



Report of the Governor's Oklahoma Unmanned Aerial Systems Council: 2015

A Strategic Plan for the Development of an Unmanned
Aerial Systems Enterprise in the State of Oklahoma



Governor's Unmanned Aerial Systems Council

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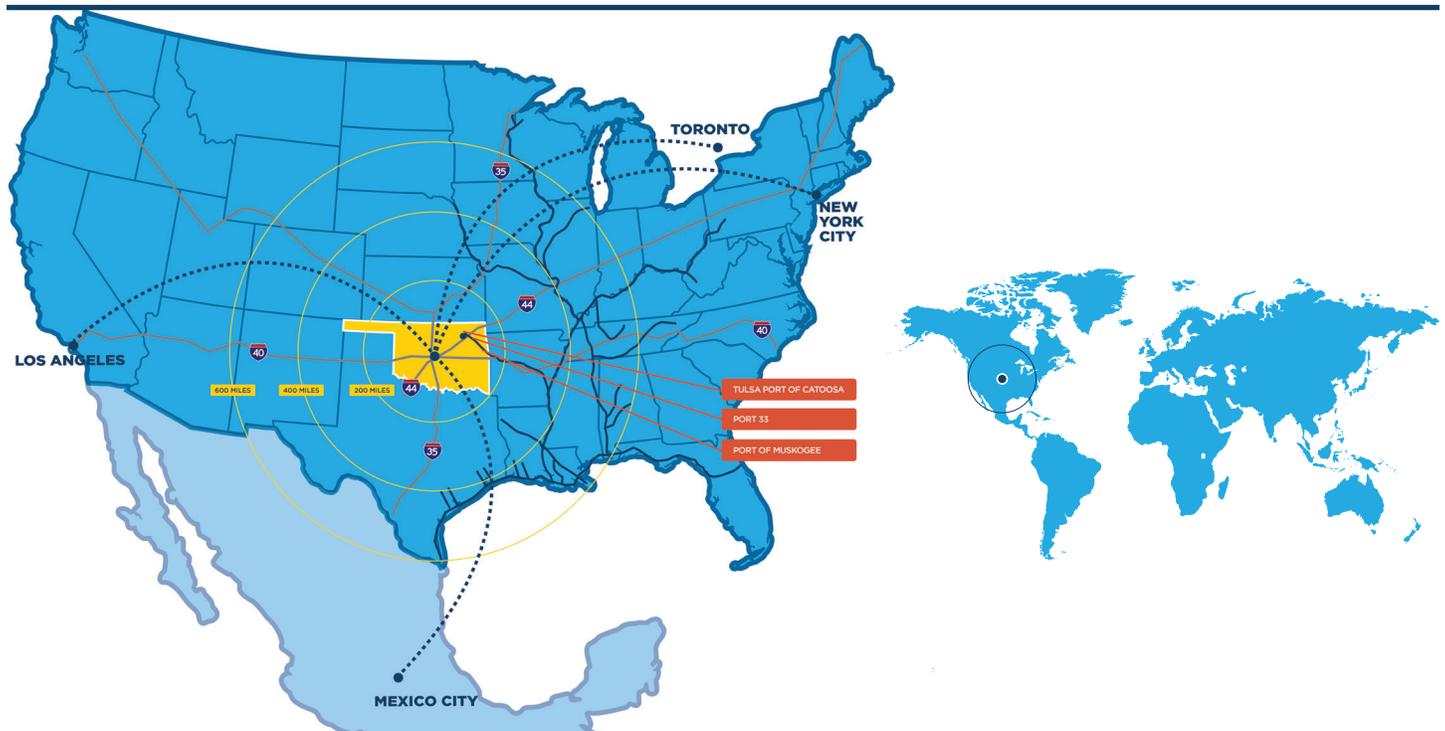


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EXECUTIVE SUMMARY

In 2011 the Unmanned Aerial Systems (UAS) Advisory Council was appointed by Oklahoma Governor Mary Fallin to establish a best path to growth of a UAS industry in Oklahoma. The result was the “Strategic Plan for the Development of an Unmanned Aerial Systems Enterprise in the State of Oklahoma,” the first version of which was published in 2012. The council, led by the Governor’s Secretary for Science and Technology, consists of individuals from the public and private sectors and is an illustration of the coordinated response from the state to the opportunities in the UAS arena. The 2012 plan was meant to be pragmatic and to build upon the strong foundation of existing UAS activities and infrastructure. Recommendations covered expansion of UAS test ranges, investment into research and development, and growth of educational and training programs. In this new, updated version of the Strategic Plan, we assess the progress made towards the recommendations from 2012 and develop new recommendations commensurate with the national developments that have occurred in the intervening years.

In addition, for this version of the Strategic Plan we have generated a “roadmap” for the development of the UAS industry in Oklahoma, covering a longer period (10 years) than that covered in this Strategic Plan. The elements of this plan, including its detailed recommendations, are consistent with and part of the overall roadmap. The roadmap may be used as a guide when further revising the Strategic Plan in future years.

Economic forecasts for the growth of the UAS industry, both worldwide and in the U.S, continue to indicate a burgeoning industry set to grow rapidly. A July 2014 report from the Teal Group indicates that UAS will continue to be the most dynamic growth sector of the aerospace industry over the coming decade. UAS spending will nearly double over the next decade from the current \$6.4 billion to \$11.5 billion per year, totaling almost \$91 billion over the next ten years. The civilian portion of this market also continues to grow, as does the U.S.’s share of the market. The Teal Group predicts that the U.S. market will account for 65% of R&D spending, and 41% of procurement. 86% of this market will be military (down from the current 89%), while the commercial sector will grow from the current 11% to 14% by the end of the decade.

The Association of Unmanned Vehicle Systems International's (AUVSI's) March 2013 report indicated that integration of UAS into the national airspace system will generate over 100,000 jobs nationwide, especially in the applications sectors. Of these sectors, the AUVSI report projects that agriculture will be the largest.

Oklahoma must position itself as a region in which this industry can flourish. Oklahoma continues to build the major assets needed to grow a significant UAS industry in the state, but growth is slow. This is partly due to the lack of clarity regarding regulations for commercial operation at the national level. However, such concerns equally affect all aspects of the industry and all regions of the country. A second, more specific reason is that Oklahoma has not yet committed to the necessary state-wide investment in organization and R&D.

Existing partnerships among and between public entities (ODOC, OAC, OSIDA, OSU, OU, UML OKNG, etc.) and private sector entities remain strong and strengthen the competitive position of the state. Oklahoma maintains a growing UAS private sector, with private companies involved in all facets of UAS. The number of private companies in Oklahoma involved in UAS as part of their business, wholly or partly, has increased by more than 45% since the 2012 Strategic Plan. Private entities in Oklahoma have strong capabilities in UAS development, test and simulation, composites, propulsion, sensors, training and many other areas. Business incentive packages in the aerospace sector continue to be popular. Leadership from state government (Governor and Legislature) and support from federal congressional members continues to be strong and unwavering and completes a well-rounded package that should enable Oklahoma to be a major player in the development of the UAS industry in this country in the coming decade.

1. CURRENT STATUS, 2015

1.1 The UAS Market

Unmanned Aerial Systems (UAS, also known as Unmanned Aircraft Systems, or Remotely Piloted Aircraft Systems, RPAS) is still the fastest growth area in the aviation industry today. The Association of Unmanned Vehicle Systems International (AUVSI) published an Economic Impact Report of UAS integration into the National Airspace System (NAS) in the U.S.¹ and concluded that 100,000 new jobs will be created as a result of this industry by the year 2025. They also concluded that **“states that create favorable regulatory and business environments for the industry and the technology will likely siphon jobs away from states that do not.”**

Application categories listed individually by AUVSI included:

- Wildfire mapping
- Agricultural monitoring
- Disaster management
- Thermal infrared power line surveys
- Law enforcement
- Telecommunication
- Weather monitoring
- Aerial imaging/mapping
- Television news coverage, sporting events, movie-making
- Environmental monitoring
- Oil and gas exploration and
- Freight transport

AUVSI based its economic forecast on Precision Agriculture, Public Safety and “Other” (to include all other markets). This has generated some criticism due to the view that the “Other” category not being as well developed as the others. Nevertheless, the data are informative.

The report concludes:

- “1. The economic impact of the integration of UAS into the NAS will total more than \$13.6 billion in the first three years of integration and will grow sustainably for the foreseeable future, cumulating to more than \$82.1 billion between 2015 and 2025;*
- 2. Integration into the NAS will create more than 34,000 manufacturing jobs and more than 70,000 new jobs in the first three years;*
- 3. By 2025, total job creation is estimated at 103,776;*
- 4. The manufacturing jobs created will be high paying (\$40,000) and require technical baccalaureate degrees;*

¹“The Economic Impact of Unmanned Aircraft Systems Integration in the United States” AUVSI, March 2013.
<http://www.auvsi.org/econreport>

5. Tax revenue to the states will total more than \$482 million in the first 11 years following integration (2015-2025); and
6. Every year that integration is delayed, the United States loses more than \$10 billion in potential economic impact. This translates to a loss of \$27.6 million per day that UAS are not integrated into the NAS.”

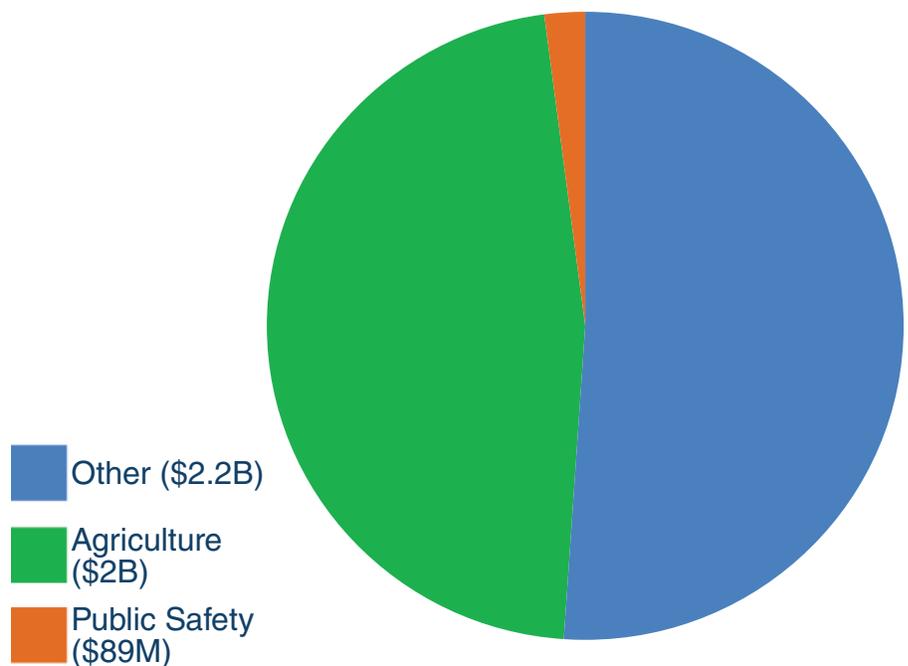
(References to Tables have been removed from the above quotation for clarity.)

See Figure 1.

The Economic Impact

Where will drones be in 2015?

- Wildfire mapping
- Disaster management
- Thermal infrared power line surveys
- Telecommunications
- Weather monitoring
- Aerial imaging/mapping
- Television news coverage, sporting events, movie-making
- Environmental monitoring
- Oil and gas exploration
- Freight transport



Source: Association for Unmanned Vehicles and Systems International
 Economic Impact Report - March, 2013
 Produced by: Matthew Schroyer, DronesForGood.com, DroneJournalism.org

Figure 1: “The Economic Impact of Unmanned Aircraft Systems Integration in the United States” AUVSI, March 2013.
<http://www.auvsi.org/econreport>

For Oklahoma, the economic impact is predicted as \$657 million and over 800 jobs by 2025, with \$5.6M in taxes collected.

General economic forecasts for the growth of the UAS industry, both worldwide and in the U.S., continue to indicate a burgeoning industry set to grow rapidly. The July 2014 report from the Teal Group² indicates that UAS continues to be the most dynamic growth sector of the aerospace industry this decade. UAS spending will nearly double over the next decade from the current \$6.4 billion to \$11.5 billion per year, totaling almost \$91 billion over the next ten years. The civilian portion of this market also continues to grow, as does the U.S.'s share of the market. The Teal Group predicts that the U.S. market will account for 65% of R&D spending, and 41% of procurement. 86% of this market will be military (down from the current 89%), while the commercial sector will grow from the current 11% to 14% by the end of the decade.

Just as companies are positioning themselves in the UAS marketplace, so too should Oklahoma position itself as a region in which these companies can flourish. Oklahoma continues to build the major assets needed to grow a significant UAS industry in the state, creating high-paid and quality jobs. However, growth is slow. This is partly due to the lack of clarity regarding regulations for commercial operation at the national level. However, such concerns affect all aspects of the industry and all geographical regions equally. A second, more specific reason is that Oklahoma has not yet committed to the kind of state-wide investment in organization and, especially, R&D that is necessary for success in this competitive arena. This is despite the fact that Oklahoma's assets continue to include nationally recognized R&D in unmanned aircraft vehicle design, payloads and radar, as well as strong programs in applications, test and verification, education and training.

Payloads will represent a significant part of this growth, with spending on electro-optic/infra-red (EO/IR) cameras, synthetic aperture radars (SAR), signals intelligence (SIGINT) and electronic warfare (EW) systems accounting for \$5.6 billion in FY23, up from the current \$2.8 billion. Manufacturers in the UAS sector will also show enterprising growth, "again continuing as one of the prime areas of growth for defense and aerospace companies", as will applications, with Google, Amazon and Facebook featured prominently in the Teal Group analysis.

1.2 FAA and the National Airspace

The most critical factor to achieve this anticipated growth is the opening of the National Airspace System (NAS) in the United States to allow integration of unmanned and manned flights. Federal legislation – the National Defense

² World Unmanned Aerial Vehicle Systems, Market Profile and Forecast 2014, the Teal Group.
<http://www.tealgroup.com/index.php/about-teal-group-corporation/press-releases/118-2014-uav-press-release>

Authorization Act (NDAA, Dec. 2011), and its associated Appropriations Act (H.R. 2055, Public Law No. 112-74, Dec. 2011) and the FAA Modernization and Reform Act (FMRA, H.R. 658, Feb. 2012) – mandated the FAA to “develop a comprehensive plan to safely integrate commercial unmanned aircraft systems into the national airspace ... the plan shall provide for the safe integration of civil unmanned aircraft systems into the national airspace system as soon as practicable, but not later than Sept. 30, 2015.”

As noted in the 2012 report, in order to achieve this goal, the FAA and UAS community will have to overcome several significant challenges. These include safe UAS operations, cultural acceptance, definition of UAS standards, definition of the usable radio spectrum and satellite bandwidth as UAS moves into commercial markets, and many other issues. The complexity of aviation rules and regulations, along with early legal challenges have confused many in the UAS community and the public, and public understanding and perception of aviation rules and regulations is an important matter. Safety, however, remains the primary focus of the FAA. Safety standards will eventually need to allow “file-and-fly” and this will require the development of “lost-link” procedures, “detect-and-avoid” capabilities, pilot training certifications, airworthiness certifications, maintenance standards, etc. Although there are currently multiple technologies that allow various levels of detect-and-avoid, including active and passive systems, achieving the above goals is non-trivial and there is a considerable distance for the UAS community to travel.

One Section of the FMRA, Section 333, has taken on high importance in recent months, primarily for small UAS operations. This section allows exemptions for some UAS as long as they are judged to meet certain safety and operational standards (“Section 333 exemptions”). To date few Section 333 exemptions have been approved, the first six being for the movie industry. There are currently (at the time of this writing) approximately 575 Section 333 exemptions requests under review at the FAA and this number is growing weekly. As of the date of this report, 47 have been approved. It is important to remember that, for small UAS, Section 333 exemptions are only important in the period before the FAA finalizes the small-UAS rules. Once the small-UAS rules are in effect, most operations will be covered by the small-UAS rules, although there will still be the potential for seeking exemptions to those rules.

An important step was the selection by the FAA of six FAA UAS Test Ranges in the U.S. to allow the use of non-exclusionary (i.e. unrestricted) airspace for integrated manned and unmanned flight operations in the NAS.

The selected sites were:

- **University of Alaska** (includes test ranges in Hawaii and Oregon)
This test site became operational May 5, 2014.
- **State of Nevada**
This test site became operational June 9, 2014.

- **New York’s Griffiss International Airport** (includes test range locations in Massachusetts).
This test site became operational Aug. 7, 2014.
- **North Dakota Department of Commerce**
This test site became operational April 21, 2014.
- **Texas A&M University – Corpus Christi**
This test site became operational June 20, 2014.
- **Virginia Polytechnic Institute and State University (Virginia Tech)**
(includes test ranges in New Jersey, partnered with Rutgers University).
This test site became operational Aug. 13, 2014.

Oklahoma was unsuccessful in its bid to become one of the selected test sites. Another important milestone has been the release, of proposed rules regarding the operation of small UAS. These rules were originally planned for release in January of 2012 and have been eagerly anticipated by the UAS community. At the time of this report the release of the draft rules has triggered a period of public comment before the final rules are set. Estimates vary as to when the final rules will be established, but range from late 2015 to early 2017. In the meantime, commercial operations are allowed only through Section 333 exemptions, or Special Airworthiness Certification. Oklahoma, via the state’s AUVSI Chapter, USA-OK, will be submitting comments on the proposed rules.

1.3 Education and Training

Academic programs will grow alongside the UAS military and commercial opportunities. Already universities across the nation are beginning to introduce UAS-related curricula into degree programs, with Oklahoma State University being the first to offer a complete UAS Option at the graduate level, as a specialization in the MS and PhD programs in Mechanical and Aerospace Engineering. OSU now also offers a Minor BS degree in UAS operation and piloting.

Spartan College of Aeronautics and Technology have started a new program in Aviation Electronics Technology devoted to UAS. The program is certified by the National Center for Aerospace and Transportation Technologies and offers a 13-month Diploma or a 16-month Associates Degree. The program is one of the first of its kind in the country.

UAS research falls into two general categories: 1) UAS technology research; and 2) research that uses UAS technology as an application tool. Different universities will specialize in different aspects of the UAS industry, with some concentrating on engineering – design and manufacture of the platform (Unmanned Aerial/Aircraft Vehicles, UAVs) – while others concentrate on pilot

training, payload design, radar and RF communications, or applications. The FAA's regulations for small UAS are more rigorous than the UAS community originally estimated. For example, the proposed rules include VLOS only and extensive training for operators.

1.4 Opportunities for Oklahoma

Oklahoma continues to occupy a favorable position in the nascent UAS industry - despite the slow progress from the FAA regarding the development of rules and regulations to enable commercial opportunities for UAS industry. As noted in this document immediate opportunities for Oklahoma exist with the DHS RAPS program, the FAA Center of Excellence (CoE) initiative, and for UAS weather research, in addition to agriculture and energy applications.

There are several major, wealth generating industries contributing to the Oklahoma economy. These are Energy (especially Oil and Gas), Agriculture, Aerospace, Defense and Security, Transportation and Information Technology. Each of these areas will benefit from the introduction of UAS technology. Potential applications include: oil and gas pipeline monitoring; power transmission and distribution line inspection; crop monitoring and spraying; livestock monitoring; and many others.

A variety of UAS assets already exist in the state to support this nascent industry. These include:

- **Chilocco (Kay County)** – 5,000 acres, including a former school comprised of approximately 170 acres, around 80 buildings, chemical and biological training facilities, RF test range and limited SUAS operations. Leased land. Class G airspace.
- **Camp Gruber Joint Maneuver Training Center (CGJMTC)** – A 33,000-acre National Guard training center comprised of firing ranges, collapsed-structure training venues, and planned refurbishment of a runway for UAS operations. Classes G & E airspace.
- **Clinton-Sherman Airport (Burns Flat, Okla.)** – A decommissioned former Strategic Air Command base with a 13,500 ft. runway and 100,000 sq. ft. of hangar space. Planned CoAs to operate UAS. Classes D or G and E airspace. Classes E and G airspace.
- **Muldrow Army Heliport (OK Army National Guard heliport at Lexington, Okla.)** – A CoA is in place to operate UAS (Class G airspace), and planned air corridors to access Ft. Sill restricted airspace and CGJMTC. Class G and E airspace.

- **Kessler Atmospheric and Ecological Field Station (KAEFS)** – A 350-acre site owned by OU, southwest of Norman. CoA to operate UAS. Classes G and E airspace.
- **Unmanned Systems Development Center (UDC)** – R&D and training facility to be constructed in the Oklahoma Technology and Research Park (Stillwater) to accommodate rapid development and prototyping of unmanned aircraft and their components and payloads. Includes electromagnetic compatibility (EMC) chambers (anechoic and reverberation) for “bench” testing of RF communications and procedures.
- **University Multispectral Laboratories (UML)** – A government-owned (under Oklahoma State University) contractor-operated 501(c)3 company. Sensor Laboratories for CBRNE and C5ISR payloads for UAS. Headquartered in Ponca City.
- **University of Tulsa** – Institute for Information Security (iSec) – A multidisciplinary program on cyber security.
- **Spartan College of Aeronautics and Technology** – Provides training to pilots and aeronautics technicians in all fifty states and many foreign countries. Specializes in electronic technician training for UAS. Located in Tulsa.
- **OU, Norman - Advanced Radar Research Center** – R&D for advanced radar development and testing. This is a state-of-the-art radar laboratory (UAS Radar and Sensor Systems Center at the OU Radar Innovations Laboratory) to develop, construct, test and evaluate radar systems that can be used specifically for UAS applications.
- **OSU, Stillwater** – UAS R&D (Education and Training) – UAS Option for MS and PhD degrees in Mechanical and Aerospace Engineering. OSU Flight Test Center for education and training; east of Stillwater. Advanced R&D for UAV construction and design.
- **Unmanned Systems Innovation Center (USIC)** – Located at the Tinker Business and Industry Park in Midwest City. Space for business, manufacturing, testing.

A map of these critical assets for Oklahoma is shown in Figure 2 on page 15.

Clearly, the opportunities for Oklahoma in the UAS business are statewide, with impact across many different regions of the state. A UAS industry in Oklahoma therefore has the potential to positively impact many communities across the state and is not centered on one region alone.

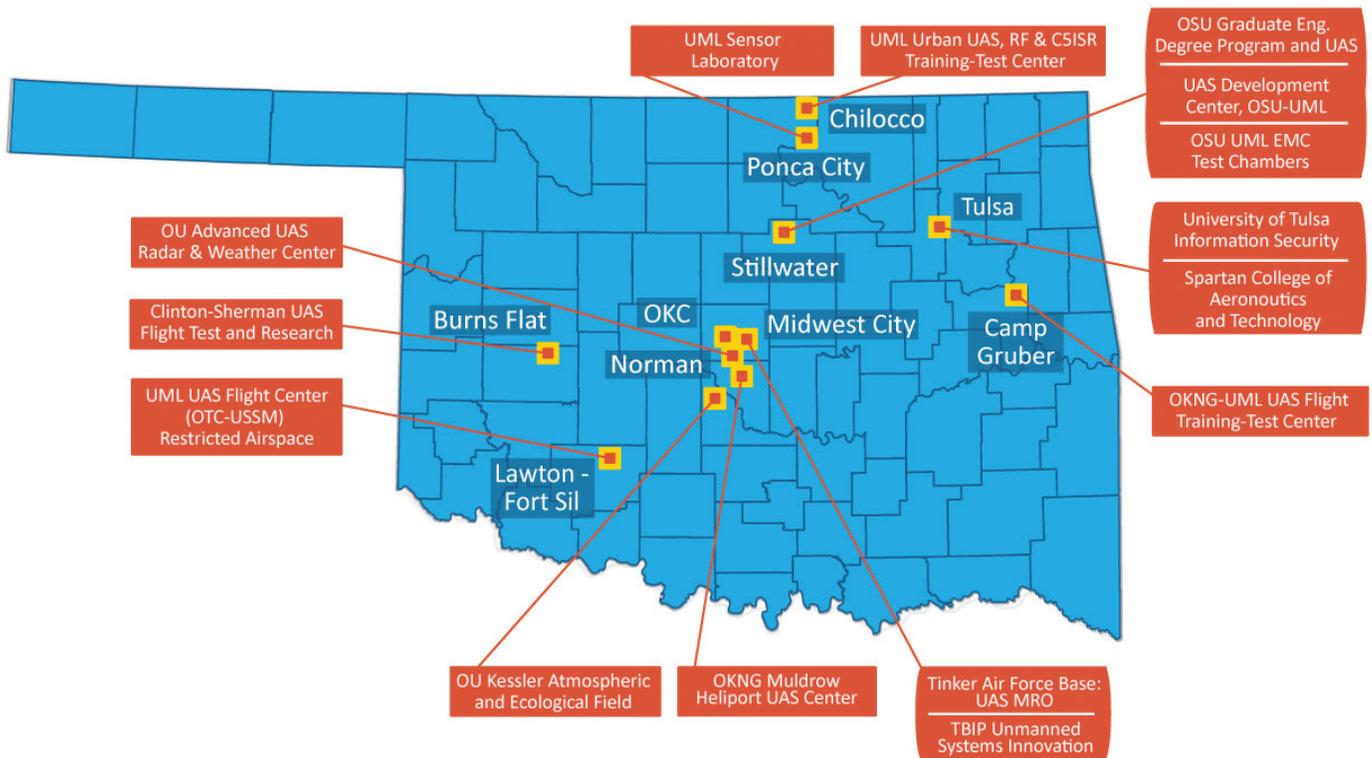


Figure 2: Existing UAS Infrastructure in Oklahoma

In addition to the existing and planned assets indicated above, it should be noted that Oklahoma is already home to many private sector companies involved in the UAS business. Existing companies (22) with some or all of their current business in UAS include (alphabetical order):

- Cherokee Nation Research Laboratories (Ponca City)*
- Design Intelligence Incorporated LLC (Norman)*
- Dow Aero Logistics LLC (Oklahoma City)*
- FlightSafety International (Broken Arrow)*
- FLIR Systems Inc. (Stillwater)*
- Frontier Electronic Systems (Stillwater)*
- General Atomics Systems Integration (Midwest City)*
- Global ResQ Inc. (Duncan)*
- Hodges Aviation (Oklahoma City)*
- L-3 Comm AMI (Broken Arrow)*
- Objectstream Inc. (Oklahoma City)*
- OSU-University Multispectral Labs, LLC (Ponca City)*
- Plexsys Interface Products Inc. (Oklahoma City)*
- Republic Aero Inc. (Duncan)*
- Scoutsman Unmanned, LLC (Edmond)*
- Supero UAS (Oklahoma City)*
- Tactical Electronics Inc. (Broken Arrow)*
- TDRS LLC (Lawton)*
- Unmanned Cowboys LLC (Stillwater)*
- Vector Air LLC (Oklahoma City)*
- Wave Technologies Inc. (Guthrie)*
- Zivko Aeronautics Inc. (Guthrie)*

The previous list represents a more than 45% increase since the 2012 Strategic Plan. *Brief descriptions of each of the above are given in Appendix 1.*

1.5 Privacy and Related Issues

The growth of UAS has the potential for enormous good and economic benefit for all residents, introducing new capabilities simply not possible at present. As with any new technology, however, new capabilities come with the potential for abuse. The state of Oklahoma takes these issues and concerns seriously. We support calls for thoughtful and informed dialogue to address these concerns and for the industry to work with privacy advocates, policymakers and legislators to provide the necessary protections against misuse.

We also recognize the delicate balance of encouraging and fostering technology innovation and economic growth while ensuring that important personal rights and safety are protected. This is only possible by careful, well-informed debate, dialogue and exchange of opinions and ideas among all stakeholders.

We also call on legislators and policymakers to look at the body of existing law to determine applicability to the UAS industry, before proposing new restrictions or laws. For example, Oklahoma has existing statutes that address privacy (including “Peeping Tom” laws), wiretapping, trespassing, and other statutes that are part of common law and criminal codes. If necessary, we recommend that these laws be strengthened first, before introducing new legislation.

We also call on legislators and policymakers to consider carefully the potential impact of any new legislation or regulation on important constitutional rights. For example, First Amendment free speech rights can be complex and it is important that any new UAS-related legislation or regulations carefully consider the potential impact on the First Amendment and other rights.

Finally, we call on all Oklahoma citizens – including public entities and officials – to conduct UAS operations in a safe and responsible manner, and in a way that recognizes and protects the rights of all people in the state.

2. FOCUS AREAS FOR RESEARCH AND APPLICATIONS DEVELOPMENT

2.1 Research

As with many new and emerging industries, the opportunities for growth are very broad. Many other states will be competing in this market and Oklahoma

must distinguish itself based on its existing assets and viable, realistic growth potential. Clearly, one of the critical areas is Research and Development. Oklahoma's universities are R&D leaders in their niche areas (aerodynamics, aeroacoustics, micro air vehicles, airframes, propulsion systems, radar, weather, cyber security, etc.) and these efforts are backed by strong collaborations with the Oklahoma private sector. *A partial list of current R&D strengths in the state is given in the Table on page 18.*

OSU's UAS R&D program is based on a strong platform in design-build-and-fly, with state-of-the-art facilities for manufacturing and testing, including the M-AVIARI (Micro Air Vehicle (MAV) Indoor Assessment and Research Instrumentation) facility at OSU. This enables flight testing of MAVs under controlled conditions, particularly in complex maneuvers such as perching or egress. Using these and related capabilities, OSU has been successful for over 15 years in national and international competitions for student teams and has won many first and second place awards. This success led to a robust effort in both undergraduate, and now graduate, research in UAS technology. The latter is the first graduate program dedicated to UAS engineering studies in the U.S. and OSU now offers a Minor BS degree in UAS pilot training.

By leveraging these R&D and education assets, combined with the UML's strong Department of Defense customer base that requires advanced operator-focused UAS technology, OSU has successfully demonstrated a rapid-response capability in development and testing of new UAS concepts. Furthermore, OSU's UML provides multiple facilities that include a 5,000-acre outdoor test and training facility at Chilocco (including an explosive-testing capability and an RF test range) and the OTC-USSM at Elgin, near Fort Sill, with access to restricted airspace including live-fire and munitions demonstrations, under appropriate agreements with the U.S. Department of the Army. The OSU/UML team will continue to grow these capabilities and linkages in the application of UAS in the defense and security sector, including partnerships with the private sector.

The OU Advanced Radar Research Center (ARRC) is developing new radar capabilities to advance UAS activities in the state and beyond. The National Weather Radar Test bed (NWRT) Phased Array Radar (PAR) operated in Norman has the capability to monitor both weather and air traffic. Development continues on the Multi-function Phased Array Radar (MPAR) concept that would dramatically impact radar surveillance.

The MPAR concept is being considered as a means of integrating the different radar surveillance goals in the U.S. and the NWRT PAR could be used to track UAS flights over the OU Kessler Atmospheric and Ecological Field Station (KAEFS) and other nearby UAS flight centers. Having the radar arm of the National Weather Service and the Radar Operations Center in our state strongly positions us in the critical area of radar development for UAS operations, as specifically called for in the FMRA and the NDAA. This is supported by the array

ACTIVE UAS-RELATED RESEARCH AREAS IN OKLAHOMA

UAS Radar Research	<ul style="list-style-type: none"> NextGen Incorporation of UAS into the National Airspace Small UAS Detection Radar Sense-and-Avoid Radar Low-Power Passive Radar (stealth) Automatic Dependent Surveillance-Broadcast Weather Radar Airport Surveillance Radar (ASR)
UAS Communication	<ul style="list-style-type: none"> Free-Space Optics for UAS Communication RF, Including Bandwidth
UAS Aeronautics	<ul style="list-style-type: none"> Aerodynamics, Including VTOL UAS Flight Dynamics and Aeroelasticity Design/Fabrication/Flight Testing Semi- and Fully Autonomous Flight Payload Delivery Systems
UAS Propulsion	<ul style="list-style-type: none"> Long-Endurance Hybrid UAV Propulsion Systems Battery-Powered Helicopters
UAS Acoustics	<ul style="list-style-type: none"> High Transmission Loss Structures Acoustic Liner Technology Internal Combustion Engine Noise Control Propeller Noise Control Vehicle Noise Control
Novel UAS Structures	<ul style="list-style-type: none"> Morphing Aircraft Unconventional Configurations, Including Biologically Inspired Micro Aerial Vehicles
UAS Payloads	<ul style="list-style-type: none"> Chemical Nano Electromechanical
Cyber Security	<ul style="list-style-type: none"> System Security and Validation Physical Systems Security (SCADA Systems) RF/Wireless Communication Security Data Encryption

Table 1: UAS Research Areas in Oklahoma

of military and civilian radar installations across the state enabling a precise picture of the NAS at all times. Oklahoma is able to leverage these radar assets via joint partnerships and agreements.

2.2 Applications

Building on the above R&D strengths will allow Oklahoma to grow rapidly in several application areas.

2.2.1 Weather

There is much interest to further develop UAS capabilities for weather monitoring. Obtaining pressure, temperature and humidity data in the lower atmosphere along with observations and measurements of the wind field will provide valuable data for weather monitoring and prediction. UAVs can aid the National Weather Service, the OU Weather Center, the National Oceanic and Atmospheric Administration (NOAA), the National Severe Storms Lab (NSSL) and others, in monitoring the location and movement of the dry line and convective initiation for pre-storm environments. Small UAS platforms have been tested by OU for these purposes. Moreover, the Oklahoma Department of Environmental Quality (DEQ) is working with OU to develop an ozone sensor that can be carried on small UAVs.

In addition, discussions are underway concerning the deployment of larger UAS at Burns Flat to conduct weather monitoring via the release of either, or both, multiple micro dropsondes or small UAS from a larger UAS vehicle to provide critical atmospheric data in a timely manner and in critical locations.

2.2.2 First Responders

In addition to being an important tool before a weather-related disaster (or any other type of disaster) strikes, UAS can be invaluable during the search and rescue phase. They can be quickly deployed, equipped with the necessary EO/IR equipment and used for both the location of personnel and victims, but also provide vital situational awareness in areas too dangerous of difficult for manned aircraft.

By being able to fly in conditions that are otherwise too dangerous, UAS can also generate significant cost savings. (For example, a manned helicopter may be typically \$200-\$400 per hour (and more) to operate compared to around \$25-\$75 for a UAS³.

³ Numbers from AUVSI-OK Chapter (USA-OK).

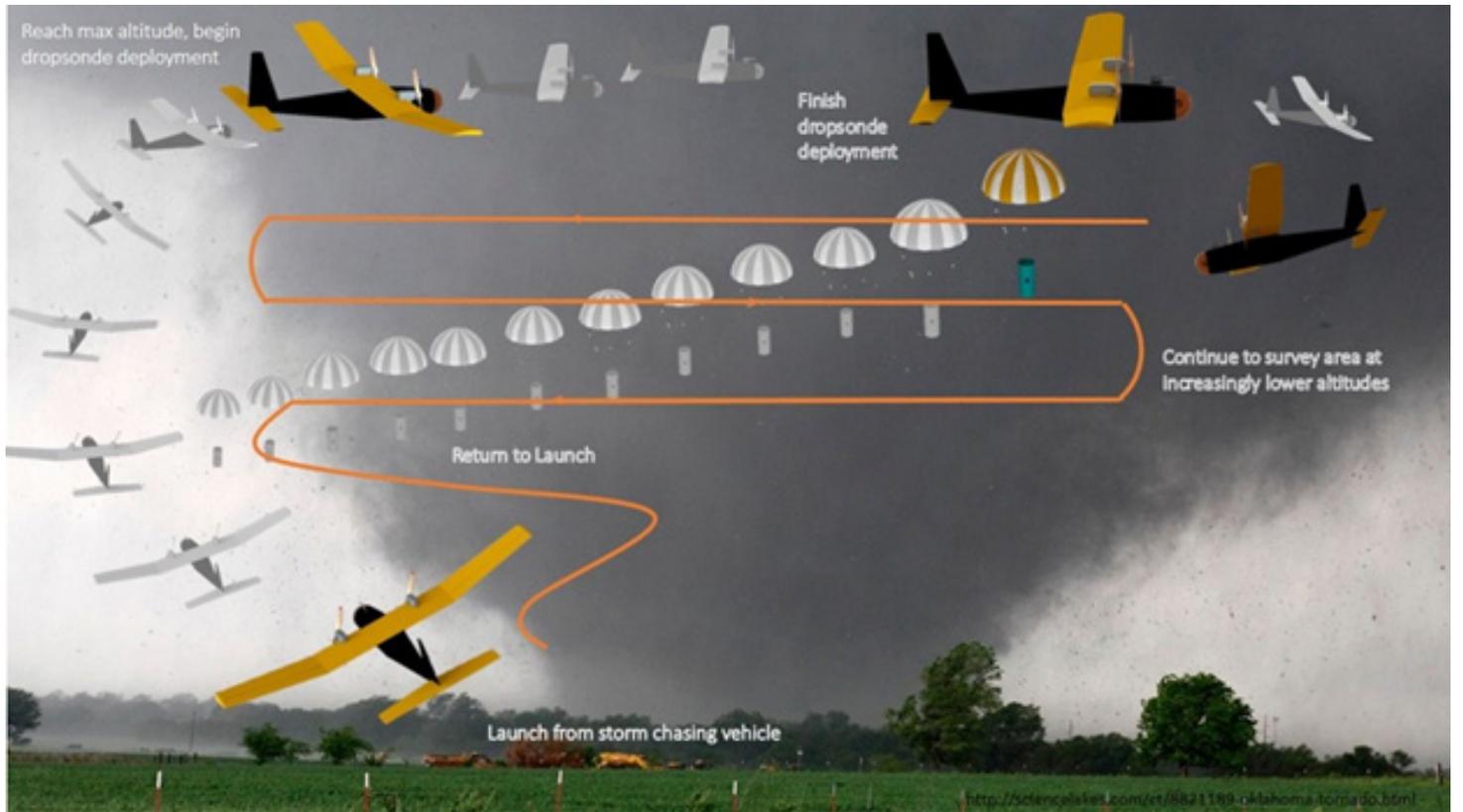


Figure 3: Proposed Concept of Operations for a Mesocyclone Analysis Research Investigation Aircraft (MARIA).



Figure 4: “Smartsonde” project focusing on UAS studies of the lower atmosphere.

Oklahoma has a clear advantage in this application area. Firstly, it is an area of the country which suffers most from natural disasters related to weather. Secondly, it is the home of the DHS's Robotic Aircraft for Public Safety program at the OTC-US in which potential UAS for first responder applications are examined by the DHS for evaluation of operational capability and training. No other part of the country has this advantage.

2.2.3 Energy

An additional area of importance for which Oklahoma is well positioned concerns the oil and gas industry – specifically pipeline inspection. UAS are often mentioned as the future of this important activity. Further, this same UAS application could also be used to monitor/inspect rail lines and water ports for maintenance, security, traffic conflicts, etc.

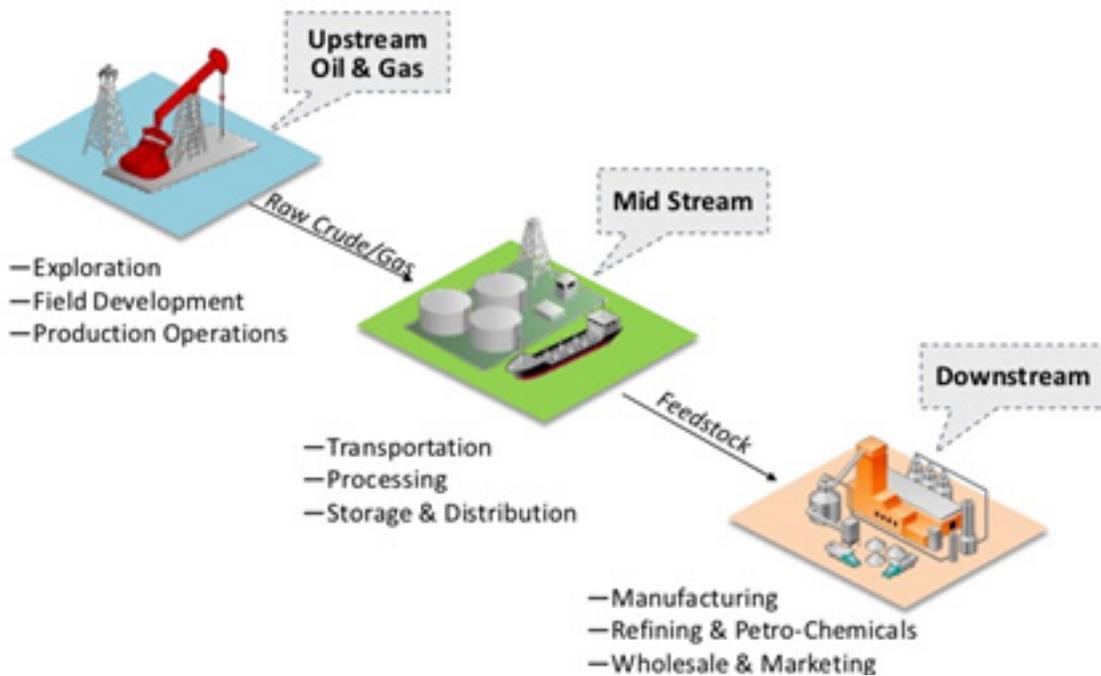


Figure 5: UAS brings value to every stage of the Oil and Gas industry



Figure 6: AUVSI projects that agriculture applications will comprise 80% of the commercial UAS market in the U.S.

2.2.4 Agriculture

UAS in agriculture is projected to be the largest UAS commercial segment in the coming decades (see AUVSI report). In Oklahoma, multiple agriculture partners, such as OSU, the Noble Foundation, Green Valley Farms, and others are all actively involved in the use of UAS in this area. The reason for this interest and the projected strength of this sector relates to the gradual automation of farming operations. Whereas once 30% of the US population worked on farms, now less than 2% do, primarily due to intensive agriculture and automation. The previously-referenced AUVSI Economic Impact Report indicates that precision agriculture will total approximately 80% of the known potential market for UAS, contributing more than \$200 billion to the country's Gross Domestic Product.

2.2.5 Aeroecology

A strength is in the emerging field of radar aeroecology, which uses radar to investigate the movement and behavior of airborne animals. This is a growing and developing field in which OU is poised to become a national leader. Using NEXRAD radar we have the capability to detect the locations of birds, bats and insects and track their movements over time. Such data will be of use in developing the necessary database for integrating UAS in the NAS, promoting air-traffic safety (e.g., mitigating the risks of collisions of aircraft with birds and bats), and discriminating between birds and micro-UAVs made to resemble and emulate birds.

2.2.6 Training

Oklahoma is also blessed with some of the world's leading flight simulator companies, including FlightSafety International and L-3 Comm AMI. As UAS becomes more established and complex, the need for more sophisticated simulation programs for UAS pilots and payload operators will become apparent. Therefore, an opportunity exists for Oklahoma companies to collaborate with major UAS original equipment manufacturers, thereby growing a new business sector, associated with UAS pilot training. This will be especially true for the larger UAVs and for complex payloads.

Infrastructure for UAS pilot training is already in place at various locations throughout the state (see Figure 2) and the opportunities for stand-alone or joint programs operated by private companies, CareerTech and universities are very strong. CareerTech also has the potential for bespoke programs in MRO for the UAS industry.

2.2.7 Cyber

Another important aspect of the development of UAS will be in the field of cyber security, and here Oklahoma is also at the forefront in a national leadership role. For UAS the pilot has been removed from the vehicle to a ground station and all communication with the vehicle is via RF and heavily reliant on computer systems. Therefore, security of the communications and computer systems becomes paramount. The University of Tulsa's (TU's) Institute for Information Security (iSec) is a multi-disciplinary program of study and research tackling cyber security issues on a global scale. TU has established itself as one of the leading schools in the country for information security research and education with more than 15 years of experience in the field. The National Security Agency (NSA) designated TU as a Center of Academic Excellence for Information Assurance Education and a Center for Academic Excellence for Information Assurance Research. With research initiatives in critical infrastructure protection, security engineering and testing, enterprise security, cyber physical systems security, network vulnerability analysis, cryptographic protocol verification, adversary characterization, dynamic risk assessment, critical infrastructure protection, digital forensics and human computer interaction, the Institute for Information Security (iSec) is developing some of the most innovative solutions available for today's emerging information security challenges. All will prove to be essential in the secure and safe operation of UAS in the NAS.

Other applications are certainly possible but the above represent the ones that are in front of Oklahoma at the present time. Others will undoubtedly emerge.

3. A UAS STRATEGIC PLAN FOR OKLAHOMA

3.1 A Ten-Year Roadmap

Based on discussions relating to this Strategic Plan and assessing the state of the UAS industry nationwide, the UAS Council has generated a 10-year roadmap for the future of UAS in the state. The roadmap is a guide that projects much further than this Strategic Plan and presents the state's broad aspirations.

The roadmap is summarized below. *The detailed roadmap is listed in Appendix 2.*



2015-2017 | PHASE I

- OCAST Support
- Infrastructure development
- UAS education plan
- Agency responsibility
- Public policy advisory
- Annual events
- Testing laboratory
- Commercial investment
- \$100 million capital pool
- Update Strategic Plan



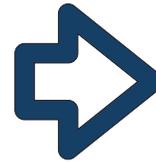
2018-2020 | PHASE II

- Weather network
- Infrastructure development
- Expand OCAST support
- International collaboration
- Industry incentives
- Innovation zones
- Innovation hubs
- FFRDC, etc.
- \$250 million capital pool
- Update Strategic Plan



2021-2025 | PHASE III

- NextGen airspace
- Communications infrastructure
- Technology challenges
- Logistics support
- Collaboration network
- STEM career pathways
- \$500 million capital pool
- Update Strategic Plan



3.2 Progress on Previous Recommendations

Oklahoma has accomplished a significant portion of the recommendations and goals outlined in the 2012 Strategic Plan. The 2012 recommendations and summaries of progress are given beginning on the next page:

RECOMMENDATION 1:

Establish a network of FAA UAS Test Sites

Including:

- Growth of capabilities and operations at the OTC-USSM
- Establish UAS operations in public-use airspace at:
 - Chilocco
 - Clinton-Sherman
 - Camp Gruber Joint Maneuver Training Center
 - Kessler Atmospheric and Ecological Field Station

Successfully achieved. Kessler, Clinton-Sherman, Gruber, Muldrow, OSU Unmanned Aircraft Flight Station all have CoAs for use of UAS in R&D and training. OTC-USSM continues to be an active site for DoD-and DHS-related UAS evaluation and training activities. However, the sites have not been linked by corridors, which is not possible due to CoA regulations. Recent developments regarding the DHS RAPS program are dealt with separately in the new recommendations, described below.



RECOMMENDATION 2: ***Build and equip the UAS Radar and Sensor Systems Center at the University of Oklahoma***

- Develop, construct, test and evaluate radar and sensor systems for UAS applications.
- Acquire and maintain UAS platform systems for use in UAS radar and sensor development.
- Develop and sustain a small UAS detection R&D program and extend the University of Oklahoma's aeroecology research.
- Develop and sustain a UAS atmospheric research and development program.
- Focus effort to create sense-and-avoid systems that will be accepted by the FAA to allow "file-and-fly" UAS systems outside of Restricted Airspace.

Completed. The OU Advanced Radar Research Center's Radar Innovations Lab was completed and opened officially in October, 2014. (See <http://arrc.ou.edu/>) The ARRC is involved in many aspects of radar research, including remote sensing, atmospheric science, system engineering, applied electromagnetics, communications and signal processing.



RECOMMENDATION 3: ***Build and equip UAS R&D facilities and UAS Industry facilities at the Oklahoma Technology and Research Park, Stillwater***

Including:

- The UML's Unmanned Systems Development Center (UDC), consisting of:
 - Electromagnetic compatibility test chambers
 - Propulsion lab
 - Acoustics lab
- Related facilities, including secure space

- The UAS University-Industry Alliance Center, consisting of:
 - OSU's entire UAS program, including research laboratories, wind tunnel, design and manufacturing lab, classrooms, offices and related facilities
 - Space for new UAS industry development, relocation and growth

Partially completed. The Unmanned System Development Center (UDC), was completed in 2013 and has been operational in university-related R&D. The Alliance Center, however, specifically facilities for industry development and relocation, is still under discussion. In addition, the Unmanned Systems Innovation Center (USIC) has been established at Tinker Business and Industry Park in Midwest City to provide a focal location for UAS business development and growth.



RECOMMENDATION 4:

Compete aggressively to become a federally directed UAS Test Range

Including one or more of the following:

- One of the FAA's six official UAS Test Ranges, as outlined in the FAA Reauthorizations Act and the NDAA.
- The DHS's SUAS Center of Technology transition for first responders.

Completed. The OTC-USSM was selected to become the test venue for DHS's RAPS program. RAPS is the DHS's Robotic Aircraft for Public Safety program and has been successfully operated in Oklahoma since 2012. Recent developments have caused the program to pause, however, due to alterations in the DoD policies for use of Restricted Airspace by non-DoD entities. However, it is anticipated that new agreements among the relevant federal agencies will soon be in place which will allow continuation of the program. Furthermore, the program may expand into non-restricted airspace via the use of CoAs. The site for the latter operations will be Chilocco, Okla.

The state competed for, but did not achieve, selection as one of the six FAA Test Sites. Feedback from the FAA and non-FAA federal sources indicated that Oklahoma's proposal achieved very high marks and, on a technical basis only, was ranked as high as #3. However, financial support for Oklahoma's proposal was not in place at the time of the proposal and therefore Oklahoma was not selected.



RECOMMENDATION 5:

Create a centralized administration to operate an integrated Oklahoma UAS Test Site Network.

- Using the T&E facilities noted in Recommendation 1, create a formal Oklahoma UAS Test Site Network for UAS development, particularly with regard to integration into the NAS.
- Create a governance model, including a management and administrative team to oversee, coordinate, facilitate and develop the network, and devise policies and rules for its operation. The administrative team will consist of representatives from public entities, i.e. OSU, OU, OKARNG, UML and OSIDA. Partner with the private sector as necessary.
- Create an Oklahoma UAS Industry Advisory Panel to work with the administrative team, on development and use of the Test Site Network.

Continuing. Currently, the integration of effort is achieved primarily via the Governor's UAS Council and state activity under the umbrella of the state's AUVSI Chapter (USA-OK). However, both of these bodies rely on volunteerism. This specific recommendation for the permanent establishment of an administrative organization was reliant upon selection as an FAA Test Site. Although it's urgency has now been diluted (since the state was not selected as one of the sites) Oklahoma should still consider a establishing a central state office and a single point-of-contact for Oklahoma UAS activities.



RECOMMENDATION 6:

Invest in Research and Development in UAS and compete for an ERC, UARC and/or FFRDC.

- Building on the facilities noted in Recommendations 1-3, the state should invest in T&E and R&D activities in UAS. OCAST, OSIDA and EDGE programs should be aligned to support this effort with possible funding provided through these entities.
- Examine what is required for the state to establish an NSF ERC, a DoD UARC, or an FFRDC specializing in UAS.
- Initiate a focused effort to capture additional SBIR/STTR funding for Oklahoma UAS technology initiatives.
- This should include investigations and development of applications of UAS including, but not limited to, safety analysis, weather studies, aero-ecology, agriculture, oil and gas pipeline and rail line inspection, water port inspection

and security, radar development, defense and security applications, first responders, law enforcement and others. Application focus areas should play to existing strengths in Oklahoma (weather, agriculture, oil and gas, etc.) and be relevant to national funding directions (DHS, DOE, NSF, NASA, etc.).

- Expand UAS research to include low altitude, medium altitude and high altitude long endurance vehicles and missions.
- Conduct cyber security research related to UAS sustainment and operations.
- Research the use of bandwidth and fully explore cost effective use of resources.

Underway. Along with others, Oklahoma will compete for the FAA Center of Excellence (as part of a team from Univ. MD, MIT, Stanford, Ohio State U., VA Tech, and others). Additionally, individual R&D groups continue to compete for federal funds on the topics mentioned and on others. Interest in cyber research in UAS remains strong but there appears to be little movement currently.



RECOMMENDATION 7:

Expand and Strengthen UAS Education and Training Capabilities.

- Continue to develop the OTC-USSM as a training center and test center for UAS pilot and payload specialist training, in collaboration with the private sector. Consider other locations as appropriate.
- Develop necessary levels and types of training required for micro, small, HALE, MALE and VTOL.
- Establish B.S., M.S. and Ph.D. degrees specializing in UAS at OSU and OU.
- Market and promote Oklahoma's education and training opportunities.
- Collaborate with the CareerTech system to provide the technical workforce needed to support the industry.
- Include training for UAS pilots, systems operators, crews, imagery analysts, UAS technology, airframe MRO, etc.

Continuing. The OTC-USSM continues to seek opportunities in this regard. OSU and OU are continuing their education programs in UAS engineering and applications, at bachelors and graduate degree levels. No specific efforts in CareerTech have been established, but interest remains strong. Opportunities may exist related to expansion of effort at Tinker AFB on MRO for UAS and there has been some progress and discussions recently.



RECOMMENDATION 8:

Establish and grow strategic partnerships and collaborations.

- With the private sector, particularly UAS OEMs.
- With other leading states in the UAS industry, including:
 - State to state
 - University to university
- Federal agencies, including:
 - FAA, DoD, DHS, NASA
 - Others, as appropriate

Continuing. Oklahoma was instrumental in forming an International Consortium, known as the International Consortium of Aeronautical Test Sites (ICATS). Membership of this nascent organization comes from the U.S. (Okla. and N.D.), Canada (Quebec), Spain (Barcelona and Andalusia), UK (West Wales) and France (Bordeaux). Additionally, various groups within Oklahoma are establishing strong relationships with several of the selected FAA Test Sites (especially ND, TX and VA), as well as growing partnerships with other universities (e.g. the FAA CoE application noted above).

Partnerships with major vehicle and system manufacturers are under discussion relating to various R&D efforts.

Close communication and discussions with the FAA, NOAA, NASA, DoD, DoT and DHS have continued and are expected to grow.



RECOMMENDATION 9:

Expand corporate UAS manufacturing presence in Oklahoma and state support to private UAS companies in Oklahoma.

- Ensure all UAS companies are aware of current state and local incentives that apply to aerospace, and support programs such as the Oklahoma Aeronautics Commission Center for Aerospace Supplier Quality (CASQ) program.
- Request a portion of OCAST and i2E funds be focused on the UAS industry.
- Apply MRO sales tax exemptions to UAS industry.
- Establish public-private partnerships between university departments and research programs with UAS private sector.

- Attract a major UAS aircraft manufacturer and/or DoD to establish a significant UAS business /base in Oklahoma.
- Publicize current Oklahoma tax and business incentives for aerospace, education and training, and high-tech businesses.

Continuing. The Oklahoma Department of Commerce have been aggressive and very supportive of the private sector in efforts to grow the UAS industry. This includes incentive packages, trade show and media support. This will continue. OCAST has agreed to consider UAS proposals in their Applied Research program and has requested state funds for a UAS Center of Excellence and equipment fund program. Major UAS manufacturing has not yet been attracted to the state.



RECOMMENDATION 10: ***Grow political support and public advocacy***

- Promote the state's UAS efforts to the state legislature and to Congress through continual communication with appropriate state legislators, agency heads and congressional members.
- Continue the promotion of Oklahoma's UAS sector via press releases, publications, interviews, media tours, conferences, trade shows and other appropriate media outlets and venues.
- Continue the annual Unmanned Systems Alliance of Oklahoma (USA-OK) UAS summits with leadership from the governor.

Continuing. This has been very successful to date and will continue. The state has strong support in congress, at the state legislature and in the Governor's office. Along with the AUVSI chapter (USA-OK) the state has been aggressive in promoting the UAS industry with political partners. As new members are elected at the federal and state levels this activity must be continual. There are still some who support negative and restrictive state legislation and this must be opposed.

ODOC has been excellent with producing marketing materials and promoting Oklahoma as a UAS state at national and international trade shows and in worldwide media outlets.

The reputation of USA-OK grows and several successful summits have been held and will continue. Additional efforts (such as WBToi) should continue in this regard.

3.3 New Recommendations

The following new recommendations are made in each of the strategic areas listed.



RECOMMENDATION 1: Identify operations and applications that make Oklahoma competitive in UAS development

- Do not focus on development of technologies for UAS integration in the National Airspace System (i.e. leave that to the six FAA Test Sites), but instead focus on applications of UAS so that Oklahoma will be considered the location where commercial companies can get to fly for business very quickly.
- Identify advantages that Oklahoma has and promote these.

Three immediate major strategies should be followed, namely the DHS RAPS program, the development of UAS in weather research, and assistance with permissions for commercial operation. These areas build upon current assets that Oklahoma possesses. Oklahoma is well placed for these developments.

The DHS RAPS program has been temporarily halted in recent months due to the re-interpretation of policy from the Department of Defense, specifically the Department of the Army, in the use of Ft. Sill Restricted Airspace by DHS for the RAPS program. However, it is anticipated that new agreements between The UAS Army and DHS will be forthcoming that will allow use of the Ft. Sill airspace by DHS for the RAPS program. The OTC-USSM will continue to be the preferred site for RAPS operations.

In addition, however, DHS has been working with the FAA to enact Certificates of Authorization (CoAs) to enable part of the RAPS program to be conducted in the NAS at Chilocco, Okla. At the time of preparation of this document, the FAA and DHS were working to complete this certification.

Oklahoma should also work with the Oklahoma congressional members to make the DHS RAPS program into a program of record in the next DHS Authorization Bill.

Oklahoma is blessed with a first-class UAS engineering program at OSU, world-leading weather research at OU, frequent severe weather and an abundance of open land. These assets place Oklahoma in a leadership position for the development of UAS systems for weather research. Regional CoAs should be established for a variety of UAS types, and collaboration with federal agencies, especially NOAA, NASA and the FAA. Funding opportunities for such research must be aggressively pursued.

In support of this effort, Oklahoma should explore funding avenues to enable the deployment of an MQ-9 Predator aircraft at Burns Flat for weather research. State agencies and officials should work with General Atomics, NOAA, NASA, FAA to enable this to occur. In addition to weather research, the deployment would also be used in support of emergency response, fire-fighting, search and rescue, etc., as needed.

Following consultations with the FAA UAS Integration Office in 2014, Oklahoma should establish a process to assist small companies with applications for commercial operations. Currently, this is through Section 333 exemptions, but in future the process will be dictated by the FAA rules for small UAS. This program should be operated by either a state agency or a private entity.

Through identification of the assets and advantages that Oklahoma possesses, the state should focus on applications (weather, first-responders, agriculture, etc.) rather than the development of technologies for UAS integration into the NAS, which will be the pruvue of those locations operating the FAA's UAS Test Sites.



RECOMMENDATION 2:

Work with Congress, through the Oklahoma congressional delegation and the House and Senate UAS Caucuses

- The goal is to enable legislation that allows the FAA to more quickly establish rules for use of UAS in commercial activities.
- Also work through Congress to allow the more widespread use of restricted airspace to enable the OTC-USSM to flourish.

Current commercial UAS operations in the United States are stifled through the blanket ban by the FAA on all commercial UAS flights. The FAA takes the position that all UAS are, by definition, aircraft and this leads to severe restrictions on UAS operations. Currently, the only way UAS can fly commercially is through exemptions in accordance with Section 333 of the 2012 Federal Aviation Administration Modernization and Reform Act (FMRA). Such exemptions are few and the bureaucracy is cumbersome and time-consuming.

The FAA has released its draft rules for operation of small UAS in the NAS. There now follows a lengthy period of public comment and revision before the final rule is published. This is not likely until 2016 or even 2017. During the intervening period much ground will be lost in the U.S., compared to overseas operations of commercial UAS.

To assist in allowing commercial flights in the U.S., Oklahoma should work closely with the congressional delegation to change definitions and rules, so that small UAS can be regulated by a different, and less cumbersome, set of regulations than apply to all other aircraft. Details should be considered and evaluated in collaboration with the Oklahoma congressional delegation and a plan developed.

The overall strategy should be to assist the FAA, not to hinder them. Oklahoma should continue to be regarded as a “friend” of the FAA.

Regarding the use of restricted airspace, Oklahoma should continue to work through the Oklahoma delegation to allow more open access to restricted airspace for UAS operations, particularly for federal customers. This will extend to UAS evaluation and training. Whatever assistance is needed must be given to enable the U.S. House and Senate to achieve this goal. Also, assistance must be given to allow university and other education and training entities to conduct flight training without violating CoA rules.



RECOMMENDATION 3:

Establish Technology Parks in Oklahoma for attracting UAS industry to the state

- The goal is to provide facilities and capabilities that are difficult for industry, especially small companies, to find elsewhere. Support infrastructure should include manufacturing, testing, training, R&D, collaborations with academia, political advocacy, market analysis, business development, and financial support.

To foster the growth of the UAS industry in Oklahoma the state should develop technology parks focused on UAS. Multiple locations are possible. In particular, the state should support development at the following locations:

1. The Tinker Business and Industrial Park (TBIP), Midwest City. The Unmanned Systems Innovation Center (USIC) has recently opened at the TBIP. The business model is to provide physical space, collaboration opportunities, access to markets, and financial investment opportunities.
2. The Oklahoma Technology and Research Park (OTRP), Stillwater. Oklahoma State University has recently opened the Unmanned Systems Development Center (UDC) at the OTRP. This is a small facility that supports R&D and education at OSU in its UAS programs (at the bachelors, masters and doctoral levels). There is currently little room for collaboration with the private sector. A recommendation carried over from the 2012 Strategic Plan is to develop a UAS Industry Alliance Center, or similarly named entity, to encourage cooperation, collaboration and

partnership between OSU and the UAS industry on projects of mutual interest as part of the overall scheme to establish Oklahoma as a center of UAS R&D activity. Models for funding the Alliance Center should be explored.

3. Other potential sites for UAS industry parks include Burns Flat and Norman.



RECOMMENDATION 4:

Establish locations for application development, particularly in energy and agriculture

- The goal is to provide facilities to enable the application development of UAS in the areas of energy (oil & gas, power distribution/transmission) and agriculture (farming and ranching).

Oklahoma should seek to establish locations in the NAS where experimental programs on applications of small UAS can be developed in the broad areas of energy and agriculture. Once the NAS is opened to UAS operation, early adoption of the technology will be in these two major market sectors. Oklahoma should establish a reputation for itself as a location where experimental approaches to the use of UAS can be assessed and techniques and practices developed.

Possible areas for this approach include Green Valley Farms, Kessler Atmospheric and Ecological Field Station, the Grand River Dam Authority and Chilocco. Oklahoma researchers, industry partners and state officials should explore what is needed to create such a location for this type of development, and then promote the use of the facility through appropriate professional (academic and commercial) media outlets.



RECOMMENDATION 5:

Establish and grow strategic partnerships with other states and organizations, domestic and international

- Oklahoma, via the OTC-USSM, was a founding partner in the creation of ICATS, the International Consortium of Aeronautical Test Sites. Growth of ICATS should be promoted.
- In addition, ad hoc and strategic partnerships should be formed with other states who are actively engaged in UAS development.

An intent of ICATS is that its members learn from what other countries are doing. ICATS is currently a new organization and is refining its mission and goals by

collaboration among its membership. Nevertheless, the overall purpose of ICATS, the first international organization of its kind, is to support the industry by enabling the development, testing and ultimate certification of UAS to allow their use in non-segregated airspace. It is envisioned that this will be accomplished by sharing information on operational safety, flight regulations, and when allowed to do so, actual operational experiences, and by also encouraging the industry to demonstrate and prove sub-system technologies. ICATS will facilitate the safe development of international standards for future UAS construction while concurrently working with the respective regulatory bodies. In collaboration with other organizations (including AUVSI, ICAO, etc.) ICATS will also work to advocate for the UAS sector with the government authorities in each province/state, national government and their agencies/ministries and departments.

Current partners in ICATS include:

- UAV Test & Service Centre (CESA), Bordeaux, France
- Oklahoma State University – University Multispectral Laboratories (OSU-UML) at the OTC-USSM, Oklahoma, U.S.
- The National Aeronautical Centre (NAC), Wales, UK
- The Unmanned Aerial System Centre of Excellence, Quebec, Canada
- The CATUAV Tech Center, Barcelona, Spain
- The Air Traffic Laboratory for Advanced Systems (ATLAS), Jaén, Spain
- The Northern Plains UAS Test Site, North Dakota, U.S.

Immediate efforts should be to increase the membership, to include the remaining five UAS Test Sites in the U.S., plus international sites in Australia, Belgium, Denmark, Iceland South Africa, and other locations.

Additionally, Oklahoma businesses and universities should seek to collaborate and partner with each other and with other national UAS organizations and, in so doing, increase the profile and influence of Oklahoma as a UAS development and commercial state.



RECOMMENDATION 6:

Maintain activity in state political and business advocacy at all appropriate levels

- Maintain strong connections with Oklahoma legislators to support UAS industry investments.
- Establish and maintain strong connections with the Oklahoma business community.

- Oppose any proposed state legislation that constrains or hampers the growth of the UAS industry in the state, such as overly restrictive and unnecessary legislation appertaining to privacy concerns, usage restrictions, etc.
- Organize public awareness campaigns as required.

Political advocacy at the state level is important for the successful development of the industry in Oklahoma. Fortunately, the state has strong leadership and firm support currently, including the Governor, Lt. Governor, and the Senate and House leadership, and elsewhere within the legislature. However, efforts must be made to ensure that this is maintained.

Similarly, advocacy and support within the general business community is required. This includes entities such as the Oklahoma Business Roundtable, the Oklahoma State Chamber and the Oklahoma Department of Commerce. Once again, current support is strong, but continual effort must be made to maintain this strong position.

Vigilance is needed to oppose any potentially constraining or restrictive legislation opposing the use of UAS in the state. A continual effort must be made in public awareness campaigns to inform the public of the current rules, regulations and laws that control the operation of UAS in Oklahoma and throughout the country. Unnecessary legislation must be avoided.



RECOMMENDATION 7:

Expand and strengthen UAS education and training opportunities

- Continue to develop the OTC-USSM as a training and evaluation center for UAS pilot and payload specialist training. Consider other locations as appropriate.
- Establish B.S., M.S. and Ph.D. degrees specializing in UAS at OSU and OU. Expand other certificate and degree options at regional universities and technology colleges, both state-supported and for-profit.
- Include training for UAS MRO
- Collaborate with the CareerTech system to provide the technical workforce needed to support the industry, including technicians, engineers, payload specialists and pilots.
- Market and promote Oklahoma's education and training opportunities.
- Market and promote the UAS area for STEM (science, technology, engineering and mathematics) education pathways and ultimate careers.

This recommendation is little changed from the 2012 Strategic Plan. The growth of the UAS industry in Oklahoma will require the availability of an educated and trained workforce. This will require programs at the CareerTech and university levels. Currently, OSU has a graduate degree option in UAS for the MS and PhD programs in mechanical and aerospace engineering. As the UAS industry developed in Oklahoma, OSU, OU and TU should consider establishing bachelor's degrees in UAS. To share resources and prevent duplication of effort, joint degree programs should be considered. Similarly, as the industry grows and workforce demands become clearer, the CareerTech system should engage with industry to determine what specialist training programs are required to support the industry.

Considering the above, it is clear that opportunities exist for the state to develop certification programs for UAS pilots and to become a nationally recognized training center for UAS operations (perhaps specializing in, for example, applications for first responders, in agriculture, oil and gas, etc.). Certifications for airworthiness of UAVs and for cyber security should also be considered. Partnerships with the FAA's Mike Monroney Center should be explored in this context, as should public-private partnerships.

The state's UAS education and training opportunities should be appropriately marketed and promoted.



RECOMMENDATION 8:

Market and promote Oklahoma as a UAS center at all appropriate venues and opportunities

- Continue to promote UAS in Oklahoma at international airshow, domestic trade shows, conferences, workshops and professional meetings
- Maintain up-to-date and modern media materials for distribution and dissemination.

Marketing Oklahoma's UAS capabilities and assets is invaluable and essential. The Department of Commerce has done an outstanding job in this regard over the past several years and this effort must be maintained. New, timely, up-to-date and modern media materials should be developed for traditional and non-traditional media outlets (shows, conferences, publications, social media, web sites, etc.).



RECOMMENDATION 9:

Establish a “UAS Center of Excellence” program (or some suitably named program) within OCAST (Oklahoma Center for the Advancement of Science)

- Establish a \$5-\$10 million program within OCAST to support the development of UAS technology and to attract UAS businesses to Oklahoma

The growth of the UAS industry in the U.S. will be highly competitive. The competition to establish a region as a home for UAS development and commerce will be fierce. Oklahoma needs to do all it can to attract the industry to Oklahoma. The availability of an R&D and Test & Evaluation (T&E) fund will be needed to remain competitive. The funds could be used for R&D, T&E support, infrastructure development, matching funds, or program development.



RECOMMENDATION 10:

Explore the viability of tax incentives for the UAS industry

- Tax exemption for products, sales and services related to unmanned aircraft technology.

Oklahoma State statutes provide for exemption to taxes under the Oklahoma Sales Tax Code. These taxes can apply to the sales of goods and services across the state’s economy. Amendment to the statutes to allow sales tax exemption for products, sales and services related to unmanned aircraft technology - for example, by amending the definition of a “qualified aircraft maintenance or manufacturing facility” to include both manned and unmanned aircraft - would provide incentives to the UAS industry to locate in Oklahoma.

Many of the recommendations contained herein are already underway and progressing well. Due to the collaboration and unity of effort within the Governor’s UAS Council and the partnerships across Oklahoma public and private enterprises, many of the recommendations have been and will continue to be accomplished in parallel. All efforts should be focused toward the achievement of the state’s common strategic objective, namely to establish Oklahoma as a leading state in the growth of the UAS industry, and for this industry to be an engine of economic development and job creation in the aerospace sector for Oklahoma and its residents.

APPENDIX 1: OKLAHOMA UAS COMPANIES

Listed below are companies who actively participate in the UAS industry in Oklahoma.

Cherokee Nation Research Laboratories (Ponca City)

Cherokee Nation Research Laboratory, LLC (CRNL) was formed in 2013 to be the operating company of the Oklahoma State University - University Multispectral Laboratories (UML). Within CNRL there are three different business elements that focus on unclassified and classified research initiatives to combat Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) threats, support of technical and tactical missions in Command, Control, Communications, Computers, Combat Systems, Intelligence, Surveillance, and Reconnaissance (C5ISR), and engineering and operation of Unmanned Aerial Systems (UAS). CRNL operates the UML's OTC-USSM, on behalf of OSU. CNRL is owned 100% by Cherokee Nation Businesses (CNB) and governed by its Board of Directors

Design Intelligence Incorporated LLC (Norman)

DII provides leading-edge technical solutions to both government and commercial clients. Clients include both federal and state government agencies along with Fortune 100 and 500 companies. DII's primary focus is development of advanced unmanned systems technology, such as micro air vehicles (MAVs). DII also develops advanced and highly efficient power management systems for small unmanned aircraft that utilize energy harvesting technology, as well as advanced energy storage technology (including hybrid technology).

Dow Aero Logistics LLC (Oklahoma City)

Dow Aero Logistics offers exemplary aftermarket support services for all types of military, commercial, business and regional aircraft, including specialty spare part sales, comprehensive Boeing inventory, parts exchange program, consignment bonds and logistics management services.

FlightSafety International (Broken Arrow)

FlightSafety International is the world's premier professional aviation training company and supplier of flight simulators, visual systems and displays to commercial, government and military organizations, providing more than a million hours of training each year to pilots, technicians and other aviation professionals. Backed by Berkshire Hathaway, one of the world's most successful and admired companies, FlightSafety operates the world's largest fleet of advanced full flight simulators at an extensive network of Learning Centers located in the United States, Canada, France, Japan, South Africa and the United Kingdom.

FLIR Systems Inc. (Stillwater)

FLIR is a world leader in the design, manufacture and marketing of thermal imaging infrared cameras. Founded in 1978, FLIR originally provided infrared imaging systems that were installed on vehicles for use in conducting energy audits. They later expanded their focus to other applications and markets for thermal imaging technology, such as stabilized thermal imaging cameras for law enforcement aircraft,

OKLAHOMA UAS COMPANIES (cont.)

radiometry devices for use in monitoring industrial systems, and thermal imaging systems for use in ground-based security and search and rescue. Today they are one of the world leaders in the design, manufacture and marketing of sensor systems that enhance perception and awareness for a wide variety of users in the commercial, industrial and government markets, internationally as well as domestically.

Frontier Electronic Systems (Stillwater)

Frontier Electronic Systems is a leader in the design and manufacture of innovative systems and equipment for government and commercial customers. Headquartered in Stillwater, team members innovate, design, manufacture and test electronic products and systems for aerospace and maritime global customers. Frontier focuses on innovative test and simulation systems; high-tech radar and video distribution products; avionics and electronics for aircraft; space flight electronics; and R&D innovation, prototype design/manufacture and engineering support.

General Atomics-Systems Integration (Midwest City)

General Atomics Systems Integration, LLC (GA-SI) is an affiliated company of General Atomics. GA-SI provides engineering services to improve the operational safety and suitability of Department of Defense aircraft weapon systems by insertion of new technologies. GA-SI is headquartered in Kaysville, Utah and has offices in Midwest City, Oklahoma and Warner Robins, Georgia. GA-SI supports Tinker AFB and MRO activities related to UAS components.

Global ResQ Inc. (Duncan)

Global ResQ is a nonprofit corporation designed to provide effective disaster response technologies, management systems, communications and logistic services.

Hodges Aviation, LLC (Choctaw)

A startup company established in 2014, Hodges Aviation is a woman-owned small business that provides a diverse range of UAS services. These services range from the provision of a heavy-lift multi rotor camera platform that can carry full size motion picture cameras, to precision agriculture UAS platforms used for creating orthographically corrected mosaic imagery of crop lands. Hodges Aviation provides first responder training opportunities to agencies throughout Oklahoma using UAS Search and Rescue (SAR) variants to support wildfire and post tornado recovery management scenarios.

L-3 Comm AMI

L-3 AMI provides design and manufacturing services for integrated electro-mechanical training system hardware, tested to the I/O and delivered to customers for final integration at a fixed price and a set schedule. Since 1981 AMI has specialized in the design and production of electro-mechanical simulated instruments and integrated training system hardware. Whether an aviation, maritime or custom related application, AMI can duplicate any type of cockpit, workstation or control console to a high-level of

fidelity, test it to the I/O and deliver it to prime government contractors for final system integration. In Broken Arrow, AMI designs and produces a wide range of hardware products for use in simulators, training devices and other applications.

Objectstream Inc. (Oklahoma City)

Founded in 2004, Objectstream Inc. is a thriving 8(a) certified information technology and management consulting firm that offers a broad range of services – aviation operations, maintenance and navigation engineering services, management services, information technology services, software development services, training and staff augmentation. Objectstream is headquartered in Oklahoma City with offices in Tennessee, Maryland and New Jersey.

OSU-University Multispectral Laboratories (UML), LLC (Ponca City)

The UML is a 501(c)(3) non-profit, Government Owned - Contractor Operated (GOCO) which provides Research, Development, Testing, and Evaluation (RDT&E), and tactical training to the United States DoD, Intelligence Communities (IC) and related agencies. Business interests include CBRNE, C5ISR and UAS operations. The UML operates the OTC-USSM near Elgin, Okla., for UAS-related training and evaluation purposes for DoD and related customers. The OTC-USSM UAS facility includes a 2200 x 60 ft. paved runway and is also the site for the U.S. Department of Homeland Security's Robotic Aircraft for Public Safety program.

PLEXSYS Interface Products Inc. (Midwest City)

PLEXSYS is an employee owned, small business that has been providing radar and airspace control training systems and services to the U.S. Air Forces Airborne Warning and Control System (AWACS) training programs since 1999. In 2013, PLEXSYS initiated a customer diversification plan that led to the development of UAS Command and Control (UAS C2) software designed to meet the evolving needs of UAVs and their various missions. OnScene Commander™ is the product that was born from this effort and provides real-time situational awareness to UAS operators on the locations of first responders on the ground as well as manned aircraft flying nearby on a common map display. OnScene Commander was developed using inputs from Oklahoma fire fighter and emergency manager subject matter experts and is the only product on the market today that incorporates the features of personnel accountability for the safety of ground crews with the airspace situational awareness tools for flight safety requirements. OnScene Commander was designed to work with consumer grade UASs, making it an affordable alternative to military grade solutions. PLEXSYS is headquartered in Camas WA with offices in OK, AK, NM, as well as Europe and Asia.

Republic Aero Inc. (Duncan)

Republic Aero is a for-profit company providing advanced UAS concept development, system engineering and operational support. Republic can assist with review of flight and operations plans, and connection with university researchers for project assistance.

OKLAHOMA UAS COMPANIES (cont.)

Scoutsman Unmanned (Edmond)

“Scoutsman Unmanned, LLC, located in Oklahoma City, Okla., is a producer of small unmanned aerial systems. Primary target markets are the agriculture/land development, first responder and photography sectors. The company offers turn-key solutions that focuses on simple functionality and ease of use for the end user. In addition to a diverse product line-up, Scoutsman provides end-to-end product solutions. This allows our customers to collect data on their own schedule, upload it to our data managing service and then receive decision-quality results immediately through cloud servers. Scoutsman is focused on an extremely low cost family of UAVs that will give its customers the best data on demand.

Supero UAS (Oklahoma City)

Since its beginning more than 20 years ago, the mission of this Internal Wing Aircraft (IWA) company has been to revolutionize the business of flying by building aircraft based on its patented lifting technology. Over the past 15 years, IWA has gone from hand-held gliders to RC (radio-controlled) aircraft to MAVs (Micro Aerial Vehicles) and today – UAVs. Supero’s principal and patent-holder of the internal wing aircraft, Robert Carr, a former instructor pilot, has developed this aircraft based on a new technology since 1976. Robert holds patents in the U.S., European Union, Norway and Australia.

Tactical Electronics Inc. (Broken Arrow)

Tactical Electronics Aviation specializes in developing vertical takeoff and landing unmanned aircraft systems. TE’s R&D department custom designs and fabricates UAV payloads. Engineered with top-of-the-line components and integrated TE wireless technology, TE’s payloads are created to provide operators with customized solutions for multiple operations. TE aviation is continually expanding to support the needs of multiple applications, including remote sensing, payload transport, oil/gas exploration and production, and structural inspections. Advanced ground control, autopilot and payload features enable TE’s unmanned aircraft systems to provide operators with immediate time critical information and enhanced situational awareness.

TDRS LLC (Lawton)

For the past eight years, TDRS LLC of Lawton, OK has provided a wide range of Department of Defense consulting services to the U.S. Army Fires Center of Excellence, Fort Sill, OK and to commercial business clients in the DoD business sector. The company has seven years of direct UAS operations experience. Over the past three years TDRS has played a significant role in the Army’s Integrated Air and Missile Defense strategic plans and made key contributions to the Army’s Counter UAS (CUAS) mission set. TDRS has provided multiple years of industry and government operational support in the CUAS role. Awaiting approval of the federal government’s commercial UAS regulations and guidelines, TDRS has developed viable commercial UAS business services and applications.

Unmanned Cowboys, LLC. (Stillwater)

Unmanned Cowboys is a multi-product company, and unites a team with several decades of combined technical experience in unmanned and robotic systems. The

four founders, two PhD candidates and two aerospace professors at OSU, supported unmanned systems and aerospace projects for commercial, academic, and defense markets. The team brings research and commercial expertise in autonomous systems, robotics, and solar panel integration. Over the last several years, our teammates developed a plug-and-adapt™ autonomy module for unmanned vehicles, an Unmanned Flying Rolling Orb (UFRO), and solar panel integration tripling the flight time for a prominent Unmanned Aircraft System (UAS). Several new projects are in development.

Vector Air (Oklahoma City)

Vector Air is an authorized reseller for the Americas, Scandinavia, and Europe for OnScene Commander, a military-grade situational awareness system, blue force tracking for states and municipalities. OnScene Commander is used for fighting and recovering from disasters, including wildfires, tornadoes, earthquakes, hurricanes, floods, and volcano eruptions. Specialties include natural disaster recovery and fighting, Situational awareness systems, UAV, Drones, Command, control, communications.

Wave Technologies Inc. (Guthrie)

Wave Technologies, Inc. (WTI) is a veteran-owned, HUBZone certified, small business. WTI provides ISR life cycle systems engineering and integration, analysis center solutions, systems engineering and technical assistance services (SETA), Tactical Aircraft and Weapons Systems, and unmanned aerial vehicle technical services to government clients in the Department of Defense, intelligence community and broader national security arena. The WTI staff can provide functional management services to include requirements definition, system planning, design, and development, integration, testing and evaluation, production engineering, accreditation, configuration management, life cycle sustainment, operations and readiness.

Zivko Aeronautics Inc. (Guthrie)

Zivko Aeronautics is a woman-owned and operated company that has been involved in aircraft and aviation since its founding in 1987. The professional staff at ZAI has over 70 years of combined experience in every aspect of aviation. The staff includes experienced FAA licensed mechanics, an FAA licensed inspector, and a full-time aeronautical/avionics/mechanical engineering staff. ZAI's quality control meets private industry standards, as well as complies with the strict MIL-I-45208A and MIL-STD45662 Department of Defense requirements. ZAI has worked extensively with several aerobatic pilots, including the 2004, 2003, 2002 & 1998 U.S. National Champion Kirby Chambliss, and the 2000 U.S National Champion, Steve Andelin. This interaction allows ZAI to fully understand the requirements of unlimited aerobatics, and to produce a highly optimized and specialized aircraft. By both thoroughly discussing the requirements of each individual customer, ZAI can produce an aircraft specifically tailored to those individual needs.

APPENDIX 2: UAS ROADMAP FOR OKLAHOMA

Overview

- UAS industry is currently the fastest growing segment of the aerospace sector. Oklahoma is poised to play a vital role; states that are investing now will gain significant advantages
- The role of state governments in the industry is constantly changing and we must be able to adapt to a dynamic and competitive industry
- Public investment must meet objectives of achieving industry diversification within Oklahoma to ensure sustainable economic and job growth

Current State of UAS Industry

- Regulatory uncertainty is currently the biggest challenge
 - At present there is value in airspace that is reserved or approved for UAS test and evaluation while regulations are developed
 - The six FAA-selected UAS test site states (and others that are emerging elsewhere) are focusing resources primarily on test site activity that involves access to physical airspace
 - There are no known plans to extend FAA test sites beyond 2017
 - Once UAS regulations and rules are in place, test sites lose their value and importance and may become irrelevant; rules for small UAS are expected to be finalized by 2016 or 2017.

Oklahoma can “Leapfrog”

- Similar to the way third world countries skipped a “copper wire infrastructure” and went directly to wireless communication, Oklahoma has the opportunity to “leapfrog” and develop the infrastructure and assets to move ahead in UAS innovation and growth so that when the rules are ready, so is Oklahoma.
- This is a competitive new growth industry; it is critical that Oklahoma makes strategic investments now.

Rollout of Roadmap

- Phase I: 2015 – 2017
- Phase II: 2018 – 2020
- Phase III: 2021 – 2025

Phase I: 2015-2017

- Establish a permanent UAS support program managed through OCAST to provide funding for fundamental research, commercialization, and small business assistance
- Create an Oklahoma UAS Infrastructure Development Plan
- Develop comprehensive Oklahoma UAS education strategic plan to include all levels of necessary workforce development for the UAS industry (Career Tech, two-year colleges, universities)
- Establish agency (e.g. OSIDA) responsibility for state oversight of UAS activity in accordance with regulations (UAS registration, liability insurance tracking/verification, etc.)
- Agency will include a permanent UAS public policy advisory entity to address

- privacy, public perception, risk perception, etc.
- Agency will establish a schedule of yearly statewide conferences/events that focus on UAS with industry-specific focus (weather, agriculture, safety, etc.)
- Begin planning and development of statewide improved UAS network capability for weather monitoring and forecasting (3D mesonet, on-demand atmospheric profiling, wildfire surveillance, etc.)
- Coordinate with USIC™, i2E and others to facilitate access to commercial investment capital for UAS industry in Oklahoma
- Establish \$100 million capital investment pool
- Revise and execute Governor’s UAS Advisory Council Strategic Plan, consistent with this UAS roadmap

Phase II: 2018-2020

- Begin statewide infrastructure upgrades and installation to support UAS operation (safety, data collection/transmission, rural broadband)
- Expand OCAST support program to address all UAS-impacted industries
- Previously selected Agency establish formal international UAS business collaboration office/role/responsibility for Oklahoma to develop global partnerships, in collaboration with ODOC
- Develop and implement a statewide network of UAS innovation zones in collaboration with career-techs, local chambers, universities, cooperative electric utilities and also align with STEM communities initiative
- In addition to “innovation zones”, also create two or three “innovation hubs” to foster early entrepreneurship
- Seek FFRDC (Federally Funded Research & Development Center) or similar status for Oklahoma UAS research activities to support federal needs (DoD and non-DoD)
- Expand investment pool to \$250 million

Phase III: 2021-2025

- Leverage improved communications infrastructure to diversify local economies
- Through OCAST develop set of strategic technology far-reaching challenges for public-private partnerships/collaboration between state research institutions and UAS industry to stimulate next generation of innovation
- Expand out-of-state collaboration network (i.e. – state-to-state relationships, international relationships, etc.)
- Develop innovative UAS-related education/career paths in cooperation with K-20 STEM efforts in collaboration with Oklahoma’s STEM Communities
- Expand investment pool to \$500 million

Sources/References

- FAA’s “Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap” https://www.faa.gov/uas/legislative_programs/uas_roadmap/media/UAS_Roadmap_2013.pdf
- DoD’s “Unmanned Systems Integrated Roadmap, FY 2013–2038” <http://www.acq.osd.mil/sts/docs/DoD%20USRM%202013.pdf>

GLOSSARY OF ACRONYMS*

A&M	Agricultural and Mechanical
AFB	Air Force Base
ARRAC	Advanced Radar Research Center
ASR	Airport Surveillance Radar
ATLAS	Air Traffic Laboratory for Advanced Systems (Spain)
AUVSI	Association of Unmanned Vehicle Systems International
C5ISR	Command, Control, Communications, Computers, Combat Systems, Intelligence, Surveillance, and Reconnaissance
CASQ	Center for Aerospace Supplier Quality
CBRNE	Chemical Biological Radiological Nuclear and Explosive
CGJMTC	Camp Gruber Joint Maneuver Training Center
CoA	Certificate of Authorization
CoE	Center of Excellence
DEQ	Department of Environmental Quality
DHS	Department of Homeland Security
DoD	Department of Defense
DoE	Department of Energy
DoT	Department of Transportation
EDGE	Economic Development Generating Excellence (program now closed)
EMC	Electromagnetic Compatibility
EO/IR	Electro-Optic/Infra-Red
ERC	Engineering Research Center
EW	Electronic Warfare
FAA	Federal Aviation Administration
FMRA	FAA Modernization and Reform Act
FFRDC	Federally Funded Research and Development Center
IC	Intelligence Communities
ICAO	International Civil Aviation Organization
ICATS	International Consortium for Aeronautical Test Sites
iSeC	Information Security Center

* (not including individual company abbreviations, trademark, logos, etc.)

ISR	Intelligence Surveillance and Reconnaissance
KAEFS	Kessler Atmospheric and Ecological Research Center
MALE	Medium Altitude Long Endurance
MAV	Micro Air Vehicle
M-AVIARI	MAV Indoor Assessment and Research Instrumentation
MD	Maryland
MIT	Massachusetts Institute of Technology
MPAR	Multi-function Phased Array Radar
MQ-9	Model number for Predator B UAS
MRO	Maintenance Repair and Overhaul
MS	Master of Science
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
ND	North Dakota
NDAA	National Defense Reauthorization Act
NEXRAD	Next Generation Radar
NOAA	National Oceanographic and Atmospheric Administration
NSA	National Security Agency
NSF	National Science Foundation
NSSL	National Severe Storms Laboratory
NWRT	National Weather Radar Test Bed
OAC	Oklahoma Aeronautics Commission
OCAST	Oklahoma Center for the Advancement of Science and Technology
ODOC	Oklahoma Department of Commerce
OEM	Original Equipment Manufacturer
OK	Oklahoma
OKNG	Oklahoma National Guard
OSIDA	Oklahoma Space Industry Development Authority
OSU	Oklahoma State University
OTC-USSM	Oklahoma Training Center – Unmanned Systems
OTRP	Oklahoma Technology and Research Park

GLOSSARY OF ACRONYMS (cont.)

OU	Oklahoma University
PAR	Phased Array Radar
PhD	Doctor of Philosophy
R&D	Research and Development
RAPS	Robotic aircraft for Public Safety
RF	Radiofrequency
RPAS	Remotely Piloted Aircraft Systems
SAR	Synthetic Aperture Radar
SBIR	Small Business Innovative Research
SCADA	Supervisory Control and Data Acquisition
SETA	Systems Engineering and Technical Assistance
SIGINT	Signals Intelligence
STEM	Science Technology Engineering Mathematics
STTR	Small Business Technology Transfer
SUAS	Small UAS
T&E	Test and Evaluation
TBIP	Tinker Business and Industry Park
TU	Tulsa University
TX	Texas
UARC	University Affiliated Research Center
UAS	Unmanned aerial (or Aircraft Systems
UAV	Unmanned Aerial (or Aircraft) Vehicle
UDC	Unmanned Systems Development Center
UK	United Kingdom
US	United States
USA-OK	Unmanned Systems Association – Oklahoma (OK Chapter of AUVSI)
USIC	Unmanned Systems Innovation Center
VA	Virginia
VLOS	Visual Line of Sight
VTOL	Vertical Take-off and Landing
WBToi	World's Best Technology open innovation



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Aerial Systems Council Spring 2015***

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