Nevada UAS Test Site
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Executive Summary

The Nevada Governor’s Office of Economic Development (“GOED”) is the lead Nevada state entity for interface and coordinating with the FAA UAS PMO for the development and integration of FAA UAS Systems under the OTA. In turn, GOED has founded and supports the non-profit Nevada Institute for Autonomous Systems (NIAS) to operate and oversee the daily operations and management of the designated test site sites and ranges. However, GOED continues to work to establish Nevada as a premier location in the world for practitioners in the autonomous systems community. GOED plans to maximize the utility of Nevada's assets to establish an unquestioned center of entrepreneurship and business excellence, resulting in recognition of Nevada as a world leader in the autonomous systems business.

GOED and NIAS personnel are hereinafter referred to collectively as (“Nevada personnel”) in this report.

Following designation by the Federal Aviation Administration (FAA) as an Unmanned Aircraft Systems (UAS) Test Site in December 2013, Nevada personnel created an aggressive annual activity plan detailing Nevada UAS Test Site stand-up activities, operational objectives, and Research and Development (R&D) activities. That plan was updated at the Technical Interchange Meeting in April 2016. In accordance with the Other Transaction Agreement (OTA), DTFACT-14-A-00003, Modification 0001, May 19, 2014, Nevada submits this required update to the original activity plan.

This update to the State of Nevada UAS Test Site Activity Plan provides an assessment of our results and proposed timelines for continued success as a designated Test Site. This update submission includes projected Research and Development (R&D) activities, engagement with current and potential academia and industry partners, and planning for technology integration and testing to be conducted on our Test Site.

As we have continued to mature as an FAA Test Site, we have embraced the fact that change and expansion of roles is necessary to support the industry and our Federal clients. Our primary expansion is from an initial focus on enabling R&D and testing for commercial applications to a growing focus toward UAS applications for commercial and public entities, their missions, and R&D on technologies that will assist integration into the NAS.

NIAS and the other UAS test sites have worked collaboratively on the NASA UTM program with significant progress as demonstrated during the National Campaign in March 2016. Developments will lead us to additional efforts that will be beneficial to both the Test Site and the FAA. We continue to strive to exceed the expectations of our clients and meet all requirements of the FAA in a world-class testing and R&D capability.
Purpose and Background of Activity Plan

The Other Transactional Agreement (OTA) between the State and the FAA requires an Activity Plan that addresses the preparation and completion of Test Site Certificates of Waiver or Authorization (COA) applications, Test Site stand-up activities and projected research activities. This plan update responds to that requirement.

This plan is intended to inform the FAA on the State of Nevada’s plan to operate its Test Site/Test Range activities in support of the FAA UAS Test Site Program. One of the plan’s objectives was to create specific processes to allow safe operations within the National Airspace System (NAS) over the State of Nevada.

Areas of Opportunity

The State of Nevada, by and through its agency, the Governor’s Office of Economic Development (GOED) and Nevada Institute for Autonomous Systems (NIAS) entered into various financial, informational, and non-compete agreements by which the Test Site undertakes several roles and obligations to support the OTA between the FAA and the State.

Nevada’s organizational structure of our team includes three institutions of higher learning from the Nevada System of Higher Education (NSHE)—the University of Nevada Las Vegas (UNLV), the University of Nevada Reno (UNR), and the Desert Research Institute (DRI). While NIAS works with clients from all domains to facilitate flight operations and assists pursuit of their R&D objectives, the institutions above have distinct R&D programs related to UAS which may or may not include flight operations and interface with NIAS. Separate R&D efforts of the NSHE teammates are conducted based on funding available through grants or industry partnerships.

GOED and NIAS Objectives for the Next Year

1. Increase tempo of flight operations. Based on Section 333 approvals and the small UAS rules which enable commercial operations of small UAS, Nevada’s focus will extend to include supporting larger systems and public aircraft operations that pose more challenging NAS access issues. We have experienced increased interest in the UAS industry for larger UAS platforms (greater than 55 pounds) and projects that will utilize these systems. The Special Airworthiness Certificate in the Experimental Category is particularly marketable to these clients. Small UAS projects are still very important, as we now have two blanket COAs for anywhere in the NAS, 200 and 400 feet above ground level and below, within Visual Line of Sight, and at specified distances from airports based on their classification (active control tower, unmanned tower, non-towered facility).

   a. Rationale: FAA Section 333 approvals for small UAS that give a direct pathway to commercial operations and the finalization of the small UAS rules in the part
107 to Title 14 Code of Federal Regulations (14 CFR) in August this year should diminish FAA’s expectations of SUAS using the Test Sites for small UAS operations.

b. As a designated UAS Test Site, we adhere to the terms of the Other Transaction Agreement and are pleased to perform Research and Development to enable increased access for UAS in the National Airspace System (NAS). The access for larger UAS will only be achieved once technology solutions are developed to enable safe access. Nevada will also concentrate on those technologies and the development of airspace that can support Beyond Visual Line of Sight (BVLOS) flight operations for both public and commercial operations.

2. **Focus on public aircraft operations through the research institutions teamed with industry and/or other governmental entities; with NIAS assistance (includes NASA and the FAA UAS COE).** Connect with the public agencies, both Federal and Nevada, within our state or surrounding states to develop or further highly visible UAS projects. Work closely with those agencies that have budgets to investigate the use of UAS for augmenting or accomplishing mission tasks.
   a. **Rationale:** Enabling public operations within the NAS can provide safer and less expensive alternatives to the current use of manned helicopter or fixed wing operations.
   b. **Examples:**
      i. Cloud seeding project based on the historic drought conditions
      ii. Wild land fire management—increasing concerns given the drought conditions (both predictive and response)
      iii. Search and rescue
      iv. Mapping and geodetic survey operations
      v. Wildlife management and conservation—wild horse counts, desert tortoise management, big horn sheep counts, wild bird surveys, etc.
      vi. Counter UAS technology
      vii. Advanced package delivery
      viii. Other possibilities of research into power line and tower inspection, wind farm surveys and monitoring, electronic news gathering, and solar energy facility monitoring.

3. **Increase connectivity with Nevada’s Research and Development Universities (UNLV, UNR, and DRI).** Nevada will continue to seek out and assist Nevada’s universities with grant proposals and projects development, emphasizing opportunities that contribute to the R&D goals provided by the FAA (sense and avoid, securing datalinks and communications, privacy, NextGen UAS integration, etc.). Nevada will
also accelerate efforts to connect industry partners and governmental agencies with our NSHE partners.

a. **Rationale:** Nevada will work to accelerate T&E and R&D engagement opportunities with our universities.

Focus Areas

Nevada understands the issues that impact the integration of UAS into the NAS. To assist the FAA in meeting the published goals for civil UAS integration into the NAS, Nevada’s efforts will focus on specific R&D and flight operations to provide data which can be valuable to the FAA. Nevada personnel will also interface with the appropriate offices within the FAA for subject area expertise and cooperative research.

**January—June 2016 Milestones Completed vs. Plan**

As a starting point for this activity plan revision, Nevada will set forth the accomplishments achieved during the first six months of 2016 against the objectives detailed in the January 2016 update submission.

**ACCOMPLISHED ACTIVITIES DURING 1st Half of 2016**

*(REPORTABLE IN THE COA ONLINE SYSTEM)*

During the 1st Quarter, CY 16, the FAA online reporting system recorded 139 COA flights for the FAA-designated Nevada UAS Test Site representing a **119% increase** from 4th Quarter totals (56 COA flights) and an approximate **1400% increase** since 3rd Quarter totals (10 COA flights) – 1 September 2015. Notably, three weeks into the 1st Quarter, FY 2016, the Nevada UAS Test Site has already flown approximately **30% (41 COA flights)** of the aggregate 1st Quarter COA totals. The Nevada UAS Test Site is postured to meet or exceed 1st Quarter COA totals by 10-20% the end of the 2nd Quarter, 2016.

During the 2nd Quarter, CY 16, the FAA online reporting system recorded 307 COA flights for the FAA-designated Nevada UAS Test Site representing a **109% increase** from 1st Quarter totals (139 COA flights). The aggregate COA total to date as of 30 June, 2016 is 512 COA flights. Two weeks into the 3rd Quarter, the Nevada UAS Test Site has already completed 52 COA flights. At this operational tempo, NIAS is on track to surpass 700 COA flights through the 4th Qtr, CY 16. This would approximately represent a **900% increase** from CY 15 COA totals.
Table 1 identifies the NIAS air mission statistics by flying or mission control (MC) entity and location:

<table>
<thead>
<tr>
<th>Organization</th>
<th>Date</th>
<th>Total COA</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperloop Tech./NIAS</td>
<td>11-13 Jan 16</td>
<td>30</td>
<td>N. Las Vegas APEX</td>
</tr>
<tr>
<td>Hyperloop Tech./NIAS</td>
<td>1/23/2016</td>
<td>10</td>
<td>N. Las Vegas APEX</td>
</tr>
<tr>
<td>Hyperloop/Tech./NIAS</td>
<td>2/5/2016</td>
<td>9</td>
<td>N. Las Vegas APEX</td>
</tr>
<tr>
<td>Hyperloop Tech./NIAS</td>
<td>2/25/2016</td>
<td>9</td>
<td>N. Las Vegas APEX</td>
</tr>
<tr>
<td>Flirtey UAS/NIAS</td>
<td>3 &amp; 4 Mar-2016</td>
<td>13</td>
<td>Hawthorne, NV</td>
</tr>
<tr>
<td>NAASIC/UNR Hydro</td>
<td>3/7-9/2016</td>
<td>20</td>
<td>N. Nevada Thermal Plant</td>
</tr>
<tr>
<td>Flirtey UAS/NIAS Package Delivery Live ABC News Filming</td>
<td>3/10/2016</td>
<td>9</td>
<td>Connelly Housing, Hawthorne, NV</td>
</tr>
<tr>
<td>Embry-Riddle Aeronautical University/NIAS</td>
<td>21-22 March 16</td>
<td>27</td>
<td>Mesquite UAS</td>
</tr>
<tr>
<td>NAASIC/UNR Hydrogeo</td>
<td>3/23/2016</td>
<td>12</td>
<td>N. Nevada Thermo Plant</td>
</tr>
<tr>
<td>1st half Subtotal</td>
<td></td>
<td><strong>139</strong></td>
<td></td>
</tr>
<tr>
<td>Boeing Insitu/NAASIC C2</td>
<td>4/3/2016</td>
<td>20</td>
<td>RRCC</td>
</tr>
<tr>
<td>Boeing Insitu/NAASIC C2</td>
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<td>21</td>
<td>RRCC</td>
</tr>
<tr>
<td>Nevada-NASA/NIAS C2</td>
<td>4/19/2016</td>
<td>32</td>
<td>Reno-Stead Airport</td>
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<tr>
<td>ERAU/NIAS C2</td>
<td>4/22-24/2016</td>
<td>70</td>
<td>Daytona Beach, FL</td>
</tr>
<tr>
<td>DRI, DA, AVSGHT/NIAS C2</td>
<td>4/29/2016</td>
<td>1</td>
<td>HADM/Hawthorne, NV</td>
</tr>
<tr>
<td>Microsoft UAS/NIAS C2</td>
<td>5/12-13/2016</td>
<td>7</td>
<td>Redmond, WA</td>
</tr>
<tr>
<td>Pah Rah Petroglyphs/NAASIC C2</td>
<td>5/20/2016</td>
<td>10</td>
<td>Reno, NV</td>
</tr>
<tr>
<td>Insitu/Boeing/NAASIC C2</td>
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<td>8</td>
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<td>2</td>
<td>HADM</td>
</tr>
<tr>
<td>Carbon Auto UAS/NAASIC C2</td>
<td>6/10/2016</td>
<td>9</td>
<td>Reno, NV</td>
</tr>
</tbody>
</table>

8
The COA applications for the Nevada UAS Test Site increased at an unprecedented rate in the 1st Quarter. The airspace Certificate of Authorization (COA) and Letter of Authorization (LOA) at Reno-Stead Airport and Hawthorne Industrial Airport were modified and approved by the FAA to allow for any size UAS to launch and recover directly from the airfield. The airspace COA and LOA at Silver Springs Airport and Tiger Airfield was modified and submitted to the FAA for approval for launch and recovery of any size UAS directly from the airfield. The airspace COA and LOAs for Beatty and Tonopah Airport were completed and will be sent to the FAA for approval in 2nd Quarter; thus, facilitating launch and recovery of any size UAS directly from both airfields. The Nevada UAS Test Site began looking at airspace opportunities that would facilitate business opportunities for Nevada Teammates beyond the State of Nevada borders and this included completing the land usage agreement and two COAs for Santa Cruz, California and submitted to the FAA for approval. NIAS and the Nevada UAS Test Site submitted its 333 Exemption to the FAA, the only Test Site to do so as a Test Site. This will bring in additional commercial opportunities to Nevada Teammates.

Nevada personnel continued efforts to advance the autonomous systems industry by executing a historic Memorandum of Understanding (MOU) with the Korean Civil UAS Research Consortium (K-CURC). South Korea plans to integrate UAS into their national airspace much in the same way as the U.S. plans. By collaborating with K-CURC, the Nevada Test Site can really advance and enhance the Nevada UAS Industry on a global front. This has the potential to create additional business streams for Nevada Teammates.

Several UAS flights were conducted by NIAS at the Hyperloop Technologies APEX site to survey and map a four-mile land location for placement of high-speed test transport cylinders changing the way people use public transportation. The Nevada Test Site has continued to advance the initiative of advancing R & D through real world applications.

The Nevada Test Site has begun to work with Nevada Teammates to develop and test innovative UAS cloud-seeding applications focused on increasing snowpack depths in the Lake Tahoe, Nevada region.

The Nevada Test Site has moved from the conceptual phase of developing UAS Economic Cluster Zones to an operational state with the introduction of several operational UAS Economic Cluster Zones (ECZ) including Reno-Stead Airport, Silver Springs Airport, Hawthorne Industrial Airport, City of Mesquite, and Nye County Beatty and Tonopah Airports. These areas are concentrated or tightly-focused UAS endeavors.

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Airspace</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>NV Energy Demo/DRI C2</td>
<td>6/29-30/2016</td>
<td>52</td>
<td>Elko, NV</td>
</tr>
<tr>
<td>2nd qtr Subtotal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st half total</td>
<td></td>
<td>307</td>
<td></td>
</tr>
<tr>
<td>1st half total</td>
<td></td>
<td>445</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 – 1st Half Air Missions Completed

In addition to the increasing flight statistics for the 1st half of the year, Nevada personnel are also reporting these additional activities:

- The COA applications for the Nevada UAS Test Site increased at an unprecedented rate in the 1st Quarter. The airspace Certificate of Authorization (COA) and Letter of Authorization (LOA) at Reno-Stead Airport and Hawthorne Industrial Airport were modified and approved by the FAA to allow for any size UAS to launch and recover directly from the airfield. The airspace COA and LOA at Silver Springs Airport and Tiger Airfield was modified and submitted to the FAA for approval for launch and recovery of any size UAS directly from the airfield. The airspace COA and LOAs for Beatty and Tonopah Airport were completed and will be sent to the FAA for approval in 2nd Quarter; thus, facilitating launch and recovery of any size UAS directly from both airfields. The Nevada UAS Test Site began looking at airspace opportunities that would facilitate business opportunities for Nevada Teammates beyond the State of Nevada borders and this included completing the land usage agreement and two COAs for Santa Cruz, California and submitted to the FAA for approval. NIAS and the Nevada UAS Test Site submitted its 333 Exemption to the FAA, the only Test Site to do so as a Test Site. This will bring in additional commercial opportunities to Nevada Teammates.

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(work projects, land cleanup or facility transformation grants, inspection or survey work, or RFP offerings) to create practical UAS business opportunities, new research and development, or a series of condition setting measures to ignite one or several UAS markets or UAS expertise in a certain geographic sphere. Creating an environment for UAS business opportunity through a series of grass roots efforts for the intended purpose of using the Nevada UAS Industry as an ignitor, leapfrogging mechanism, or medium for emerging economic development, growth, or transformation (DGT) is the intended purpose of the UAS ECZ.

- NIAS formalized an agreement with a large energy company to conduct proof of concept UAS flights for power line survey and inspection. Ultimately, if the results are acceptable, real world projects could be possible in the future as BVLOS UAS survey flights become a reality.
- NIAS was in contact with several counter UAS companies that were interested in using the Nevada UAS test site to test their new technology. We are working through various UAS range options for cUAS testing.
- Dr. Chris Walach presented at the 2016 International Conference on Unmanned Aircraft Systems, ICUAS'16.
- NIAS toured the DronePort in Boulder city and met with officials to discuss ways to collaborate on bringing UAS companies to test and develop.
- UAS flight training continued with instructors from Truckee Meadows Community College
- NIAS, GOED and several Nevada teammates exhibited at AUVSI 2016 annual meeting
- NIAS relocated headquarters to Switch’s Innevation Center in Las Vegas.
- Press releases were issued for NASA, Cloud Seeding, XPONENTIAL 2016, EHang and Microsoft activities

July – December 2016 Pending and Planned COAs

The Nevada UAS Test Site did not submit any additional FAA COA applications; however, Nevada personnel chose to focus on maximizing active COAs and conducting initial preparations for beyond visual line of sight (BVLOS) safety case planning and development. Current COAs submitted to the FAA and still in the cue for approval include: Silver Springs, Tiger Airfield, Beatty, and Tonopah Airports. The Nevada UAS Test Site is waiting on FAA approval for its submitted 333 Exemption since April 2016. The Nevada UAS Test Site received FAA approval for two Santa Cruz, CA COAs.

Pending and Planned Special Airworthiness Certificates

We have two SAC/ECs planned for the 2\textsuperscript{nd} half of the year.
NASA-NIAS UTM Update

The Nevada-NASA team includes: GOED (PI), NIAS (operational control and NASA PMO), Reno-Tahoe Airport Authority (RTAA), UNR, and GC2IT. The Nevada-NASA team are successfully completing UTM Phase Build 1 with Build 2 scheduled for roll out and operational testing in October 2016.

During the 1st Quarter, CY 16, the Nevada-NASA team finalized all of the NASA required Task Order (TO)-1 UAS Test Plans, TO-2 Systems Security Management Plans, software agreements, and Reno-Stead COA-207 enhancements to set the stage for the “National Campaign” proof-of-UTM performance flights on 19-20 April 2016. These flights will test the scheduling of missions in the UTM and Mission Management software by launching at least four UAS aircraft in the air at the same time across the six FAA-designated UAS Test Sites—all simultaneously monitored by the NASA UTM software. The Nevada team has set the pace among the Test Sites by the integration of even more enhanced visual and data situational awareness screens than the first phase UTM software and management would normally provide. These achievements and the exceptional relationship building efforts have positioned Nevada as the NASA location of choice over any other potential NASA Test Site location. Just announced by the NASA team – all UTM Build 2 (TCL2) test flights will be conducted at the Reno-Stead Test Range. This represents a huge vote of confidence in the Nevada-NASA team capability, teamwork, and expertise to accomplish the mission.

A key aspect of the NASA contract is the build-out and equipping of the Nevada Autonomous and NextGen Collaborative Environment (NUANCE) laboratory where live UAS flight operations may be monitored in a laboratory environment; thus, allowing the Nevada UAS Test Site team to combine (mix) Live, Virtual, and Constructive (LVC) systems and scenarios in one testing setting. Leading all other Test Sites, the last phases are underway with NASA official review processes to be fully integrated with NASA LVC systems, as well as fully incorporating LSTAR (Nevada is the only test site with the LSTAR RADAR system for enhanced tracking UAS tests), and RangeVue, as well as ready to incorporate the FAA NextGen-ADS-B traffic management system. Nevada now has the best range and is the best equipped of all the test sites for Beyond-Visual-Line-of-Sight (BVLOS) UAS testing – a key goal and requirement for NASA UTM testing strategy.

NIAS and NASA co-signed a Space Act Agreement to formalize our support of the Unmanned Traffic Management (UTM) platform and other future research and development Operational Test and Evaluation (OT&E) platforms and programs. The NIAS-UNR/NAASIC-RTAA/RTS-GC2IT/FRAero team collaborated closely with the NASA-Ames to successfully plan and fly 28 UTM missions in support of the UTM-TCL1 “National Campaign” test flight demonstration on 19 April. The Nevada Team flew a total of 28 UTM nationally coordinated test missions in support of the NASA OT&E demo event – twice as many missions as any other of the six test sites, and has earned the distinction as the Test-Site-of-Choice for the NASA UTM
and other NASA R&D OT&E flight test requirements, including UAS Beyond-Visual-Line-of-Sight and Sense and Avoid development of capability and testing. Pulling together with the NASA planners and approvers, the Nevada team has made the TCL2 “shakedown” tests at Reno-Stead 27-30 June a welcoming and fully successful operation. The Stead Airport management and operations staff put in a monumental effort to prepare their airport facilities, the range area and daily support and safety oversight for the test flights.

NUANCE Lab: NASA indicated that we were first of the 6 Test Sites to complete the System Security Plan (SSP), and the first team to have the pre-connection design meeting with NASA. This marks a significant milestone in the development of the NUANCE Live-Virtual-Constructive Distributed Environment (LVC-DE) Gateway capability given the absence of any existing infrastructure at the start of the SSP process.

2016 NSHE Research Activities Update

Desert Research Institute (DRI)

The Desert Research Institute is continuing to pursue UAS applications research and collaborations. The following are current and new activities.

Current Activities:

1. The NV Governor’s Office of Economic Development (GOED) awarded a project entitled: Development of Unmanned Aircraft System (UAS) for Agricultural Applications. The project will be initiated at the beginning of April with initial UAS flights occurring shortly thereafter. DRI will work with NIAS to use the FAA blanket COA. The team will acquire UAS multispectral data to assess field and crop conditions such as irrigation efficiency and crop stress.

2. Adam Watts (DRI) in collaboration with Drone America and AviSight performed initial autonomous test flights for a UAS cloud seeding platform. The press release for this event was: Autonomous cloud seeding aircraft successfully tested in Nevada. Revolutionary project uniting DRI expertise and Drone America technology

Figure 1. Drone America DAx8 UAS platform with two cloud seeding flares emitting silver iodide particles to induce rain/snow.
3. Adam Watts (DRI) has continued to collaborate with NASA Ames Research Center and Canadian companies to explore UAS wildfire applications, markets and business development. He also continues to evaluate payloads for fire-related UAS operations.

4. Lynn Fenstermaker, DRI UAS Liaison, completed and was awarded a NIAS UAS observer certificate.

5. Lynn Fenstermaker (DRI) worked with U.S. Army Corps of Engineers to acquire 2016 color and color-infrared imagery of biological soil crust features in the Mojave Desert. The Army Corps is using an eBee fixed wing to acquire the images. 11-12 flights (each approximately 20 min in length) were performed during a 2-day period (March 15–16, 2016). Figures 2 and 3 are examples of an individual photo and a resulting mosaic covering the entire study area. DRI is continuing to collaborate with the University of Nevada Reno (UNR) to advise engineering students on UAS related projects that will include 2-3 Reno-area UAS companies.

![Figure 2](image1.png)

**Figure 2.** This is a single color infrared photograph acquired by the U.S. Army Corps of Engineers eBee UAS.

![Figure 3](image2.png)

**Figure 3.** A mosaic of color infrared photographs that encompass the entire study area.

**New and Future Activities:**

1. Hans Moosmuller (DRI) with a team of researchers from UNR and University of Nevada Las Vegas (UNLV) submitted a proposal to the 2016 NASA EPSCoR Research CAN
program (Experimental Program to Stimulate Competitive Research; Cooperative Agreement Notice). The proposal is entitled “Satellite and UAS Sensing of Wildland Fire Processes and Effects Supporting Fire Science and Management”, if awarded, will provide $1.25 million in research funding.

2. DRI, UNLV, and UNR faculty have initiated discussions to prepare a National Science Foundation (NSF) EPSCoR pre-proposal for a $20 million effort to grow UAS and autonomous systems infrastructure within the state.

The Desert Research Institute is continuing to pursue UAS applications research, development and collaborations. Some of the highlights are discussed below by topic area.

**Current Research and Development Activities**

**UAS Agriculture Research Application:** The NV Governor’s Office of Economic Development (GOED) funded a project entitled: Development of Unmanned Aircraft System (UAS) for Agricultural Applications on April 1, 2016. The goals of this project are to acquire and analyze UAS visible (RGB), near infrared and thermal infrared image data to assess variances in field and crop conditions due to pests, disease, environmental conditions (e.g., saline soils) and irrigation inefficiencies. The project was initiated at the beginning of April and a several UAS flights were conducted on June 9th by the project’s business partner, AboveNV. Both fixed wing and rotor platforms were deployed to acquire RGB, near infrared and thermal infrared imagery of agricultural fields, both platforms are depicted in Figure 1.

Although the focus of this project is the development of image products that are of value to the farm manager (see examples in Figure 2), we are also examining efficiencies in UAS operations and image acquisition. All flights to date have been conducted under AboveNV’s Section 333 authorization. To expand UAS operations for this project, DRI and AboveNV are working with the Nevada Institute for Autonomous Systems (NIAS) to become a NIAS Node. This will expand our opportunities for UAS operations at other locations. Because this project has just started, we do not have any specific early research insights to report.

![Figure 2: Examples image products from the June 9, 2016 UAS flights over agricultural fields near Winnemucca NV. The left figure is a natural color image of an alfalfa field; the center figure is a hill-slope image of the same field and depicts elevation; and the](image-url)
right figure is a NDVI (normalized difference vegetation index) image where brighter shades of green indicate higher vegetation cover; elevation contours are superimposed on this image.

New and Future Research and Development Activities

DRI, UNLV and UNR faculty are continuing discussions to prepare a National Science Foundation (NSF) EPSCoR pre-proposal for a $20 million effort to grow UAS and autonomous systems infrastructure within the state.

Lessons Learned

UAS Agricultural Research Application: The primary lessons learned to date for this newly initiated activity include:

1. The hex-rotor platform is performing better under typical afternoon NV wind conditions than anticipated;
2. Image pre-processing time and accuracy will be enhanced after AboveNV completes a hardware/software engineering effort to directly link the UAS platform GPS metadata file with the camera photographs.
3. Efficiencies in deploying ground validation targets are being addressed by comparing inexpensive white vinyl tiles (12” by 24”) and targets created using marker spray paint (glo-orange). Rapid deployment of ground calibration targets must be achieved to ensure that each agricultural field has demarcated ground targets prior to UAS flight operations.

UAS Flight Activities

UAS Agricultural Research Application:

On June 9, 2016, six UAS flights were conducted to meet the mission for that day. The focus of the UAS operation was to acquire RGB, near infrared and some thermal infrared imagery of three 130 acre agricultural fields; one with a pea crop and two with alfalfa. The flights occurred between the hours of 7:30 am (thermal camera) and 2:00 pm. Flights were discontinued at approximately 2 pm because of the increase in wind gusts (typical for summers in NV) and the development of dust devils. All flights began with a complete system check of hardware and software for both the platform and the sensors. Visual observers verified that conditions were appropriate for launch (weather and flying birds) and that all safety protocols were followed. Take-off and landings were performed manually by the pilot and image acquisition was performed autonomously by a pre-defined flight plan that was uploaded to the UAS platform.

The only significant research and development lesson learned from these flights was that cloth ground targets did not perform well. Targets were moved/lost due to dust devils and gusts as well as ground squirrels dragging targets into their burrows.
University of Nevada Las Vegas (UNLV)

UNLV On-Going UAV Projects

1. Enhanced situational awareness using unmanned autonomous systems for disaster remediation ($600,000, NSF, Yim in collaboration with UNR and University of Utah).

2. Infrastructure for enabling mobile manipulation of unmanned aerial vehicle (MM_UAV) (Research and Design, $256,000, P. Oh, NSF).

3. Developed agile and robust consequence monitoring system ($310,000, W. Yim, Sandia National Labs).

4. The Flying Orchestra: A Flying Aerial Robot Live Entertainment System, $92,000, S. J. Kim and P. Stuberrud (with Skyworks), Governor's Office of Economic Development. We plan to work on developing an indoor tracking system for coordinating multiple drones and visualizing musical signage while flying.


6. Developed Plug-and-Play Interchangeable Components for Unmanned Aerial System with Mobile Manipulation Capability ($249,000, A. Barzilov and W. Yim, Savannah River Nuclear Solutions, LLC).

7. Low-Cost Multiple Unmanned Aircraft System for Remote Contour Mapping of a Nuclear Radiation Field ($48,000, P. Oh, NSTec).


10. Development of the second generation air quality measurement UAS (David James).
PROJECT: Development of Unmanned Aerial System with Plug-and-Play Interchangeable Sensor Components and Mobile Manipulation Capability
Woosoon Yim (Co-PI), Alexander Barzilov (PI)

To address the needs of remote sensing and sampling applications, we are developing UAS with plug-and-play interchangeable components: (1) neutron/gamma radiation sensor, (2) gas sensor, and (3) miniature manipulator. The remotely-controlled octocopter with 6.8-kg payload is equipped with the onboard devices (a lidar, Lepton FLIR sensor, Pixhawk flight controller, and a 3DR radio transceiver) and the add-on components. The CLYC radiation sensor allows simultaneous neutron and photon measurements with effective signal discrimination. The electrochemical gas sensor enables a real-time pattern recognition analysis of gases in air. The manipulator enables interaction with the environment such as sample collection and handling, supported with the adaptive UAS control schemes. The plug-and-play interface enables easy attachment of components in the field conditions.

![UAS platform with plug-and-play components.](image)

Fig. 1. UAS platform with plug-and-play components.

(a) (b)

Plug-and-play, add-on UAS components:
(a) CLYC detector assembly; (b) gas sensor board.

Neutron/photon PSD analysis for CLYC sensor.

University of Nevada Reno / Nevada Advanced Autonomous Systems Innovation Center (NAASIC)

UNR focused on or are working serval UAS projects simultaneously including:

1. NASA-NAASIC UTM Project
   a. Software development and testing for UAS integration in the NAS
   b. Ongoing mentoring of undergraduate students involved in UTM research

2. NAASIC is providing Mission Coordination and Flight Operations Support under the NIAS to Insitu, a Boeing subsidiary, for testing of their new Ground Control System, ICOMC2. The first round of flight tests took place during April 3-5, 2016. The second round of testing is scheduled for May 3-4, 2016.

3. NAASIC is working with graduate students and faculty in the UNR Dept. of Anthropology to conduct UAV research on BLM property to produce high resolution maps of archaeology sites for creation of baseline datasets and detection of artifacts. The test flights are scheduled for the third week in May.

4. NAASIC will be providing Mission Coordination and Flight Operations support to Sudeep Chandra, UNR Professor of Biology, to conduct a habitat survey using drones at Mahogany Creek/Summit Lake in Northern Nevada. Summit Lake is home to a strong population of Lahontan Cutthroat trout and sage grouse. The mission is to identify the following attributes along the stream: pools/ riffles, riparian vegetation, and stream temperature. These flights are planned for August.

5. NAASIC is providing technology transfer mentoring and support to a company that is developing innovative propulsion systems that will benefit UAS technology.
6. NAASIC has a contract with Weston Solutions to survey uranium mine tailings with UAVs on the Navajo Lands in New Mexico and Arizona for the EPA. These flights are not yet scheduled.

**Completed projects in the 1st Half**

1. Design, construction, staffing, computer network installation, and furnishing of the NUANCE lab at the Reno-Stead Airport.

2. NAASIC partnered with Dr. Scott Tyler from the UNR Dept. of Geology to conduct UAV aerial surveys at the Ormat Brady Hot Springs Geothermal Plant as part of a DOE-funded research project entitled *The Porotomo Project*. Other partners included Oregon St. Univ., Univ. of Wisconsin, Temple Univ., Lawrence Livermore Nat. Lab., Lawrence Berkeley Nat. Lab., and Silixa Ltd. The research flights in March, 2016, were NAASIC’s first opportunity to act as Mission Coordinator under the NIAS. More information about the Porotomo project can be found at the following link: [http://geoscience.wisc.edu/geoscience/people/faculty/feitl/porotomo/](http://geoscience.wisc.edu/geoscience/people/faculty/feitl/porotomo/)

**Top three lessons learned:**

NAASIC has acted as the Mission Coordinator for the State of Nevada Test Site under the direction of the Nevada Institute of Autonomous Systems (NIAS). The first flight operations were conducted with a group of scientists from the University of Nevada, Reno, and the Oregon State University for aerial data collection. The second set of flights were with Insitu and the public purpose of these missions was to test a new ground control system that will be the focus of an undergraduate course being taught jointly by Insitu and the UNR College of Engineering in Fall 2016.

1. Start planning the missions as early as possible. There is an overwhelming number of documents about the crew qualifications, certifications, and training; the aircraft specifications and maintenance; the GCS; the location of the flights; the legal documents to establish a relationship between both parties; the insurance; and other forms of permission, such as media rights. The process of planning a UAV mission can take several weeks and if not done properly, the result can be disorganization and stress for everyone involved. Recommendation - never think it is too early to start planning.

2. Make sure that all of the crew members are not only well prepared for their role in the mission, but that they are aware of the overall mission plan and objectives. The ability for any crew member to contribute to the overall success of the mission is increased if they are engaged with what is going on around them. Recommendation – conduct thorough mission briefs and range safety briefs.

3. Another important aspect of the missions was the comfort of the crew. Flying UAVs is often done in remote locations where there are no amenities and little protection from the elements. We have learned to stress to the crew to not underestimate how hot, cold, windy, or wet it can get in the field. Lack of proper clothing and hydration is a common
problem. Recommendation - make sure that everyone is highly aware of anticipated weather, range conditions, and availability of food, water, and bathrooms.

I. Major Research and Development Activities

1. Dr. Richard Kelley continues to be very involved in the NASA UTM project with software development and testing. NASA will be returning to Reno at the end of June for the UTM TCL-2 software checkout #2.

2. The grand opening of the Nevada Unmanned Aircraft and NextGen Collaborative Environment Laboratory (NUANCE) Lab at Reno-Stead airport was held on April 6, 2016. This event was coordinated by the Reno-Tahoe Airport Authority and attended by Governor Brian Sandoval, UNR Administrators, NASA representatives, GC2IT, Flight Research Assoc., and NIAS.

3. NAASIC hosted the first annual Search and Rescue (SAR) Symposium from April 6-8. There were 12 speakers, a discussion panel, and 2 breakout sessions that covered topics from Advanced Search Techniques with Drones to Sensor Technologies and Beyond Line of Sight. Nearly 100 people attended from across the country, as well as many first responders from Washoe County and neighboring counties. The Symposium will be repeated next year.

4. UNR is an Insitu Registered Software for Training member and is offering an undergraduate course on the Insitu ICOMC2/Inexa ground control software and Integrator plug-in applications in the Department of Engineering in fall 2016. Insitu visited the UNR campus on June 5-8 to train 3 UNR Engineering faculty and 2 NAASIC staff members on the use and instruction of ICOMC2/Inexa. The course will be part of the UAS minor curriculum at UNR.

II. Top 3 Lessons Learned

1. Problem: the biggest challenge to flying UAVs in Nevada is the process of gathering all of the requirement documents. It is sometimes a challenge for our customers to submit the documents to us in a timely fashion. Solution: a firm, but gentle approach and planning for sufficient lead time.

2. Problem: the FAA data reporting sheets are a bit cumbersome to fill in. Solution: pre-fill as much as possible before you go in the field.

3. Problem: We would like to offer more opportunities to complete the practical training for Visual Observers, but the paperwork under the COA is very time consuming. Solution: develop different regulations for VO practical training.
III. Featured Research Project

NAASIC was instrumental in the successful execution of the NASA UTM Project Task 1 Initial Safe National UAS integration Campaign/Initiative for the State of Nevada Test Site. Dr. Kelley and his team of undergraduate students worked for months developing, implementing, and testing the UTM software for integration of UAS in the NAS. Each test site was required to have 4 aircraft in the air for the test, so NAASIC purchased 2 new platforms and partnered with the UNR Hydrogeology UAS team to use 2 of their platforms. NAASIC assembled the ground crew, which included 2 Nodes, and 4 each of PICs, Vehicle Operators, GCS Operators, VOs, and volunteers to record the flight data. The flight crew complied with COA regulations and completed the Crew Resource Management Training and obtained their Class II medical certificates. NAASIC, with the help of the RTAA, handled other logistics, such as ensuring that the north and south test sites each had tents, tables, chairs, generators, extension cords, power strips, emergency supplies, and water. NAASIC also provided labelled volunteer vests, radios, clipboards, and FAA data sheets to the operators, VOs and volunteers. A dress rehearsal was conducted on Friday, April 15, from 9am to 1pm and the National Campaign flight operations took place from 9am-12pm on Tuesday, April 20. NAASIC compiled the Range Operations Book and submitted the completed FAA data sheets to NIAS.

The National Campaign was NAASIC’s most complex flight operation to date. Although there were a few small software issues during the test (it was a test after all), NAASIC was extremely pleased with the outcome. The crew and the volunteers worked so well together that we hope to assemble the same crew for future flights. Communication between the PICs and the NASA point of contact went smoothly, as did communication among all of the ground flight crews. The weather was perfect and 28 missions were conducted. We owe the success of the operation to the many partners and volunteers who contributed their time and efforts, but especially to Dr. Kelley for his technical contributions and for training the undergraduate students who were at the controls. In the end, the success of the mission rested on the shoulders of the students.

IV. Flight Activities

NAASIC provided Mission Coordination to Insitu, a Boeing subsidiary, for testing of their new Ground Control System, ICOMC2/Inexa. Test flight operations took place at the Reno Radio Control Club on April 3-4 (41 missions), May 5-26 (21 missions), and June 2 (8 missions). NAASIC coordinated test flights for graduate students and faculty in the UNR Dept. of Anthropology to conduct aerial surveys of archaeology sites on BLM property just north of Reno. NAASIC provided the aircraft and crew for the BLM flights on 5-20-16 (10 missions). Data processing for these missions is ongoing. NAASIC is also collaborating with the UNR Dept. of Anthropology to map the Ft. Churchill State Historic Site with UAVs. These flights were scheduled for 5-24-16, but have been postponed until next quarter. NAASIC provided
N2AMS support for Ausley and Assoc./Carbon Autonomous by conducting an Airworthiness Statement evaluation on 3 different UAS platforms on 6/10/2016.

**Featured Research Project.** NAASIC was instrumental in the successful execution of the NASA UTM Project Task 1 Initial Safe National UAS integration Campaign/Initiative for the State of Nevada UAS Test Site. Dr. Kelley and his team of undergraduate students worked for months developing, implementing, and testing the UTM software for integration of UAS in the NAS. Each test site location at the Reno-Stead Airport UAS Range was required to have four aircraft in the air for the test, so NAASIC purchased two new platforms and partnered with the UNR Hydrogeology UAS team to use two of their platforms. NAASIC assembled the ground crew, which included two Nodes, and four PICs, Vehicle Operators, GCS Operators, VOs, and volunteers to record the flight data. The flight crew complied with COA regulations and completed the Crew Resource Management Training and obtained their Class II medical certificates. NAASIC, with the help of the RTAA, handled other logistics, such as ensuring that the north and south test sites each had tents, tables, chairs, generators, extension cords, power strips, emergency supplies, and water. NAASIC also provided labelled volunteer vests, radios, clipboards, and FAA data sheets to the operators, VOs and volunteers. A dress rehearsal was conducted on Friday, April 15, from 9am to 1pm and the National Campaign flight operations took place from 9am-12pm on Tuesday, April 20. NAASIC compiled the Range Operations Book and submitted the completed FAA data sheets to NIAS.

The NASA National Campaign was NAASIC’s most complex flight operation to date. Although there were a few small software issues during the test (it was a test after all), NAASIC was extremely pleased with the outcome. Communication between the PICs, flight crew members, NIAS, and NASA went smoothly. The weather was optimal for the flying UAS and 32 COA flights were completed. We owe the success of the operation to the many partners and volunteers who contributed their time and efforts, but especially to Dr. Kelley for his technical contributions and for training the undergraduate students who were at the controls.

**Flight Activities.** NAASIC provided mission coordination to Insitu, a Boeing subsidiary, for testing of their new Ground Control System, ICOMC2/Inexa. Test flight operations took place at the Reno Radio Control Club on April 3-4, May 5-26, and June 2. NAASIC coordinated test flights for graduate students and faculty in the UNR Dept. of Anthropology to conduct aerial surveys of archaeology sites on BLM property just north of Reno. NAASIC provided the aircraft and crew for the BLM flights on 5-20-16. Data processing for these missions is ongoing. NAASIC is also collaborating with the UNR Dept. of Anthropology to map the Ft. Churchill State Historic Site with UAVs. These flights were scheduled for 5-24-16, but have been postponed until next quarter. NAASIC provided support for Ausley and Assoc./Carbon Autonomous by conducting an Airworthiness review and evaluation with NIAS on 3 different UAS platforms on 6/10/2016.
Lessons Learned. The biggest challenge to flying UAVs in Nevada is the process of gathering all of the required FAA flight documents. It is sometimes a challenge for our customers to submit the documents to us in a timely fashion. Solution: a firm, but gentle approach and plenty of lead time.

Summary

Nevada personnel have surpassed operational 1\textsuperscript{st} and 2\textsuperscript{nd} Quarter milestones and will continue to accelerate the Nevada UAS Industry growth by increasing COA flights, opening up airspace opportunities, and generating or stimulating the Nevada UAS business leads. Nevada personnel will continue to develop new relationships that result in real business opportunities for Nevada Teammates. Nevada personnel will also continue to develop grass-roots UAS focused efforts through the expansion of the operational concept of the UAS Economic Cluster Zones throughout Nevada. These efforts will be even more critical for 3\textsuperscript{rd} Quarter and beyond. Finally, Nevada personnel will continue to prepare for and capitalize on the next wave of UAS innovation – i.e., the integration of unmanned aviation and driverless vehicles.

Nevada personnel have surpassed previous operational milestone projections by a wide-margin and will continue to accelerate the Nevada UAS Industry growth by increasing COA flights, opening up airspace opportunities to Nevada Teammates and NIAS command and control (C2) nodes, and generating or stimulating the Nevada UAS business leads. Nevada continues to advance research projects and the Nevada UAS Industry in multiple areas including Cloud Seeding, Counter UAS, Urban Package Delivery, and Consumer Drone Safety establishing Nevada as global thought leader. Nevada personnel have begun collaboration with several city municipalities to advance the concept of the UAS Economic Cluster Zones throughout Nevada. These efforts will benefit Nevada UAS businesses by ensuring viable work projects and continual business growth quarter-over-quarter.

The next six months will be an expansion of activities began during the 1\textsuperscript{st} half reporting period. Nevada personnel will increase efforts towards larger UAS operations and R&D focused on new applications including; cloud seeding, cUAS, advanced package delivery and associated technologies. In addition, Nevada personnel will continue to develop airspace infrastructure to support BVLOS UAS flight operations and pursue opportunities that will stimulate UAS Economic Cluster Zone development.
## Appendix A: Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
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<tr>
<td>BLM</td>
<td>Bureau Of Land Management</td>
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<td>BVLOS</td>
<td>Beyond Visual Line of Sight</td>
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<tr>
<td>CFR</td>
<td>Code Of Federal Regulations</td>
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<tr>
<td>COA</td>
<td>Certificate of Waiver or Authorization</td>
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<tr>
<td>COE</td>
<td>Center Of Excellence</td>
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<tr>
<td>DAR</td>
<td>Designated Airworthiness Representative</td>
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<tr>
<td>DRI</td>
<td>Desert Research Institute</td>
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<td>FAA</td>
<td>Federal Aviation Administration</td>
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<td>FAAST</td>
<td>FAA Safety Team</td>
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<td>FTC</td>
<td>Federal Trade Commission</td>
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<tr>
<td>GOED</td>
<td>Governor’s Office of Economic Development</td>
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<tr>
<td>JPDO</td>
<td>Joint Planning and Development Office</td>
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<tr>
<td>MM_UAV</td>
<td>Mobile Manipulation of Unmanned Aerial Vehicle</td>
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<tr>
<td>N/A</td>
<td>Not Applicable</td>
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<tr>
<td>NAASIC</td>
<td>Nevada Advanced Autonomous Systems Innovation Center</td>
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<td>NAS</td>
<td>National Airspace System</td>
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<td>NASA</td>
<td>National Aeronautics And Space Administration</td>
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<td>Naval Air Systems Command</td>
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<td>NIAS</td>
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<td>NM</td>
<td>Nautical Miles</td>
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<td>NNSS</td>
<td>Nevada National Security Site</td>
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<td>NOAA</td>
<td>National Oceanic And Atmospheric Administration</td>
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<td>NSHE</td>
<td>Nevada System of Higher Education</td>
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<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<td>OL</td>
<td>Operating Location</td>
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<tr>
<td>Acronym</td>
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<td>OTA</td>
<td>Other Transaction Agreement</td>
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