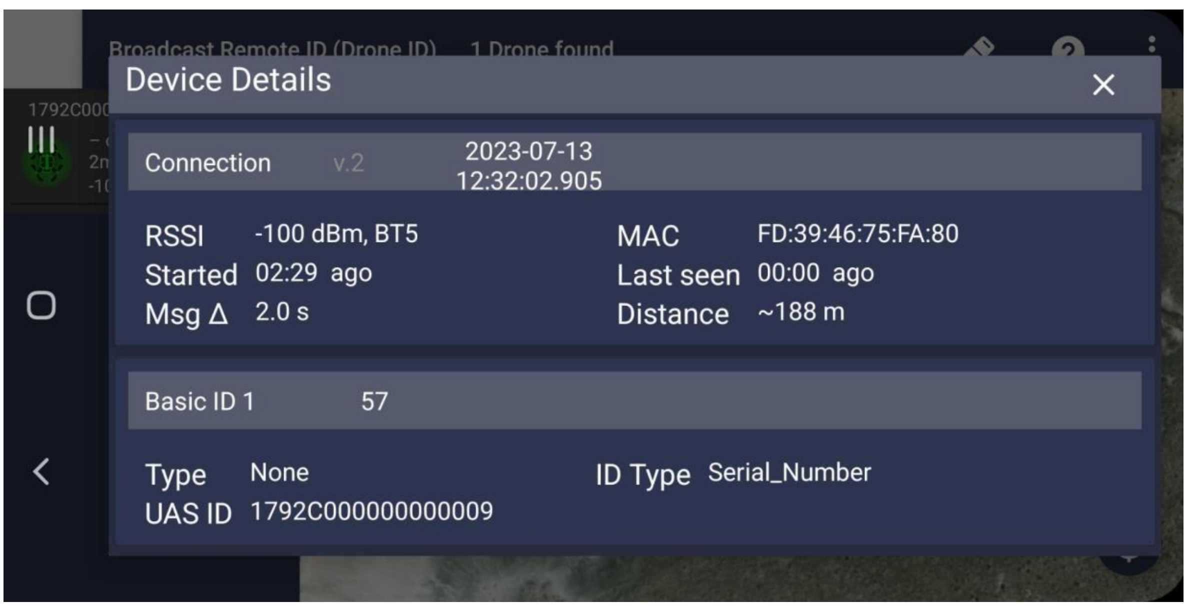

Figure 21: Screenshot of BRID app (mobile) providing information per the standard

4.4. Verification of Nominal NRID

Purpose: Test nominal functionality for NRID.

Description: UAS connected to a USS provides NRID. See Figure 22 that depicts the functional test area.

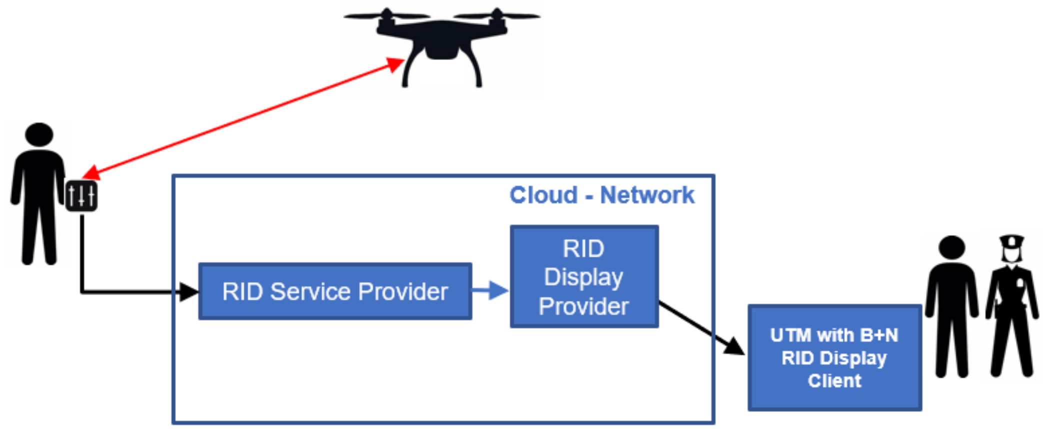

Figure 22: Functional area for test

Test Objectives

- NRID data displayed on ANRA CTR app (mobile and Web) per standard

Equipment Requirement

- (1) GCS connected to UAS
- (1) ANRA CTR app
- Internet

Results

Successfully achieved objectives.

The app screenshots in Figures 23-26 depict:

- ANRA CTR app (Web) displaying BRID messages that were converted into NRID messages and provided Remote ID information per the standard.
- ANRA CTR app (mobile) displaying BRID messages that were converted into NRID messages and provided Remote ID information per the standard.

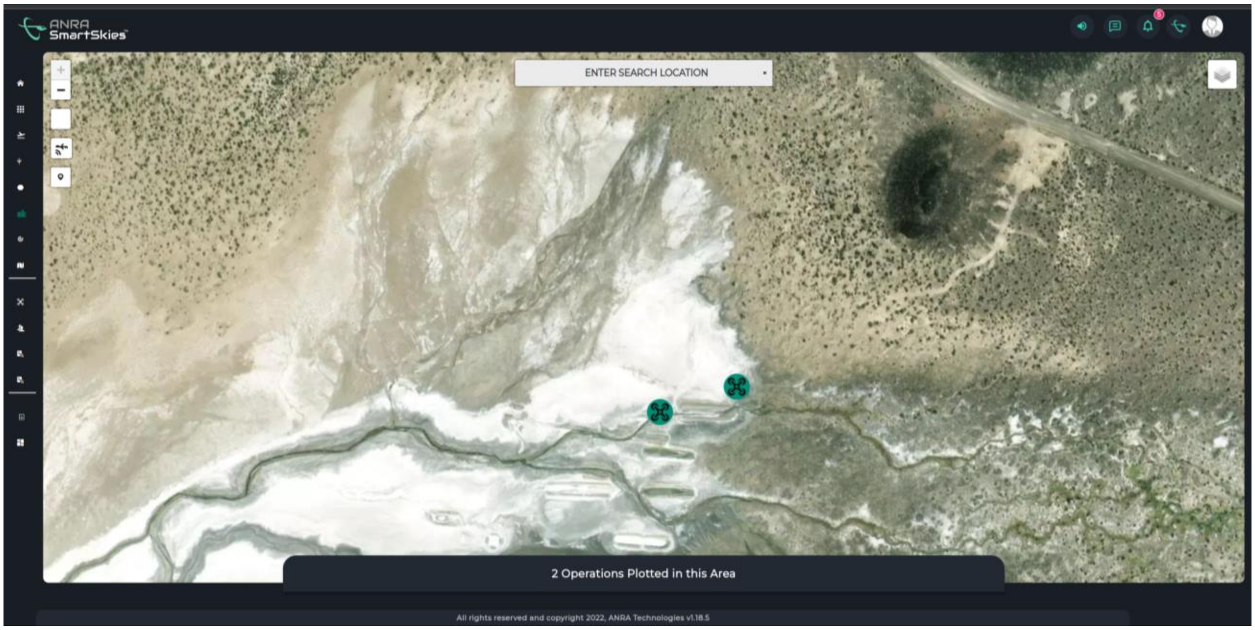

Figure 23: Screenshot of ANRA CTR app (Web) displaying NRID capabilities

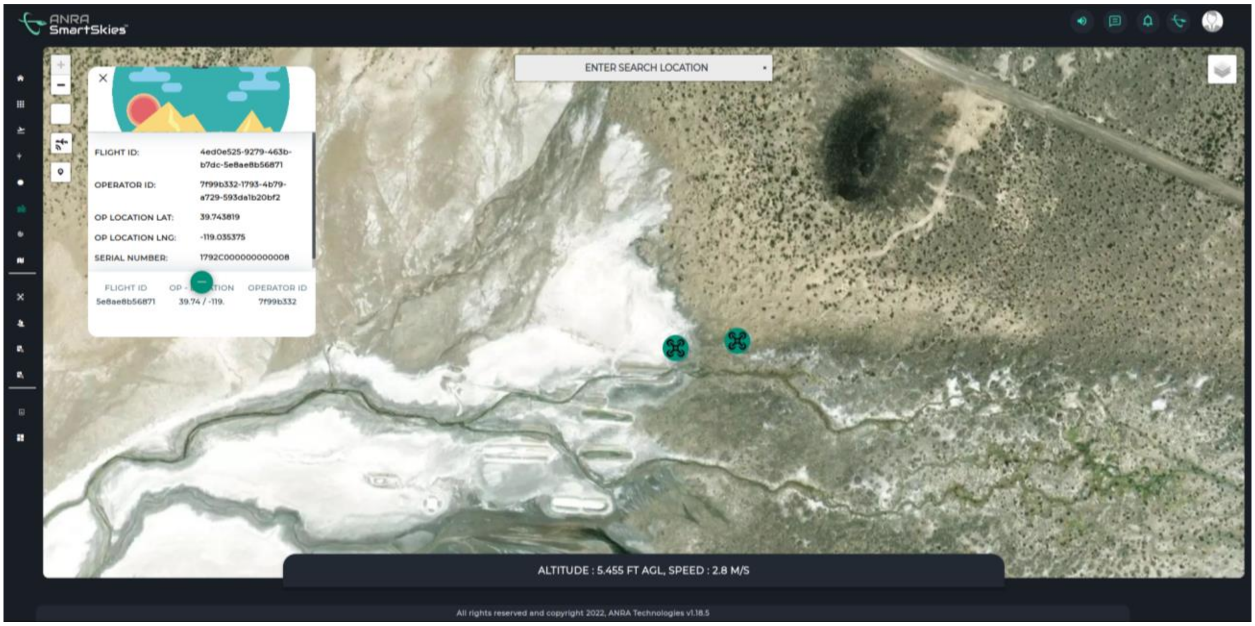

Figure 24: Screenshot of ANRA CTR app (Web) allows the user to select a drone to obtain additional Remote ID details upon clicking on the drone icon.

Figure 25: Screenshot of ANRA CTR app (mobile) provided NRID capabilities, depicting two BRID equipped drones

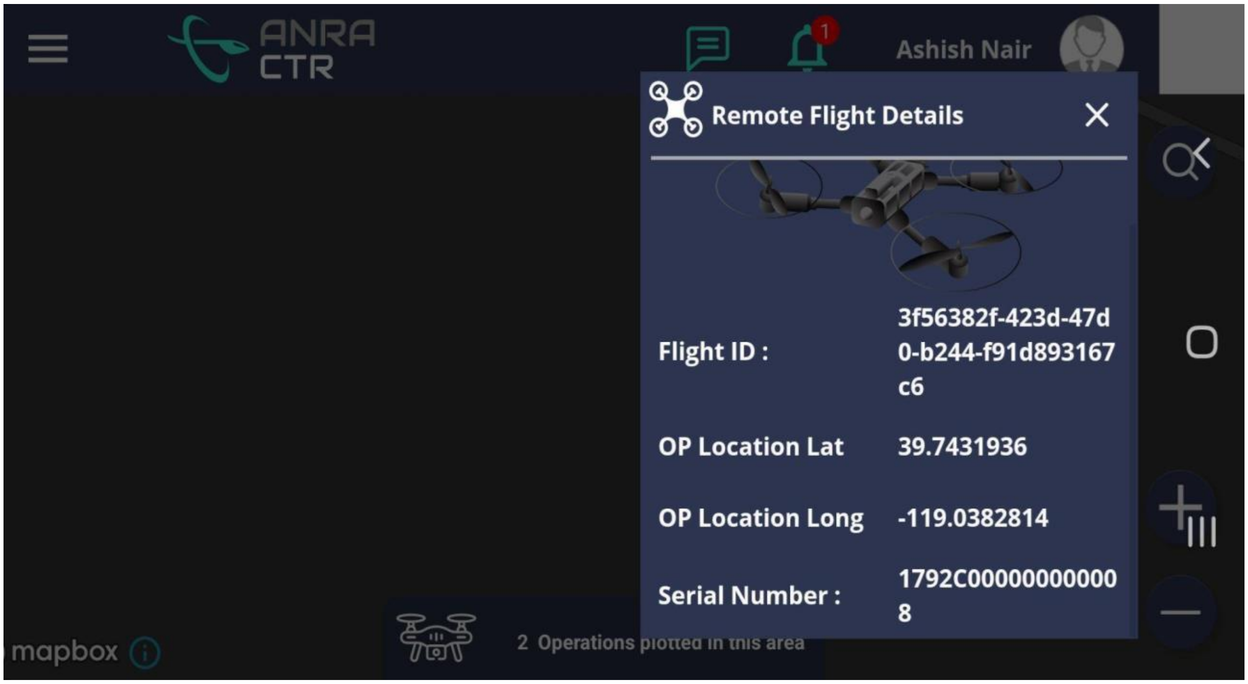

Figure 26: Screenshot of ANRA CTR app (mobile) provided Remote ID details for drone NRID drone.

4.5. Verification of BRID Ground Receiver Messages Being Converted Into NRID Messages

Purpose: BRID messages are received by a ground receiver, then sent through a gateway to be converted into NRID messages and viewed on Web or mobile devices.

Test Description: BRID messages received via a ground receiver that are transmitted via cellular connection to the cloud-based BRID gateway. Using a BRID app (Web), the user accesses Remote ID message information. See Figure 27 that depicts the functional test areas information. See Figure 27 that depicts the functional test areas.

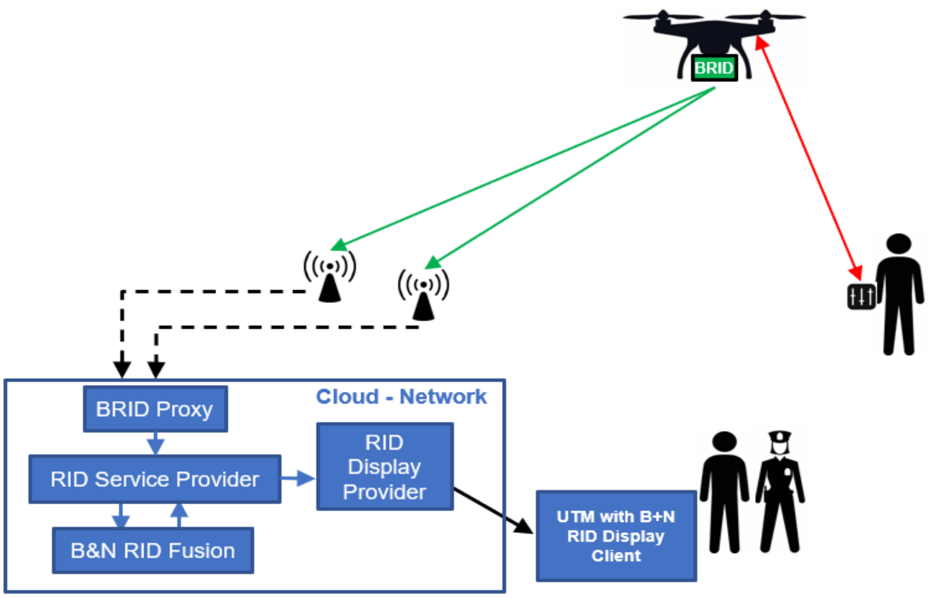

Figure 27: Functional areas for test

Test Objectives

- BRID messages received by Ground Receiver and sent to gateway for conversion into NRID messages and displayed in ANRA CTR app (mobile and Web).

Equipment Requirements

- BRID module
- BRID ground receiver with internet connection
- Laptop with internet connection

Result

The app screenshot in Figures 28 depicts the ANRA CTR app (Web) providing BRID capabilities.

Figure 28: The ANRA CTR app (Web) provided BRID capabilities. Light purple lines depict the flight path of the drone

4.6. Verification of an Electronic Flight Bag (EFB) Receiving BRID Data

Purpose: BRID data displayed in EFB for pilot situational awareness in crewed aircraft.

Test Description: BRID EFB receiver mounted on GA crewed aircraft obtains BRID signal from airborne drone then transmits data via WIFI signal to an iPad with a ForeFlight app that depicts BRID location. See Figure 29 that depicts the functional test areas.

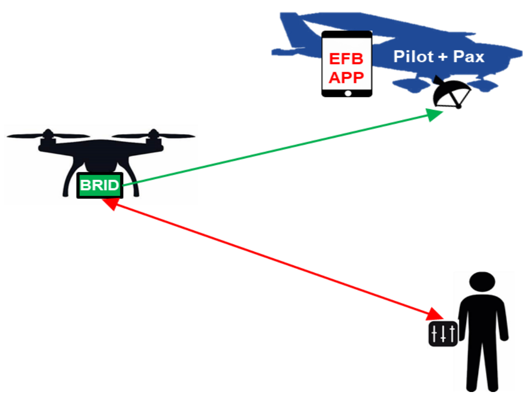

Figure 29: Functional areas for test

Test Objectives

- Connect the EFB receiver with the ForeFlight app.
- Receive BRID from airborne UAS and display their BRID information on an EFB.

Equipment Requirements

- BRID Transmitter

- (2) BRID EFB Receivers
- (2) iPads with ForeFlight installed

Results

One EFB BRID receiver was mounted on the right-wing strut (Figure 30) of the xCub and the second EFB BRID receiver was mounted inside the cabin (Figure 31). Two receivers were used to provide data redundancy and both were connected to separate iPads that were operating Foreflight.

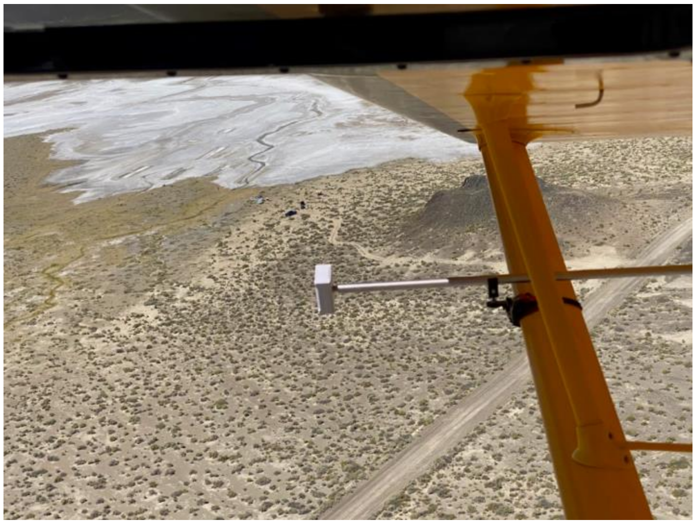

Figure 30: Starboard side view from inside the airborne xCub with external EFB receiver shown mounted on pole extending from the wing strut.

Figure 31: EFB BRID receiver mounted above xCub glareshield on cockpit starboard window.

Figure 32 is a screenshot of the Foreflight app that shows three BRID modules - two are depicted in motion which have associated vectors and the third icon (yellow) is the stationary ground BRID.

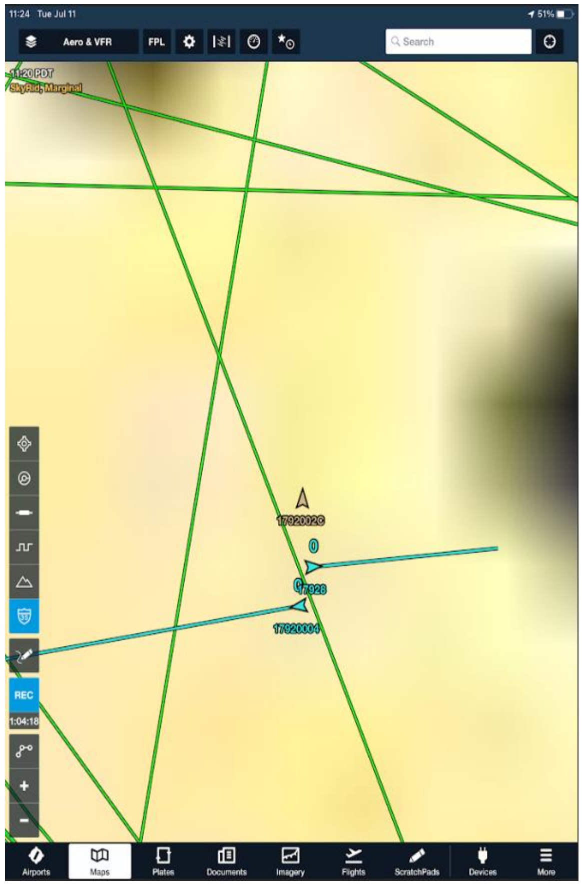

Figure 32: Foreflight screenshot that shows three BRID modules, two of which have associated vectors (blue) and the third icon as the stationary ground BRID module (yellow). Historical flight path of xCub aircraft depicted as green lines.

4.7. Database Correlation

Purpose: Correlation of BRID query by authorized personnel (e.g., Public Safety or Law Enforcement) with a mock FAA database.

Test Description: Tested correlation of BRID data with a dummy database using same data protocols used for FAA UAS Field Trials (UFT). See Figure 33 that depicts the functional test areas.

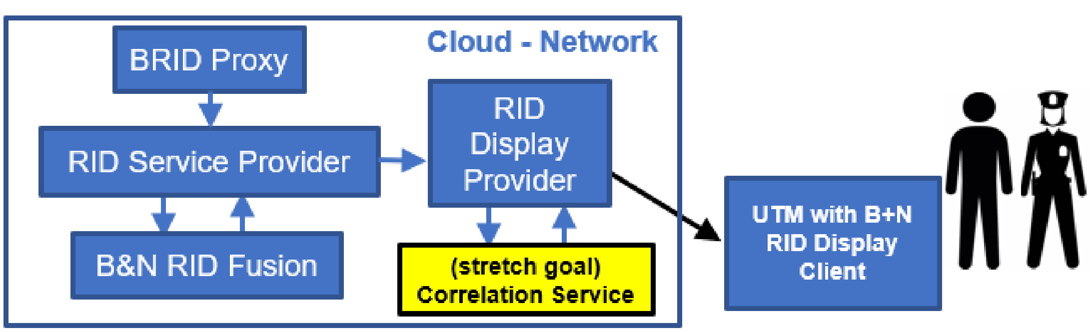

Figure 33: Functional areas for test

Test Objectives

- Return valid results for Data Correlation.

Equipment Requirements

- BRID Transmitter
- Android phone with BRID receiver application

Results

The app screenshots in Figures 34-36 depict successful correlation results.

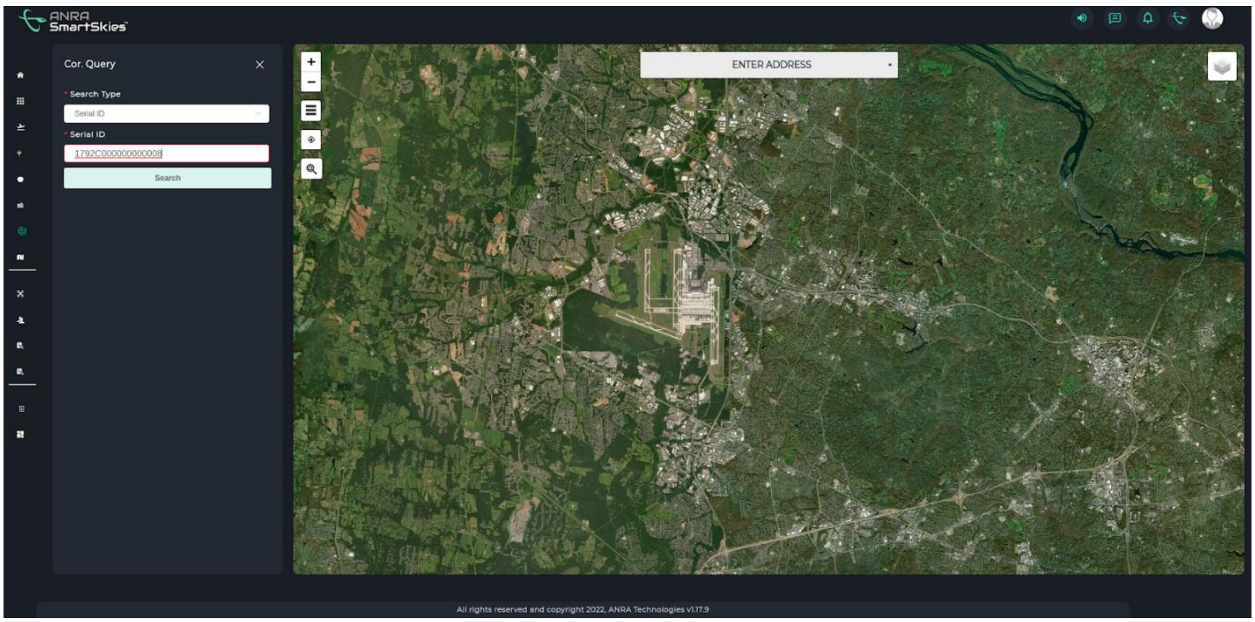

Figure 34: ANRA CTR app (Web) Data Correlation menu.

Figure 35: Law Enforcement participation

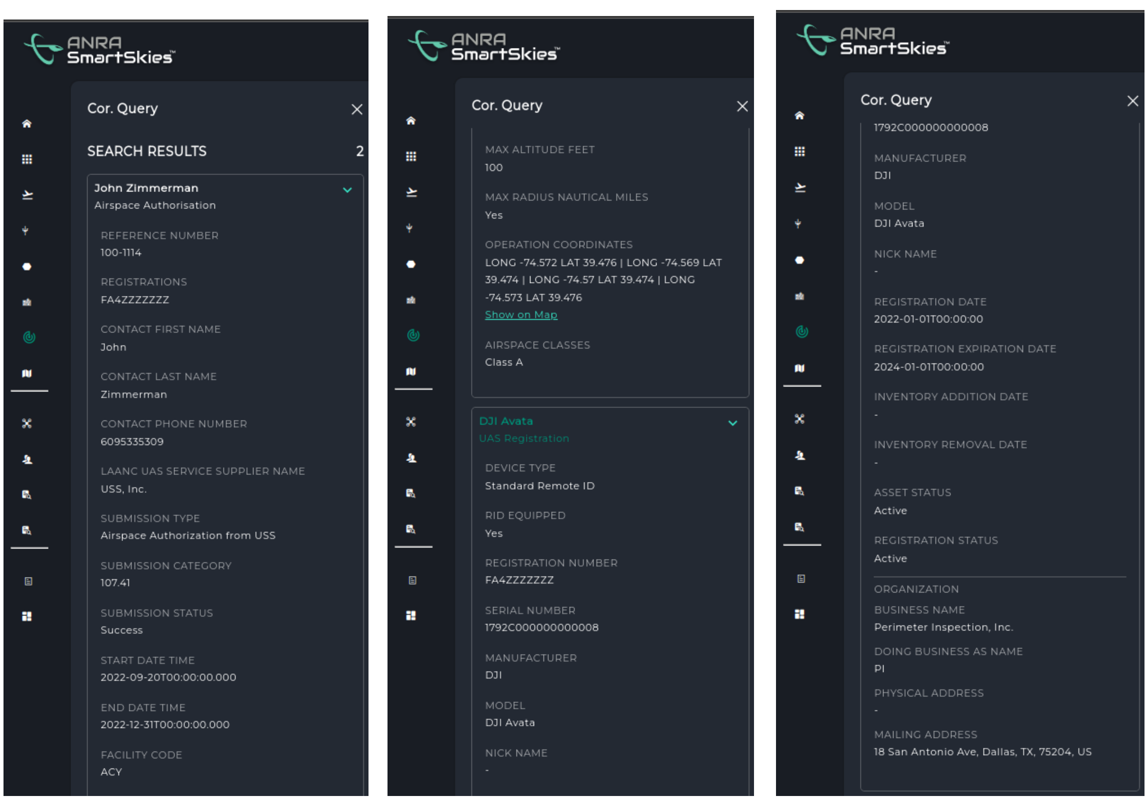

Figure 36: ANRA CTR app
(Web) correlation results

4.8. Data Collection

The below data metrics were identified in the original test report in Table 7.

Metric	Description	Data Source	Captured By	When Tested
M-1	System Latency between data capture points.	ANRA system Logs	ANRA	Phase 1
M-2	Percentage of Network Tracks Correlated with BRID Tracks	ANRA system logs	ANRA	Phase 1
M-3	Calls to correlator # of successful calls # of unsuccessful calls	ANRA system logs	ANRA	Phase 1
M-4	Variance between onboard aircraft GPS and reported BRID GPS locations	ANRA system logs and UNR Tlogs	ANRA/UNR	Phase 1
M-5	Closest Point of Approach between Crewed Aircraft and BRID aircraft	uAvionix EFB receiver logs and UNR flight logs	uAvionix	Phase 2
M-6	Percent of Crewed aircraft passes that resulted in successful BRID packet capture onboard aircraft within nominal range	uAvionix EFB receiver logs and UNR flight logs	uAvionix / UNR	Phase 2

Table 7: Data metrics

- **Metric M-1:** System Latency between data capture points.

  Data from BRID messages from the uAvionix module is received by the BRID ground receiver and then sent to ANRA BRID-Package-Manager service over LTE, then onto to the ANRA Remote ID service, next to ANRA Display Provider Service and then displayed on the ANRA Remote ID app. To help measure this path, ANRA developed in-house software to assist with data analysis using a tool called “Golang Parser” that:

  - Converted the raw data into a CSV files
  - The parser reads various sections and subsections of each data row (which essentially serves as a data point for analysis), recognizes headers like timestamp, lat-long values, etc., and puts them into separate columns in the CSV file.
  - The CSV file is later used to understand the nature of the collected data and analyzed.
  - One data point is equivalent to one BRID message transmission.

For this analysis, latency was calculated as the time difference between when the drones were displayed on the ANRA user interface and when data was received from the aircraft.

The data metrics analysis was performed using 28,621 data points captured by the ANRA service during the Phase 2 testing with the following outcomes:

- 28,143 data points of the total points had an end-to-end latency less than 1 second
- 477 data points (or 1.6%) of the data had a latency greater than 1 second.

We surmise this difference could be a result of lag due to the BRID ground receiver network for which BRID data is transmitted to the ANRA service, or due to the GCS laptop network on which NRID data is sent to the ANRA service.

The mean end-to-end latency for all data collected equates to 0.53 seconds.

- Mean: 0.53 seconds
- Min: 0 (means less than 100th of a second)
- Max: 60
- Median: 0 (means less than 100th of a second)
- 95% Percentile: 0.02

Time syncing was enabled on all servers used for testing, set to UTC time and the time is synchronized across all the services.

- **Metric M-2:** Percentage of network tracks correlated with BRID tracks.

  One of the main goals for this project was to convert BRID messages into NRID messages so they can be shared throughout the network using UTM provided by a USS. The M-2 metric is to assess the numbers of BRID messages that were dropped during conversion into NRID.

  - Only applicable for drones that had both NRID and BRID capability, that is, a drone connected to UTM while carrying a BRID module on board.
  - Calculated the percentage by 100 * (1-[X/Y]), where:
    - X = Number of Instances where both Operation ID and Flight serial ID was returned on our display provider logs for a single drone.
    - Y = Number of total ID’s returned on our Display Provider service side logs.
  - For testing the values are:
    - X = 244
    - Y = 28,621
    - M2% = 100*(1-244/28621) = 100*(1 - 0.0852) = 99.14%
  - We observed a non-zero value for X that is likely due to lack of network connectivity at the test site which contributed to a lag in data transfer and generated duplicate IDs for the same drone. We surmise this difference could be a result of lag due to the BRID ground receiver network for which BRID data is transmitted to the ANRA service, or due to the GCS laptop network on which NRID data is sent to the ANRA service.

- **Metric M-3 (Stretch Goal):** Successful Calls to Data Correlator
  One of the key BRID stakeholders is public safety and law enforcement and their ability to access additional information about the drone registered user associated with the unique BRID. For this test, a mock database was developed that was modeled upon the same system used during the FAA UTM Field Tests (UFT) that were conducted at New York and Virginia UAS Test sites in 2023. ANRA participated in UFT at both test sites and developed a correlation service and mock database for this project.

  - Calculated using ANRA's data correlation service logs.
  - ANRA's data correlation service on entering the serial ID shows all the relevant information about the drone and its operator.
  - Number of Successful calls = 11
  - Number of Unsuccessful calls = 0

- **Metric M-4: Variance between onboard aircraft GPS and reported BRID GPS locations**
  During Phase 1 testing and data log analysis we realized that to adequately analyze this metric, we must consider both GPS modules - the one located on the drone and the other within the BRID module. The significant variance observed in the GPS location data between the two units prohibits us from establishing any meaningful correlation between the latitude and longitude values and other relevant parameters. Time stamps were not helpful for correlating because of the latency and there was no common point to correlate the data as the lat/long values will be different for two GPS modules. Consequently, the acquisition of this data metric serves no practical purpose and was not able to be assessed.

- **Metric M-5:** Closest Point of Approach between Crewed Aircraft and BRID aircraft
  We calculated the shortest distance between the xCub aircraft equipped with the SkyRID EFB BRID Receiver and the drones with BRID modules using the Foreflight GDL90 logs. This required:

  1. Coordinates and altitude for the BRID module on drone and EFB BRID Receiver on xCub at same time.
  2. To find the distance between coordinates of the UAS and xCub, applied the Haversine formula.
     D = 2 * 6371 * ASIN(SQRT(SIN((Lat1-Lat2)/2)^2 + COS(Lat1) * COS(Lat2) * SIN((Long1-Long2)/2)^2))
  3. The distance calculated above is in kilometers which is then converted to feet to match the altitudes units.
  4. With this data, calculated X using the Pythagorean theorem, see Figure 37.
  5. Shortest distance: 952 feet and was the closest point of approach.

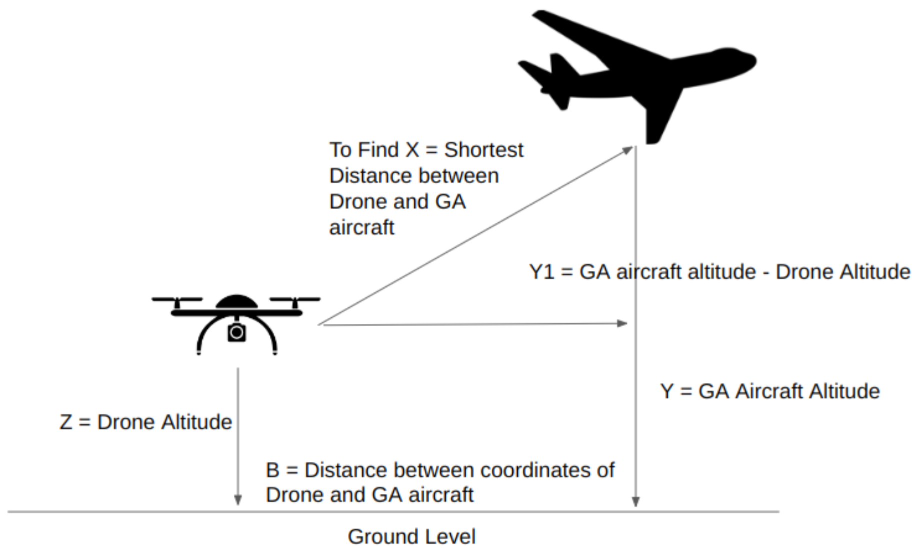

Figure 37: Illustrates calculation for distance between drone and xCub

- **Metric M-6:** Percent of crewed aircraft passes that resulted in successful BRID packet capture onboard xCub EFB within nominal range.

  To calculate this metric:

  1. Nominal range was defined as operation of the xCub greater than 500 feet but less than 1 mile from BRID transmitters.
  2. Using the Foreflight GDL90 logs to calculate the number of times traffic was discovered and the number of times ownship was observed.
  3. # of times traffic messages received = 11,913
  4. # of time ownship message received = 26,191
  5. % of successful BRID messages captured = 11,913/26,191*100 = 45.49%, depicted in Figure 38.

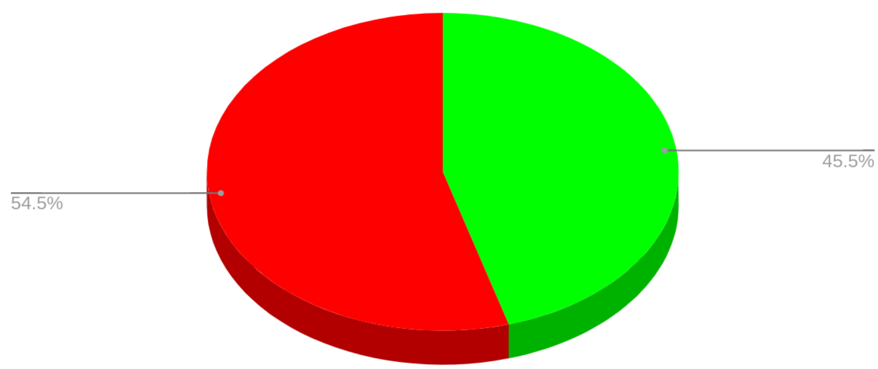

Figure 38: Percentage of successful BRID messages captured on xCub EFB receiver at nominal range

- **Metric M-7 (Stretch Goal): Signal Strength and the Slant Range**

Since this was a stretch goal, a preliminary analysis was conducted to measure BRID signal strength.

To calculate this metric:

- Drone (3DR Solo) flew a predefined pattern in the vicinity of the BRID ground receiver.
- Slant Length (distance) was calculated by BRID ground receiver software.
- Received Signal Strength Indicator (RSSI) in decibel-milliwatts (dBm) was calculated by BRID ground receiver software.

Figure 39 depicts the RSSI in dBm from a signal that was transmitted from the BRID module and received by the BRID ground receiver, providing its associated distance. The blue line represents BRID data packages that were received by the BRID ground receiver.

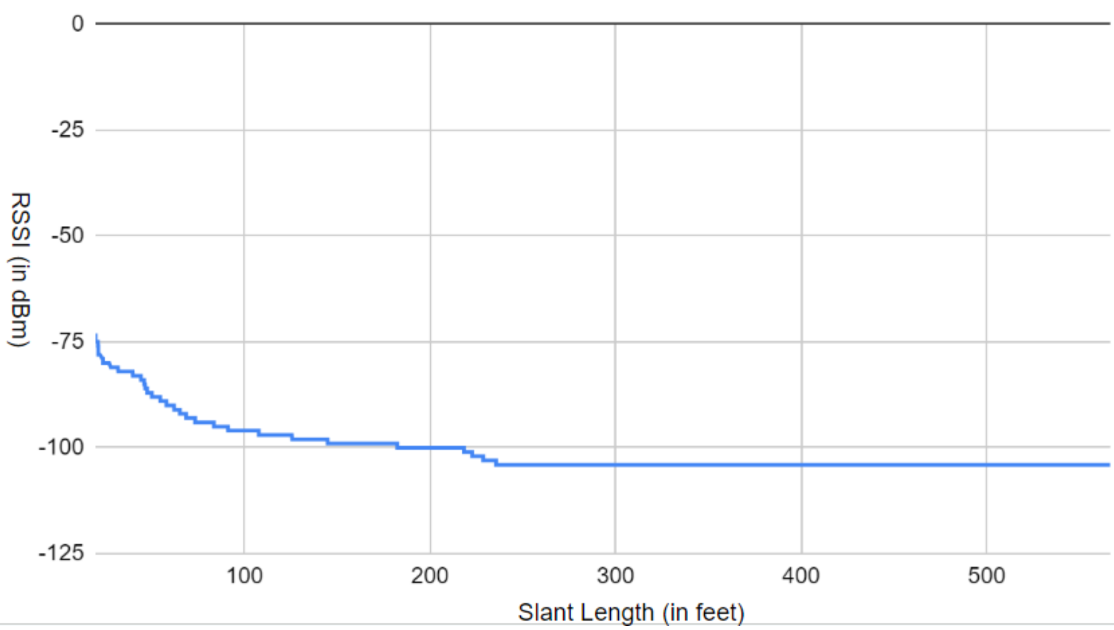

Figure 39: X-axis depicts distance between the BRID module and BRID ground receiver. The X-axis depicts the RSSI in dBm. The blue line indicates BRID data packages received at the BRID ground receiver.

Flight scenarios were limited to a ceiling of 230 feet and should not be indicative of a poorly performing ground receiver.

The lowest value measured was 7.5 feet and associated with a flight path for the drone's closest point of approach to the ground receiver.

As anticipated, the data confirms signal reception degrades with distance.

5. Challenges

From the perspective of project or test execution, there were no significant challenges.

- The police that supported Phase 1 testing did express concern for their lack of understanding regarding their role as law enforcement and this new capability
- Although not in project scope, the tested BRID had an integrated internal GPS receiver. This GPS required a clear view of the sky to generate a position input. Depending on the sUAS model and design, finding a site to mount the BRID can be challenging. On two of the sUAS the BRID was mounted internally, but with an RF transparent cover. On the Solo drone the lack of an adequate top mount location required a chin mount modification as shown in the image. This chin mount was in lieu of a payload sensor gimbal which was not used for testing.
- Although not in project scope, Bluetooth compatible BRID modules had to operate in a 2.4 GHz RF noisy environment onboard UNR sUAS. Maximizing module distance from existing RC control Tx/Rx while maintaining an adequate view of sky for GPS required careful evaluation to maximize BRID broadcast range.

6. Lessons Learned

- EFB equipped crewed aircraft can improve situation awareness of BRID drone locations.
- Police saw value in BRID but desired to see BRID information being networked as NRID for the long-term solution.
- Current implementation of ANRA's Remote ID app, user interface depicts the takeoff location as a green GCS icon, when it would be better represented by a different icon that indicates takeoff location.
- ANRA's Remote ID implementation uses an icon for aircraft that presents itself as a green drone icon when BRID data is received and converted into NRID messages. ANRA is researching the need for presenting a more intuitive way of presenting BRID-only drones when compared to drones that are connected and supplying their telemetry to UTM.
- Although not in project scope, the external EFB BRID receiver gained BRID signal earlier and subsequently held BRID signals longer than internally mounted EFB BRID receiver, likely due to the cockpit window interfering with BRID signal reception. .

7. Recommendations

- Recommend the FAA collaborate with industry on what occurs next for Remote ID Client Display providers (like ANRA) on what's next for deploying this capability to law enforcement and the public.
- Recommend the FAA collaborate with industry on how to integrate Remote ID Display providers (like ANRA) with the FAA Correlation Service that will allow authorized users to access an FAA database for additional information about the registered drone operator.
- Recommend the FAA continue to pursue NRID research to support expanded operations, use cases, and advanced UTM functions.

Appendix A (1 of 2): Integrated Master Schedule

						Preparation									Test/Report				
	Task		Lead	Support	Dependency	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Deliverables
1	Integration and Development		ANRA																
1.1	Kickoff Meeting	Prepare and participate in the contract kick-off meeting with UAS Integration Office (AUS). Provide a briefing about the project to be executed that will include the project objectives, a high-level project timeline, the roles and responsibilities, and the project risks and opportunities.	ANRA	All			M1.1												Kickoff Meeting Slides (Task 1.1), Sep 19, 2022
1.2	Integrated Master Schedule	Includes a detailed project timeline and resource planning (personnel, equipment, and facilities) and submit to AUS for review and acceptance.	ANRA	All			M1.2												Integrated MS (Task 1.2), Sep 19, 2022
2	Develop CONOPs		ANRA																
2.1	Use Case and Scenarios	Assess and develop new use cases to support historical, real-time and predictive uses from public safety and law enforcement stakeholders.	UNR	All				M2.1											Use Case and Scenarios (Task 2.1), Oct 19, 2022
2.2	B+N RID Distribution Concept	Develop concept for collecting, aggregating and re-transmitting B-RID messages by converting them to N-RID messages that are shared within the USS Network.	ANRA	UAVX															
2.3	Crewed Aircraft B-RID Situation Awareness	Explore the utilization of B-RID messages by piloted aircraft to increase total situational awareness in the NAS.	UAVX	UNR															
2.4	B+N RID in UTM	Study impact on how the industry will leverage N-RID for UTM operations in concert with current B-RID requirements	ANRA	UAVX															
2.5	User Credentialling	Consider how to properly credential public safety display clients, public safety users, management of Personally Identifiable Information (PII) exchanges/uses among the various entities involved in a Remote ID exchange.	ANRA	UAVX															
2.6	CONOPs	Prepare and submit document	ANRA	All				M2.6											CONOPs (Task 2.6), Oct 19, 2022
3	Design, Development, and Integration		ANRA																
3.1	Architecture	Design architecture for proposed final solution	ANRA	All	2.6				M3.1										Architecture (Task 3.1), Nov 19, 2022
3.2	Interface Control Document	Develop an Interface Control Documents to record of all interface information (drawings, diagrams, tables, and textual information) between subsystems and systems.	ANRA	UAVX	3.1					M3.2									Interface Control Document (Task 3.2), Dec 19, 2022
3.3	ASTM Alignment and Regulations	Alignment with existing ASTM standards and regulations	ANRA	UAVX															
3.4	EFB Standards Alignment	Alignment with industry standards such as GDL90 for EFB integration.	UAVX																
3.5	B-RID Modules	Provision B-RID modules. • Low SWaP B-RID module for drone Integration • Networkable ground B-RID receiver with USS Integration • Airborne B-RID receiver with WiFi capability for Integration with Electronic Flight Bag	UAVX	ANRA	3.2														
3.6	Conduct B-RID with N-RID fusion in USS	Conduct B-RID with N-RID fusion in USS	ANRA	UAVX	3.2														
3.7	B+N RID Fusion	Fuse B-RID Messaging into Federated Network using advanced machine learning (ML) and artificial intelligence (AI) • Establish fusion methods to incorporate B-RID messages into the N-RID message definition, discovery, and exchange framework • Implement B+N RID message exchange protocols	ANRA		3.2														

Appendix A (2 of 2): Integrated Master Schedule

						Preparation									Test/Report				
	Task		Lead	Support	Dependency	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Deliverables
4	Test Plan Development		UNR																
4.1	Test Plan	Prepare and submit a test plan for the simulations and live flight demonstrations.	UNR	All											MS 1				Test Plan (Task 4.1), May 19, 2023
4.1.1	Bench Test	HITL/SITL simulations. Plan for simulation activities for two, week-long shakedowns with intermittent breaks for troubleshooting and software updates.	ANRA		4.1														
4.1.2	Phase 1	Drone live flight activities for a week-long campaign separated by time to resolve issues	UNR		4.1														
4.1.2	Phase 2	Crewed aircraft and drone live flight activities for a weeklong campaign separated by time to resolve issues	UNR		4.1														
4.2	Test Cards	Construct Test Cards/Identify Metrics	UNR	All	4.1														
4.2.1	UPP2	Reference RID lessons learned from FAA UPP2	ANRA																
4.2.2	Use Cases and Scenarios	Use cases and scenarios will be constructed that explore new use cases enabled by B+N RID ▪ For Phase 1, use cases will focus on public safety and law enforcement utilization of B+N RID messaging ▪ For Phase 2, use cases will focus on crewed aircraft operator utilization of BBRID messaging	UNR	All	2.1														
4.2.3	USS Architecture	Required USS solution architecture will be defined and incorporated into simulation services and actors	ANRA	All	3.1														
4.2.4	Metrics	Metrics will be identified that will inform performance of the B+N RID network coverage and exchanges	ANRA	All	3.2														
4.2.5	Standards and Regulations	Alignment with standards and regulations	UAVX	All															
4.3	Safety and Risk Assessment	Develop safety case and risk assessment	UNR	All	4.1														
5	Conduct Test and Demonstration		UNR																
5.1	SITL/HITL Bench Testing		ANRA		4.1														
5.1.1	Bench Testing	Conduct Hardware (HITL) and Software (SITL) in the loop bench testing.	ANRA	UAVX	4.1														
5.1.2	Simulation	Simulate use case scenarios in environments that will be defined in the CONOPs	ANRA	UAVX	4.1														
5.1.3	Checks	Tests will include connectivity checks, data protocol exchanges, and interoperability checks.	ANRA	UAVX	4.1														
5.1.4	Test Venue	Testing will be conducted at ANRA facilities or the Nevada Test Site.	ANRA	UAVX	4.1														
5.1.5	Report	Prepare and submit Bench Test Report.	ANRA	UAVX	4.1											MS 1			Bench Test Report (Task 5.1), Jun 19, 2023
5.2	Phase 1 Demo: Drone	Drone Flights	UNR	All	4.1, 5.1.5														
5.2.1	Duration	Conduct 1-week field deployment at Nevada Test Site for a minimum of 20 separate drone flights, each with a duration of no less than 15 minutes	UNR	All	4.1														
5.2.2	Configure	Configure UASs with prototype B-RID broadcast modules	UNR	UAVX	4.1														
5.2.3	Ground Receivers	Deploy prototype networked RID receiver modules in the field	UAVX		4.1														
5.2.4	UAS-USS Integration	Integrate UASs with USS to generate N-RID messaging	ANRA	UNR	4.1														
5.2.5	Demo	Demonstrate various live flight B+N RID use cases, as defined in Test Plan	UNR	All	4.1														
5.3	Phase 1 Demo Report	Prepare and submit Phase 1 Demo Report.	ANRA	All	4.1												MS 2		Phase 1 Report (Task 5.2), Jul 19, 2023
5.4	Phase 2 Demo: Crewed aircraft flights	Crewed aircraft flights	UNR	All	4.1, 5.3														
5.4.1	Duration	Conduct 1-week field deployment at Nevada Test Site for a minimum of 20 separate drone flights, each with a duration of no less than 15 minutes.	UNR		4.1														
5.4.2	Configure	Configure UASs with prototype B-RID broadcast modules	UAVX		4.1														
5.4.3	EFB	Embed prototype B-RID receiver module in existing portable Automatic Dependent Surveillance-Broadcast (ADS-B) receiver in a manner that conforms to known aviation standards for easy future integration into Electronic Flight Bag applications.	UAVX	UNR	4.1														
5.4.4	Demo	Demonstrate various live flight B-RID use cases, as defined in Test Plan.	UNR	All	4.1														
5.4.5	Crewed Aircraft Use Cases	Using crewed aircraft, assess use cases for improved situational awareness of UAS operations at low altitude	UNR	UAVX	4.1														
5.4.6	Crewed Pilot	FAA certified pilots will provide services for operating their crewed aircraft (e.g., Cessna 172) per Test and Safety Plan.	UNR		4.1														
5.5	Phase 2 Demo Report	Prepare and submit Phase 2 Report	ANRA	All	4.1													MS 3	Phase 2 Report (Task 5.3), Aug 18, 2023
5.5.1	Final Presentation	Final Presentation	ANRA	All	4.1, 5.1.5, 5.3, 5.5														
5.5.2	Documentation	Document all demonstration findings for a Final Presentation to the FAA	ANRA	All															
5.5.3	Content	Presentation will include all components from Final Report.	ANRA	All															
5.6	Submit	Prepare and submit PowerPoint slides	ANRA	All															

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