

# Unmanned Aircraft System for Remote Contour Mapping of a Nuclear Radiation Field RSLN-15-15, Year 2 of 3

## **PIs:**

Karen McCall and Russell Malchow

## **Prime Project Members:**

RSL: Rick Fischer, Michael Lukens, Mark Adan, Michael Howard

STL: Rusty Trainham

UNLV: Paul Oh, Pareshkumar Brahmbhatt

## **Acknowledgments**

Lance McLean, Michael Madlener, Chris Joines, Michael Toland, Susan Roberts, Emmanuel Avaro, David Carder, Shawn Cadwell, Dave Krausnick, Ki Park

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## Purpose

### [Review Journal News Article and Video - Drones with rad detection](#)

- An unmanned aircraft system (UAS) has the advantages of fast deployment and low-altitude flying, which enhances sensitivity and wide area coverage, eliminates radiation exposure health safety restrictions, gives the ability to access highly hazardous or radioactive areas, etc.
- A UAS can be configured with the nuclear detecting sensor optimized to measure the radiation associated with the event.
- A multi-UAS has advantages over a single UAS, especially in time-critical tasks such as detecting nuclear radiation.
- UAS may be helpful in plume definition, ground deposition, moving source, and static or moving spills.

## Benefit

In a nuclear accident or in the aftermath of IND or RDD detonation, radioactive materials may pose a severe health threat to individuals near the site of the incident, but not to a UAS.

## Innovation

- While others have flown small sensors on UAS of varying sizes, we intend to fly both small and large radiation detectors on our UAS.
- We will integrate with other sensors for imagery and high-resolution hyperspectral imagery.
- We intend to explore algorithms and enable mapping of the radiation environment.
- We identified the need to push AMS, ER, and CM into the UAS era. Other attempts have not gotten us off the mark as a company.
- This proposal initiated the research and examines small UAS (sUAS), but real CONOPS is in larger platforms. Thus, this project is a step toward mastering larger platforms.

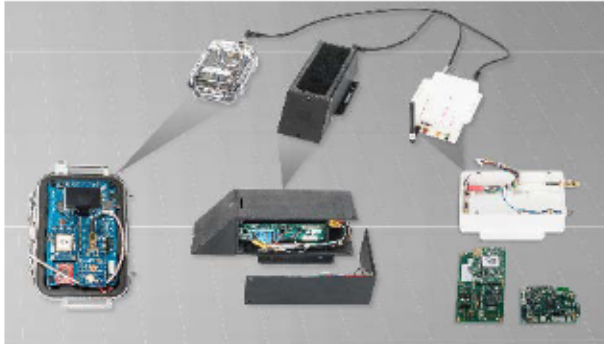


## Technical Approach

Domain	SDRD UAS Strategic Initiative – Phase A	STATUS
<b>Mission statement</b>	By FY18, NNSS will operate an unmanned aerial system with a detector, returning data relevant to determining radiological hazards on the ground, demonstrating the ability to integrate systems and detectors into the system.	Infrastructure established
<b>Environment</b>	The demonstrated system: Will fly low and slow to allow for radiological detection but above or around obstacles;	Training Flights conducted and continuing
<b>Awareness and navigation</b>	Will be programmed using standard autopilot waypoints and actively monitored;	Reviewing Flight Management Systems for incorporating onto the various platforms
<b>Sensors</b>	Will incorporate a radiological and other sensor for reporting on the presence of and identification of radiological hazards; and other hazards	Infrastructure established. Integrating Sensors
<b>Communication</b>	Will communicate in real time or near-real time relevant navigation and detection information. Information will be formatted and relayed so as to be useful for a current software platform or platforms.	Infrastructure established. Data telemetry tested.
<b>Architecture</b>	Will implement a current architecture or architectures.	Established a team to establish standards for sensor integration.

## Technical Approach

Develop small sensors



Integrate sensors into platforms



Train our aviation team to be UAS operators



## Progress

The following aspects of the SDRD have been accomplished or are in progress:

- Acquisition of UAS platforms and sensors
- UAS operator training for aviation staff to be able to operate the UAS platforms and conduct required maintenance
- Integrated radiological detection sensors and optical sensors into Sandstorm UAS platform
- Integrated RSL radiological detection sensors into UNLV hexacopters and achieved preprogrammed UAS flight with 3 platforms flying in formation

## UAS Platforms Purchased



Sandstorm Fixed-Winged - Heavy Payload



T-28 Aircraft - Training Aircraft



3DR Solo - Very Small Payload



Tarot Octocopter - Heavy Load - Multi-Sensor

# Technical Accomplishments

- Obtain UAS platforms for sensor payloads for radiation detection and electro/optical systems for R&D.

*Obtained 2 Sandstorm UAS Platforms in FY15. Operator training has begun.*



- Test a variety of sensor arrays and securely transmit the location, identity, and intensity of radionuclide contamination to a remote base station.

*April 2016, conducted UAS flight with SafeCast and Desert Eagle gamma radiation detectors. Data were telemetered to a ground station.*



SafeCast  
GM  
Detector

Desert  
Eagle NaI  
Detector



# Technical Accomplishments

- Integrate and test complementary sensors, including optical systems, such as hyperspectral, thermal, and visual cameras, or chemical sensors.

*April 2016, conducted UAS flight with Digital Video Camera. Data were telemetered to a ground station. Data collected in conjunction with radiological data on the UAS platform.*

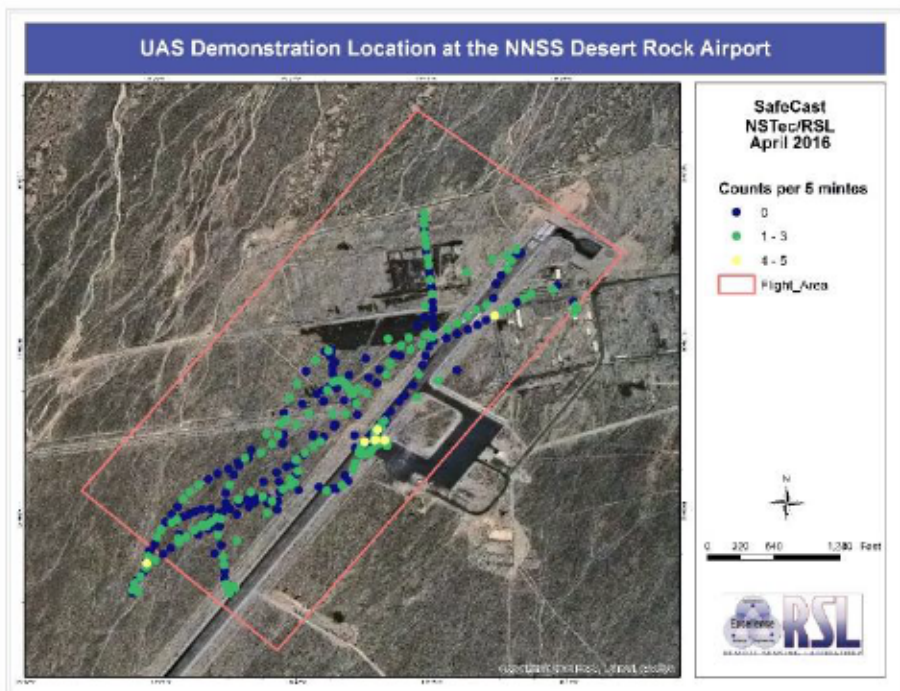


Digital  
Video  
Camera

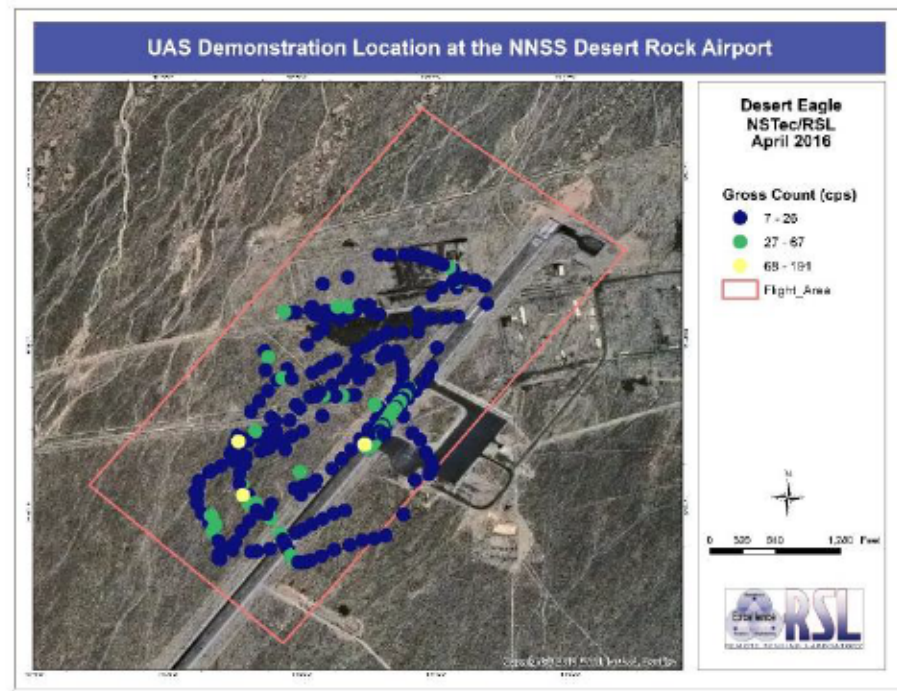


# Technical Accomplishments

April UAS Demonstration Flight  
2 rad sources: ~5 mCi Co, ~19 mCi Cs



SafeCast Data Results



Desert Eagle Data Results

GPS issues discovered. Independent tests were conducted with the radiation detector sensors and GPS unit.

# Technical Accomplishments

- In collaboration with UNLV, explore the use of formation flights using multiple UAVs and algorithms for search of a source.
  - **Acquired 3 Unmanned Aerial Vehicle (UAV) Platforms**
  - **Completed full electronics testing and assembly of each UAV (14 hours each)**
  - **Ground tested UAV for preprogrammed mission capability**
  - **Integrated Safecast bGeigie Nano Sensor:** LND 7317 “Pancake” Halogen-Quenched Geiger-Mueller (GM) tube; 2”; effective diameter 1.75” (45 mm); mica window density 1.5–2.0 mg/cm<sup>2</sup>; capable of detecting Alpha, Beta, and Gamma radiation. With Medcom iRover controller and HV (high voltage) supply.

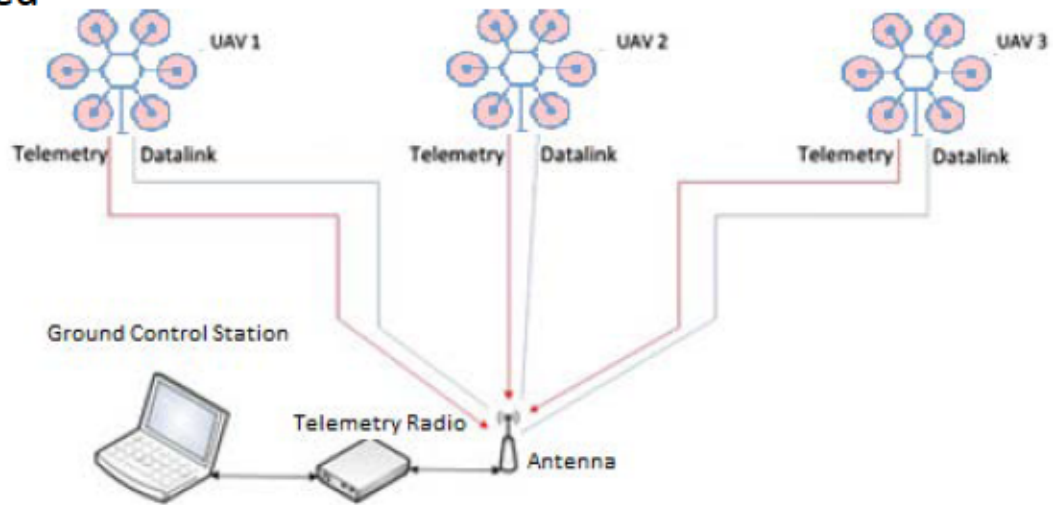


# Technical Accomplishments

- In collaboration with UNLV, explore the use of formation flights using multiple UAVs and algorithms for search of a source.

## Overview of Current Control Scheme

- Centralized control by ground station software
- Data link for telemetry and Command & Control (C&C)
- Allows for real-time monitoring of UAV
- Requires separate antenna for multiple UAV connection
- Reliability range is limited
- Bandwidth congestion
- Requires separate telemetry radio modem



# Technical Accomplishments

- In collaboration with UNLV, explore the use of formation flights using multiple UASs and algorithms for search of a source.

## ***Overview of Field Test Results: Outdoor short preprogrammed mission***



## Results

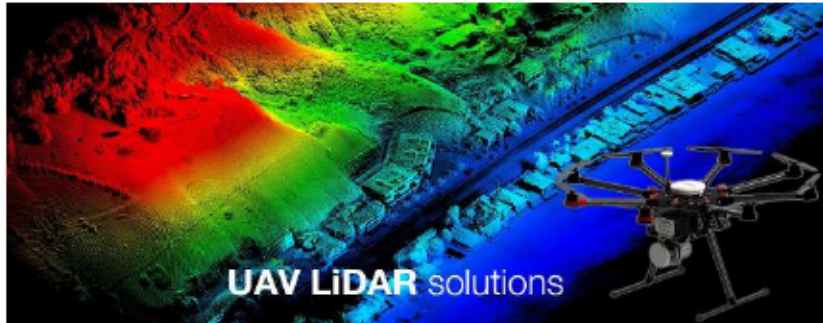
### UAS Operations

- Increase our efficiency in UAS platform operations to perform the standard aerial detection patterns
- Gather more sensor data to better understand the limitations and advantages using UAS platforms for aerial data collection

### UAS Formation

- Incorporate radiation sensors into formation flights. Data will be sent to separate ground stations.
- Allow for UAS-to-UAS communication for situational awareness and coordination of flight patterns

# Future UAS Sensor Purchases



**LiDAR Sensor**



**Hi-Def Digital Camera**

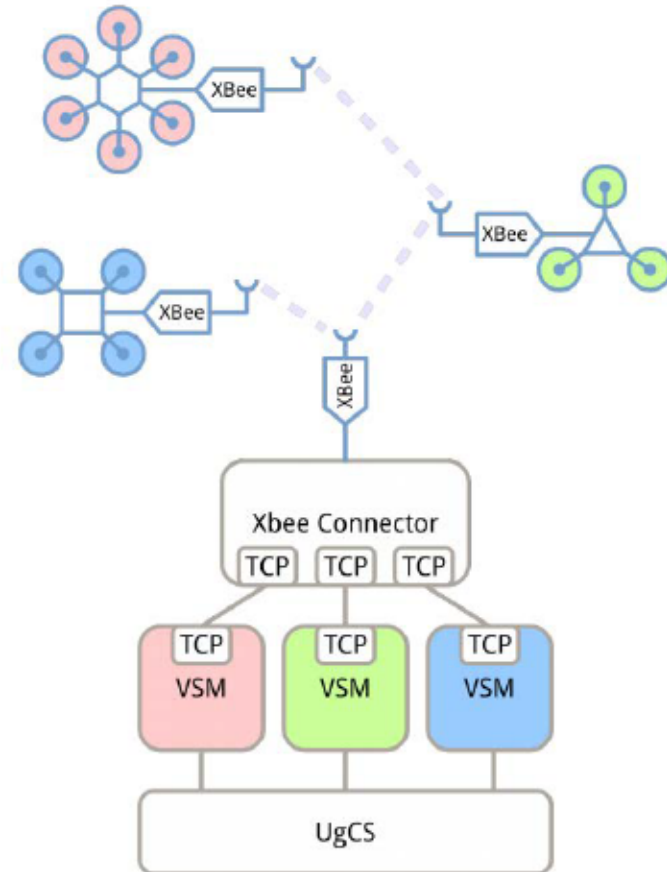
**Hyperspectral Camera**



# UNLV Future Direction



- Centralized Mesh Network
- Increases range of communications without sacrificing power consumption
- Allows for Vehicle-to-Vehicle communications
- Allows for Mixed mode Centralized and Decentralized control
- Increase robustness of flight pattern
- UAV platforms can self organize when targeted intensity is located by 1 UAV



# Conferences and Outreach

## UAS TAAC Conference December 2015 Albuquerque, NM



Hosted at the Physical Science Laboratory  
New Mexico State University

December 9-11th, 2015  
Hyatt Regency Santa Fe Resort  
Albuquerque, New Mexico

November 18, 2015

Richard Fischer  
Aviation Section Manager  
National Security Technologies  
1700 Arnold Avenue  
Albuquerque, NV 87102

Dear Mr. Fischer:

We are very pleased to have you participate in our UAS TAAC 2015. Thank you for your time and support to us in greatly appreciate it.

This year's UAS TAAC begins with an opening reception on Monday, December 8, followed by two days (December 9-10) of presentations and a day of field activities (December 11).

You are scheduled to:

- Give a briefing (10:00 AM) UAS Operations and Testing at the Nevada National Security Site (formerly known as the Nevada Test Site)
- Attend "Half-day December 10"
- Travel: 1:00 am
- Duration: 4-5 hours

[UAS TAAC 2015](#)

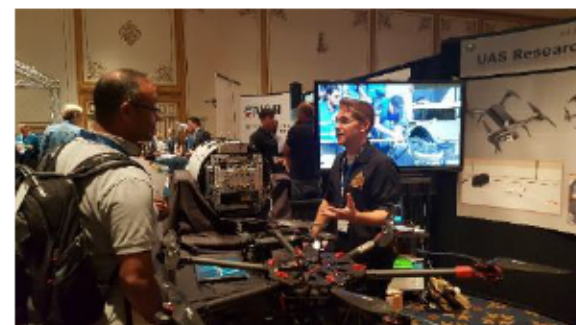
### UAS Operations and Testing at the Nevada National Security Site

**Richard Fischer**  
Remote Sensing Laboratory Aviation Manager  
National Security Technologies, LLC  
December 10, 2015

## AUVSI May 2016 New Orleans, LA



## InterDrone September 2016 Las Vegas, NV



## Impact and Outcome

- Technology abstract filed
- Collaborations
  - NDA with Praxis
  - NDA with H3D
- Commercial Service/SPP R&D
  - Unmanned Systems, Incorporated (USI)
  - AeroTarget International
  - GC2IT
- Conducting technology discussions with universities
  - Dr. Paul Oh (UNLV)
  - Dr. Kostas Alexis (UNR)
  - Dr. Kocherberger (Virginia Tech)