

# UNMANNED VEHICLE SYSTEMS in Virginia



Virginia is home to a unique combination of assets that position the Commonwealth to take a major leadership role in the emerging field of Unmanned Systems (UMS), not only in all domains of Unmanned Systems (air, land, and sea), but also in the entire support structure—from education, research and development, testing, deployment, maintenance, and multiple related services.

Virginia is currently a national leader in the development, manufacture, and creative use of UMS. Home to the eighth largest concentration of unmanned system firms in the nation, Virginia has committed to leveraging its unique resources to create an innovation ecosystem that will not only underpin industry development, but also support the advancement of beneficial applications.

Virginia, through its world-leading Unmanned Systems Commission and other government agencies and public-private partnerships, seeks to provide a foundation for the technologies, cyber security, big data, and manufacturing facilities necessary to create a highly reliable unmanned systems industry for the future.

In June 2015, Virginia Governor Terry McAuliffe signed Executive Order 43, creating an Unmanned Systems Commission that capitalizes on Virginia's unique qualities, provides for long-term planning of research and development, and defines the challenges to UMS that Virginian ingenuity, innovation, and business can help solve. Virginia has done something that no other state can match – successfully aligned business, government, and citizen interests to grow the UMS industry in a safe and rewarding way.

## INTRODUCTION

Virginia offers a number of competitive advantages for UMS firms: a stable and friendly regulatory environment, a unique geography with ample testing locations, a plethora of civil business and existing technology firms, an ample and well-trained workforce. and a host of educational institutions conducting advanced research and training the next generation of industry leaders.

Simply put, recognizing the value of beneficial applications of this technology in Virginia, the United States, and the world, Virginia has positioned itself as the go-to place for unmanned vehicle systems industries. As a national leader in technology, Virginia is positioned to help define the blossoming unmanned vehicle systems industry by drawing from the incredible resources of the state, including an educated and technology-proficient workforce, diverse geography, existing technology companies, and strong military presence.

In addition to Virginia's many commercial stakeholders, academic stakeholders include university researchers who are inventing new technology and university educators who are developing the workforce to sustain and lead the industry. Virginia has a strong, twofold academic stake: 1) workforce development and 2) research and development. Unmanned systems will remain a major priority for the U.S. military, and a variety of commercial applications are beginning to evolve as the regulatory climate adjusts to the new reality of highly automated vehicles.

The purpose of this report is to highlight the work being done in Virginia in the field of unmanned vehicle systems, both through state government, federal and defense, higher education, and the private sector. It is clear that Virginia is *the* place to be for unmanned vehicle systems.

## A BRIEF PRIMER ON UNMANNED SYSTEMS

**Unmanned systems** are relatively new and rapidly changing as are the guidelines that regulate their use — so much so that there is no standard industry definition for "unmanned systems." However, the industry generally includes both manufacturing and non-manufacturing activities.

The UMS manufacturing industries comprise firms that produce the finished vehicles and those that produce the components and instruments, which may be upstream from the vehicle manufacturers. The non-manufacturing industries consist of specialized technology, design, programming, and consulting services, which are inputs to the manufacturing industries. Another way to consider UMS is that the "unmanned" portion represents a new product line for existing vehicle and related technology industries.

Unmanned systems include intelligent cars, self-guiding tractors, water surface and underwater vehicles, and unmanned aircraft. Autonomous (driverless) vehicle technology has matured to a point where civil and commercial applications are feasible and compelling. From aging seniors hoping to keep their independence thanks to self-driving cars, to farmers hoping to gain advance warning of crop problems, the technology holds the potential to benefit our citizens and industries in many ways.

Advances in automation and related technologies have led to an exponential growth in demand for unmanned systems services and applications. Ready access to very inexpensive and easy to use Unmanned Aerial Systems (UAS) platforms by companies large and small has led to innovative uses spanning film production, agriculture, infrastructure inspections, first responders, lifesaving, and natural resources management. These advances are rapidly finding their way into automobiles, farm and other surface machinery, and maritime surface and underwater systems.

Within the field of UMS, the industry consists of a vast number of entrepreneurs and startup firms exploring various business models and systems that can be provided at low cost to many customers, with major corporations largely engaged in production of very high cost systems supporting demanding Department of Defense (DoD) applications. These major corporations are actively watching the UMS market evolution to identify business models, including related services, appropriate to the strategies and cost structures of the large firms. In addition to its applications, autonomous vehicle technology is poised to positively impact jobs and economic health throughout Virginia.



## THE VIRGINIA STORY

Ranked consistently near the top in Forbes' annual list of Best States for Business, Virginia provides a wealth of opportunities, a great atmosphere for development, expansion, and leadership that truly understands the importance of maintaining the best business environment for economic prosperity.

A variety of performance-based incentives, from tax credits to tax exemptions, are Virginia's investment in its economic future. The Commonwealth works enthusiastically with new and expanding employers who demonstrate a willingness to invest in those who invest in Virginia, create a high standard of living for Virginians, and enhance local and state economies through increased revenue growth.

#### PRO-BUSINESS ADVANTAGES FOR COMPANIES



- Strategic east coast location and excellent infrastructure provide easy access to national and global markets
- Stable, low tax costs for corporations and individuals and a 6% corporate income tax
- Minimized payroll costs with low worker's compensation rates and a low unemployment tax
- Favorable business environment that protects "at will" and "right-to-work" employment practices
- One of the highest-ranked states in high-technology employment
- 38 established Technology Zones
- A vibrant and diverse multi-cultural community where employees can live and work
- An experienced, educated and productive workforce
- Recruitment and training programs to help businesses become operational faster and maintain their competitive advantage
- More than 2,300 certified buildings and sites located across the Commonwealth

Virginia's role in the aerospace industry started in 1917 when the nation's first civil aeronautics laboratory was established in Hampton—it is now known as the NASA Langley Research Center—a center for unmanned systems research, development and operations.

Global leader Rolls-Royce produces components in its Crosspointe campus in Prince George County, also home to a world-class applied research collaborative – the Commonwealth Center for Advanced Manufacturing (CCAM). Alcoa Howmet, Dynamic Aviation, Moog, Orbital Science, and The Aerospace Corporation have seen Virginia has one of the best places to do business and continue to develop their operations here, creating 69 industry projects and over 7,268 jobs with investments worth \$1.79 billion over the last 10 years.¹

Aerospace companies continue to grow rapidly in Virginia, taking full advantage of the superior support industries including manufacturing, transportation, and well-established and maintained infrastructure with access to all regions via rail, air, and marine. Virginia is a right-to-work state with the sixth lowest unionization rate in the United States. The Port of Virginia allows companies to export and import through a facility capable of handling post-Panamax ships and has no overhead obstructions between it and the Atlantic Ocean, allowing manufacturing and trade of heavy, large, and high-yield payloads, lowering costs and maximizing return. Interstate and rail networks in Virginia provide access to the Northeast, Southeast and Midwest.

<sup>&</sup>lt;sup>1</sup> Yesvirginia.org



# UNMANNED SYSTEMS: COMPETITIVE ADVANTAGES IN VIRGINIA

Virginia has become the friendliest state in the nation for unmanned system (UMS) development and business creation and is positioned to become an international leader in UMS economies. Over the past few years, Virginia has gone from being a state looking to limit UAS markets, to an active supporter of unmanned systems by providing the resources, environments, support, infrastructure, and personnel unparalleled by any other state; a journey heralded by state legislators and executive officers.

Virginia offers a number of competitive advantages for UMS firms: a stable and friendly regulatory environment, a unique geography with ample testing locations, a plethora of civil business and existing technology firms, an ample and well-trained workforce, and a host of educational institutions conducting advanced research and training the next generation of industry leaders.

# VIRGINIA REGULATORY ENVIRONMENT

Because the biggest problem facing unmanned aircraft systems today is a lack of understanding of the current regulatory environment, Virginia's commitment to a stable, friendly regulatory environment commitment provides provides perhaps the most important difference between Virginia and other states. Virginia poses no state requirements of UAS operators, relying on the Federal regulations (other than the requirement for law enforcement search warrants).

Virginia has led the way in becoming a friendly partner for unmanned aircraft systems, relying upon the Federal Aviation Administration to regulate air space while also maintaining certain limitations on law enforcement use that puts the public's mind at ease and cultivates investment from industry. Virginia continues to lead the United States UAS research field with its successful bids for both a UAS Test Site and the UAS Center of Excellence participation.

The Virginia Department of Transportation (VDOT) and the Department of Motor Vehicles have entered a new partnership

with the Virginia Tech Transportation Institute, Transurban, and the high-definition mapping business HERE, to create the Virginia Automated Corridors.

Early on, Virginia recognized that maritime unmanned systems play just as important of a role in the development of a technologically driven economy as UASs. Rather than dedicate funds and support strictly to unmanned aircraft, Virginia focused

Virginia strives to bring together the boldest and brightest engineers and businesses community members in a future oriented capacity.

on UMS—Unmanned Systems—as an overall approach to research and development unlike any other state. By leveraging the unique qualities of the region, businesses and educators gain access to universities, small companies, and large firms that are advancing maritime vehicles, autonomy, manufacturing, and servicing.

With leadership in research and education, Virginia has also been able to overcome early attempts to ban or heavily limit the use of unmanned systems. Cultivating meaningful relationships throughout the unmanned systems community will happen quickly as the state outpaces national and international competition through direct support of industry partnerships, positive and clear legal approaches to control unwanted UAS flights, and the promotion of investment in UAS economies directly and indirectly related to flight operations.



# VIRGINIA UNMANNED SYSTEMS COMMISSION

Rather than responding with fear of the potential misuse of a new technology, the Governor and Virginia General Assembly have embraced and supported unmanned vehicle systems. In June 2015, Virginia Governor Terry McAuliffe created the Virginia Unmanned Systems Commission, brought into effect by Executive Order 43. The VUSC brings together a force for innovation and bold leadership.

The Commission consists of the Secretaries of Technology, Commerce and Trade, Transportation, Education, Veterans and Defense Affairs, two Congressional representatives, and eleven citizen members. U.S. Senator Mark Warner and Congressman Scott Rigell serve as Congressional leadership to this committee, emphasizing the importance of this new industry to Virginia's leadership.

It is further bolstered by the private industry involvement of Aurora Flight Science's CEO John Langford, Nicole Barranco, Director State Government Relations, Volkswagen Group of America, Robert Dehnert, Senior Director of Raytheon Company, Guy Sanitate of the Scitor Corporation, Jim Hughes, Vice President of Submarine Programs, Newport News Shipbuilding, Victoria Cox, Senior Technical Advisor of Veracity Engineering, and Young Kim, CEO of Digital Harvest. Importantly for the unmanned vehicle systems industry, this commission is embracing a private-public representation that is a national model for friendly, but safe and regulated, autonomous systems growth.<sup>3</sup>

Where some states have become overly constrictive to varying applications of UMS—signaling a willingness to over-legislate the use of UASs—Virginia limited their restriction to law enforcement and the need for a warrant before use. Virginia was the 12<sup>th</sup> state to create such a requirement that is widely seen as a necessary step in developing an appropriate framework for law enforcement use.

While limiting law enforcement use now copied throughout the United States, Virginia's SB 1301 protected important, non-government, uses including "research and development conducted by institutions of higher education or other research organizations... or the use of unmanned aircraft systems for private, commercial, or recreational use." This small portion of the bill is what initially separated Virginia from a number of states legislating and regulating UMS.

# UNIQUE GEOGRAPHICAL ADVANTAGES

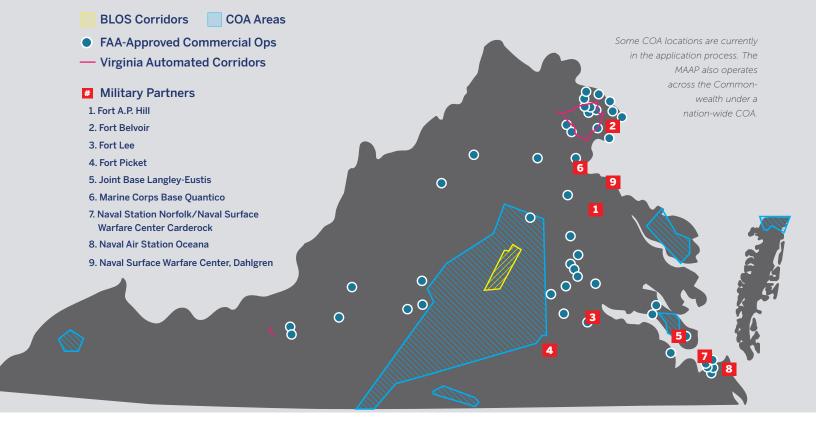
# PROXIMITY TO DECISION-MAKERS

Virginia exhibits unique qualities that most other states cannot claim. Its geographical location allows for companies to have access to the Nation's political decision-making center in Washington, D.C. With unparalleled access to federal legislators and the executive branch, educational and business groups have seen it in their own best interests to call Virginia home.

The leading UMS voice in the world, the Association for Unmanned Vehicle Systems International, which stewards efforts to create and define UMS policy, is headquartered in Arlington, Virginia and hosts universities and businesses at events throughout the state.

The state also provides a home to NASA's Wallop's Island which is just now completing a UAS specific landing strip facility for research and development, NASA Langley Research Center focusing on Command and Control (C2), autonomous systems, vehicle architecture, human factors, and Unmanned Traffic Management (UTM), a number of law enforcement agencies, and military and paramilitary organizations that drive demand and growth for the UMS sector in research, development, and

<sup>2</sup>http://lis.virginia.gov/cgi-bin/legp604.exe?ses=151&typ=bil&val=sb1301 <sup>3</sup>http://vus.virginia.gov/ums-commission/ums-commissioners



training at Quantico, Naval Surface Warfare Dahlgren and Carderock, Fort Eustis, and other Virginia installations.

#### TOPOGRAPHICAL ADVANTAGES: AIR, LAND, AND SEA

#### Air

The Beyond the Horizon Corridor is a prime example of the Commonwealth's commitment to the UAS Industry and private-public partnership leadership that Virginia provides in the UAS Industry by cultivating bonds between education, research and development firms, infrastructure and industry members, and UAS innovators in a business-creating environment.

Virginia's Beyond the Horizon Corridor currently offers a 185 square mile testing environment consisting of 27 miles of pipeline infrastructure, 24 miles of power line, 13 miles of rail line, and a variety of agricultural assets all to be used for operational training, business proposition validation, and reliability standardization. This "corridor" of Virginian terrain will soon be expanded to well over 2000 square miles, containing 100 miles of linear infrastructure below airspace ideally suited for testing and maturation of unmanned vehicle systems.

Importantly for UAS manufacturers, operators, and service providers, this corridor provides an opportunity for testing of Beyond Line of Sight (BLOS) operations, including for long linear infrastructure and equipment, all within the FAA regulatory structure and in partnership with world-leading technology companies drawn by the Mid-Atlantic Aviation Partnership Test Site at Virginia Tech.

The vision for the Beyond Horizon Corridor is to be the best place for training and operational validation for the oil and gas, rail, and power line management companies and research groups looking to use unmanned systems for their operations and within their country's National Aviation Authorities (NAAs) legal limits. The unique aspects of this environmentally friendly, robust, and focused

environment will allow any company access to a flight environment that is safe, reliable, controlled, and data driven so that they may can gain valuable, first-hand experience for UAS operations for their particular need.

This private-public partnership is currently defined in a Memorandum of Understanding with Virginia Tech, American Aerospace Technologies, Inc., Dominion Resources, Pipeline Research Council International (PRCI), Black & Veatch, and facilitated by Virginia law firm Williams Mullen to strengthen Virginia's leadership in the research and development of cutting edge UAS technologies.

By working with the Federal Aviation Administration (FAA) and all other relevant government agencies, these initiatives aim to maximize the technologies and benefits of UAS specifically for inspecting and monitoring infrastructure and equipment, a role considered to be among the top three most important uses of UAS technologies.<sup>4</sup>

 $<sup>^4</sup>http://www.doav.virginia.gov/Downloads/Studies/UAVs\%20 lin\%20 Virginia/The Future Of UVS In Virginia 2014.pdf$ 

Though many UAS groups, especially those with agricultural focus, believe precision agriculture will represent 80% of the commercial uses for UASs. currently the international marketplace has seen pipeline management and infrastructure inspection as the most successful business cases beyond videography or aerial photography. 5 Both markets, agriculture and infrastructure inspection, will be served by the Beyond the Horizon initiative, as it will contain a testing environment consisting of miles of pipeline infrastructure, power line, rail line, and a

variety of agricultural assets all available for operational training, business proposition validation, and reliability standardization.

Beyond Line of Sight operations are the missing business operation necessary in most cases for meaningful investment and growth of a UAS company. Most organizations fail in getting approval for testing longer, more autonomous flights in the national air space. The regulatory structure simply does not allow for such flight except in extremely unique cases without further validation of a Concept of Operations (CONOPS) or systems reliability. The Beyond the Horizons Corridor will be that bridge for validating an operation or system in a BLOS environment and to provide a commercial operator the data needed to prove their air worthiness, become licensed in BLOS conditions, and attract investment in an internationally competitive market.

#### Land

Virginia paves the way in the development of automated and autonomous land vehicle technologies, including automotive automation and autonomous systems for commercial and defense applications. We have the subject covered from applied research through technology maturation and highway testing of automated cars.

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The Virginia Department of Transportation (VDOT) and the Department of Motor Vehicles have entered into a new partnership with the Virginia Tech Transportation Institute (VTTI), Transurban and HERE to create the Virginia Automated Corridors. This initiative will streamline the use of Virginia roads and stateof-the-art test facilities for automated-vehicle testing, certification, and migration towards deployment.

These corridors cover more than 70 miles of interstates and arterials in the Northern Virginia

region and will provide car companies and suppliers of automated vehicles the ideal, real-world environments they need to test complex scenarios prior to putting their vehicles on more roadways. The proximity of the Virginia Automated Corridors to Washington, DC facilitates access to the northern Virginia technology corridor and decision makers in DoD and Federal agencies.

Two test-track environments are included—the Virginia Smart Road at VTTI and the Virginia International Raceway. The corridors integrate access to dedicated high-occupancy toll lanes, high-definition mapping capabilities, real-time traffic and incidents, intelligent routing, location cloud technology, pavement markings maintained by VDOT for completeness and retro-reflectivity, accurate localization via high-precision global navigation satellite systems, dedicated short-range communications and cellular technology, and sophisticated, unobtrusive data acquisition systems.

#### Sea

Unmanned vehicles are routinely performing environmental monitoring in the open ocean and in bays throughout America. While unmanned aircraft have stolen the public spotlight, a perhaps even more important impact of autonomous developments may come in the maritime systems. While maritime unmanned systems seem to be separate in the eye of the public,

<sup>5</sup>http://www.infoag.org/abstract\_papers/papers/abstract\_214.pdf

their supporting technologies and innovative solutions to collision avoidance, command and control, autonomy, and battery life are the same. Beyond surface systems, the needs of underwater systems to go deeper, stay down longer, and minimize support systems or pressurization to maximize locomotion define the mission.<sup>6</sup>

Early on, Virginia recognized that maritime unmanned systems play just as important a role in the development of a technologically driven economy as UASs. Rather than dedicate funds and support strictly to unmanned aircraft, Virginia focused on UMS—Unmanned Systems—as an overall approach to research and development unlike any other state. By leveraging the unique qualities of the region, businesses and educators gain access to universities, small companies, and large firms that are advancing maritime vehicles, autonomy, manufacturing, and servicing.

Virginia's unique geographical position provides access to waters ranging from marshes and shallow rivers to a massive, historic, infrastructure-rich bay and wide-open ocean. Joint missions with the Mid-Atlantic Aviation Partnership or NASA Wallops exist to enable swarm or nodal communication between ground, air, and underwater vehicles without human intervention. These areas enable new companies to work with leading institutions to rapidly develop new solutions to global challenges with local area firms all seeking to provide needed support.

To develop this unique capability, the Virginia Hampton Roads waters and the Joint Atlantic & Chesapeake Ranges Cooperative (JACRC) were created. This Collaborative Test & Training Support center has already provided vital access to the U.S. Navy's GhostSwimmer Unmanned Underwater Vehicle (UUV) and the Office of Naval Research (ONR) testing of autonomous Swarmboats. While these examples are both military in nature, maritime unmanned systems are expected to provide data for the crabbing industries, recreation, and water monitoring going forward alongside many new, unforeseen initiatives. The continued development of all autonomous robotics is the focus of Virginia's UMS efforts and has been widely embraced by maritime unmanned systems firms internationally.

The oceanic deep waters, Chesapeake Bay, Hampton Roads harbor, and nearby rivers and marshes provide an incredibly rich testing environment that has been employed in recent years by the NASA Jet Propulsion Laboratory (JPL), Pennsylvania State University, ONR, and DARPA.



U.S. Navy's GhostSwimmer UUV

Examples of testing in Virginia include the 2014 ONR testing of robotic swarming boats in the James River and the ONR Project Silent Nemo tests at Joint Expeditionary Base Little Creek, a 5-foot, 100-pound experimental robot developed by Boston Engineering that is designed to look and swim like a Bluefin tuna. Project leadership for the swarm boat demonstration was provided by the Naval Surface Warfare Carderock Combatant Craft Division in Norfolk and autonomous systems developed by Spatial Integrated Systems of Virginia Beach.

In the field of maritime unmanned systems, the eastern Virginia regions, including Hampton Roads, provide a world-class maritime development environment. These regions provide:

- Universities, small companies, and large firms that are advancing maritime vehicles, autonomy, and manufacturing and servicing.
- Proximity to defense agencies funding the development of future generations of unmanned systems for the warfighter, including Defense Advanced Research Project Agency (DARPA), Office of Naval Research (ONR), and Naval Surface Warfare centers Dahlgren and Carderock.

- Access to waters ranging from marshes to shallow rivers to oceanic.
- Close proximity to system users, including numerous defense installations and assets. for rapid prototyping, testing, and feedback.
- Close proximity to Washington, DC stakeholders.
- A family friendly locale with low cost of living in vibrant city locations.
- Mid-Atlantic Aviation Partnership support for UAS operations for joint maritime/air testing.
- Close proximity to use cases including defense, Virginia Institute of Marine Science and Chesapeake Bay resource protection needs, and a nascent offshore energy industry.

#### **CIVIL BUSINESSES AND EXISTING FIRMS**

The UMS industry in the United States has been hampered by a lack of federal regulations creating a confusing environment for investors and entrepreneurs alike. Even still, Virginia has shown a resilient and inspiring history of innovation and attracted investment capitol throughout the past few years largely based upon the characteristics that define the rest of Virginia's business landscape. More than 260 aerospace firms call Virginia home, drawn by skilled workforce, strong economic growth and a pro-business environment.

Virginia is home to a number of large system integrators (companies that combine existing subsystems to create new technologies) with significant expertise in autonomy, and a number of small- and medium-sized companies that have established themselves as leaders in the emerging unmanned systems domain.

While state government has acted to define Virginia as a leader in this Science, Technology, Engineering, and Math (STEM) related industry, and established the UMS commercial field as a vital "key to building the new Virginian economy," it is the civil businesses that are bolstering and benefiting society.7

Even within a federal regulatory environment still developing and sometimes hard to navigate, Virginia small businesses have blossomed and investment has flourished. In spite of confusing federal regulation, Virginia has seen the creation and authorization of 59 Section 333 Exempt companies, in eight distinct categories or functions, from ten different counties.8 These companies represent the entrepreneurial characteristics of Virginia and illustrate the demand by today's evolving businesses.

#### Let's Fly Wisely & CACI International Inc.

#### Flirtev

It has never been so clear that Virginian UMS companies are leading the nation. On June 17, 2015, Flirtey conducted the first FAA approved medical supplies delivery during research flights at Wise, Virginia.9 Flirtey, a startup with its origin in Australia, originally sought out the test site at the University of Nevada, but found that Virginia was a preferable landscape for developing, innovating, promoting, and completing their first mission.

From humble beginnings with a goal of delivering schoolbooks in Australia, Flirtey teamed with Virginian leaders the Mid-Atlantic Aviation Partnership (who partnered with NASA), and the Remote Area Medical free clinic, to take advantage of a once per year event that brings out underserved citizens for medical analysis and treatment in rural Wise County.

Wise County can be difficult to service for delivery trucks and take a long time for delivery. The goal for Flirtey was to deliver 24 packages of medicine for 24 people, separated between 6 UAS delivery flights.

The flights, a proof-of-concept for the delivery industry, cut delivery of much needed medicines from "more than a day to half an hour."10 While this event seems like an easy to recognize fit for Flirtey and for Wise County, a great amount of effort is involved in ensuring that a pathfinder project like this one is allowed to take place. These flights could not have happened without the support from government and partnerships available in Virginia—a significant reason that Flirtey chose the Virginia test site team over Nevada's. Under the supervision of the Mid-Atlantic Aviation Partnership and in conjunction with NASA counterparts, the "Let's Fly Wisely" was a huge success for Flirtey, the FAA, NASA, and Virginia.

 <sup>7</sup> https://governor.virginia.gov/media/3896/eo-43-establishment-of-the-unmanned-systems-commissionada.pdf
 8 http://faa-drone-exemptions.silk.co/page/VIrginia (as of 11/03/2015)
 9 http://www.gizmag.com/flirtey-drones-deliver-medicine-in-us-first/38102/
 10 http://www.gizmag.com/flirtey-drones-deliver-medicine-in-us-first/38102

Virginia's government, local medical organizations, and the FAA UAS Program Office made this happen by developing relationships and building support. Flirtey's "Kitty Hawk-like" proof of concept is an example that illustrates the need for the partnerships Virginia cultivates daily. By bringing together lawyers representing Continuing Legal Education (CLE), local government, and entrepreneurial leaders, Virginia showed how it leads the nation through collaboration.<sup>11</sup>

The CLE has embraced UAS law and regulatory expertise and the experience they developed can help guide any new company through the regulatory and legislative hurdles that are present at the Federal level while ensuring complete confidence in their legality. Flirtey beat the rest of the delivery UAS companies to the punch because of these unique Virginian qualities, and is now seen as a real, independent competitor on the international stage.<sup>12</sup>

#### **CACI International**

CACI's information solutions and services support national security missions and government transformation for Intelligence, Defense, and Federal Civilian customers. A Fortune magazine World's Most Admired Company in the IT Services industry, CACI is a member of the Fortune 1000 Largest Companies, the Russell 2000 Index, and the S&P SmallCap 600 Index. CACI provides dynamic careers for over 16,300 employees in 120 offices worldwide.

#### **Pathfinder**

In October, 2015, the FAA expanded its Pathfinder Program involving UAS in the United States to include a promising project led by the Virginia Company CACI International Inc. This pathfinder project highlights the company's passive UAS detection, identification, and tracking system for use at airports. The CACI partnership is part of the larger UAS Pathfinder Program announced by the FAA in May 2015 and continues to bring forward technology and policy in a rapidly evolving UMS ecosystem.<sup>13</sup>

The CACI UMS program is providing a technology capable of detecting, identifying, and tracking UAS passively; a technology that promises to revolutionize airport safety. By incorporating advances in geo-fence technology or digital gateways, new companies find innovative futures alongside world-leading partners.

Virginia offers these strategic partnerships for building open, well-supported industries with a centralized focus of ensuring that the UAS industry has the enabling technologies necessary for ensuring success. Only through safe, collaborative, and legal pathways for UMS operators, manufacturers, and investors will the industry realize the overall potential needed to revolutionize the national economy.

#### **SkyTracker**

CACI's SkyTracker™ system accurately and reliably detects, identifies, tracks, and mitigates threats from unmanned aircraft systems (UAS) misuse. This proprietary CACI technology has been demonstrated to address a variety of UAS threat scenarios. The system is widely applicable, from protecting airports to safeguarding critical infrastructure or events—anywhere UAS pose a potential risk to people or assets. SkyTracker provides continuous, automated monitoring, day or night, in any weather condition.

Unlike other technologies, SkyTracker's mitigation capability won't disrupt legitimate electronics or communications systems in the area. Furthermore, the system will not interfere with UAS that are operated responsibly as determined by the U.S. government. SkyTracker has the unique capability to identify and locate both UAS and their ground operators, improving responders' ability to act in incidents of inadvertent or unlawful misuse.

SkyTracker's passive detection capability creates an electronic perimeter boundary that is superior to geofencing. The modular system protects geographically compact locations surrounding such high-value assets as government buildings, embassies, and stadiums, and is scalable to provide wide-area defense of critical infrastructure, airports, military bases, and areas under temporary flight bans such as locations experiencing forest fires.

SkyTracker uses UAS radio links to precisely identify and locate systems flying in banned or protected airspace. It also locates ground operators within seconds, enhancing responders' capability to rapidly engage only with the operators misusing their aircraft. The system provides accurate geolocation and tracking of misused aircraft while differentiating them from other UAS in the area, and leverages cutting-edge technology to continually adapt to evolving threats.

<sup>&</sup>quot;http://www.courtbar.org/cle

<sup>&</sup>lt;sup>12</sup>http://www.forbes.com/sites/jlim/2015/07/23/flirtey-demos-worlds-first-drone-delivery-tech-in-u-s

<sup>&</sup>lt;sup>13</sup>https://www.faa.gov/news/updates/?newsId=83927



#### **Small Business Stories**

Very important success stories for the UAS industry have come in the very limited amount of time that the FAA has been granting Section 333 exemptions to the 14 CFR regulations preventing commercial operations of small unmanned aircraft.14 While recently the number of granted exemptions for companies looking to operate UASs commercially has been artificially hindered due to technical problems in the FAA process, entrepreneurs of Virginia have been able to gain important commercial access to the air space at an exceptional rate. Of the 2,134 exemptions that exist today, 66 belong to Virginia based companies (updated Oct. 9, 2015), ranking 8th in total number of 333 exemptions in the United States.

The 59 Virginia companies with exemptions listed "photography, film, or videography" as their main line of business at the highest rate (31.5%), "Real Estate" as the second highest rate (18.5%), "Utilities and Infrastructure Inspection" as the third highest rate (15.2%), and "Agriculture"

at the fourth highest rate (12%). These rates are similar across the nation and show how videography and real estate, unidentified for their potential previous to this boom in certification, have taken a lead role in the commercial markets.<sup>15</sup>

Where most analysts believed that the greatest and most immediate commercial applications for small UAS would be in the agricultural or surveying fields alone, the data has shown a propensity for unrecognized applications and therefore the most important function of government is to provide a system agnostic approach to regulations—allowing business to solve problems without interference. This is the approach Virginia is taking and it contributes to much of the UMS success in the state.

While "emergency services" is a relatively small rate (7.7%) of the overall commercial operations in Virginia with Section 333 exemptions, a trend in the marketplace shows this will grow tremendously over the coming months. <sup>16</sup> These emergency service providers

will work hand-in-hand with law enforcement and defense agencies to develop the systems, policies, and procedures that define that specific micro-industry. Virginia's regulatory environment does allow for private companies to aid in search-and-rescue functions as well as emergency response and disaster relief, encouraging private market participation and cooperation with law enforcement and first responders.

As the FAA UAS Roadmap moves into the Integration and Evolution stages, and away from accommodation, the number of exemption 333s and Certificates of Authorizations or Waivers (CoAs) will diminish, in favor of standardized certification processes and clarity in the UAS regulatory environment.<sup>17</sup> This will allow every participant in the UAS field to take part in the national air space at a much more regular, and business friendly environment. Until then, it is very important to be familiar with the federal and state legislation timelines and practices all over the nation.

# EXISTING TECHNOLOGY FIRMS

## NASA & The Defense Industry

The National Aeronautics and Space Administration (NASA) and the defense industry as a whole should not be overlooked as a unique provider of opportunity in Virginia. While the defense industry is spread throughout the nation, Virginia's position is unique in the breadth of contracts and relationships available through the Department of Defense (DoD).

<sup>&</sup>lt;sup>14</sup> https://www.faa.gov/uas/legislative\_programs/section\_333

<sup>15</sup> http://faa-drone-exemptions.silk.co/page/Vlrginia

https://fas.org/irp/program/collect/service.pdf

As of FY 2013, Virginia accounted for more than \$44.6 billion in defense contracts alone, making it the No. 1 state for total revenue driven by DoD investment. 18 This success is not driven simply by the geographical access to Washington D.C., but by the long-term investments made by leading aerospace companies and government agencies in the region; investments that are likely to continue growing with the business friendly environment and partnership development in UMS technologies.

Twelve defense contractors are headquartered in Virginia, including Alliant Techsystems, Atlantic Diving Supply, Booz Allen Hamilton, CACI, CSC, DynCorp, General Dynamics, Huntington Ingalls, ITT Exelis, Leidos, ManTech, and Northrop Grumman. Of those, two are among the top four leading UMS companies in the world – Northrop Grumman and General Dynamics.

While such heavy-hitters in the same field may intimidate some companies, by being co-located in the Virginia area, new companies gain access to corporate entrepreneurial initiatives that enable cross-collaboration, increased likelihood of buyout, and a "silicon valley" like atmosphere focused in their field. These defense contractors have seen the value in access to national leaders in Washington D.C., as well as a close proximity to the Pentagon and 19 defense installations. With the Federal government focusing on investing in start-up companies by making access to venture capital easier for government related tech firms, localizing a business in Virginia has never been more important.<sup>19</sup>

These 19 defense installations have cultivated programs that enable service members and procurement officers to engage with communities in the UMS industry. By collaborating locally, diminishing the need for travel expense and increasing face-to-face communication and discussion, UMS companies gain a leg up on any non-local competition. These defense installations, defense contractors, and smaller firms have therefore been able to create collaborative partnerships and projects much more easily than other organizations; leading directly to research and development capabilities throughout the state.

Research and development is the first fundamental step toward innovation. By collaborating with competitors and developing private partnerships that enable potential customers to outline their needs directly to engineering production, the iterative process of innovation comes faster and with much greater return. Virginia has therefore made these partnerships its main focus over the last five years, and the area is reaping the rewards of those efforts.

Twelve defense contractors are headquartered in Virginia, including Alliant Techsystems, Atlantic Diving Supply, Booz Allen Hamilton, CACI, CSC, DynCorp, General Dynamics, Huntington Ingalls, ITT Exelis, Leidos, ManTech, and Northrop Grumman. Of those, two are among the top 4 leading UMS companies in the world – Northrop Grumman and General Dynamics.

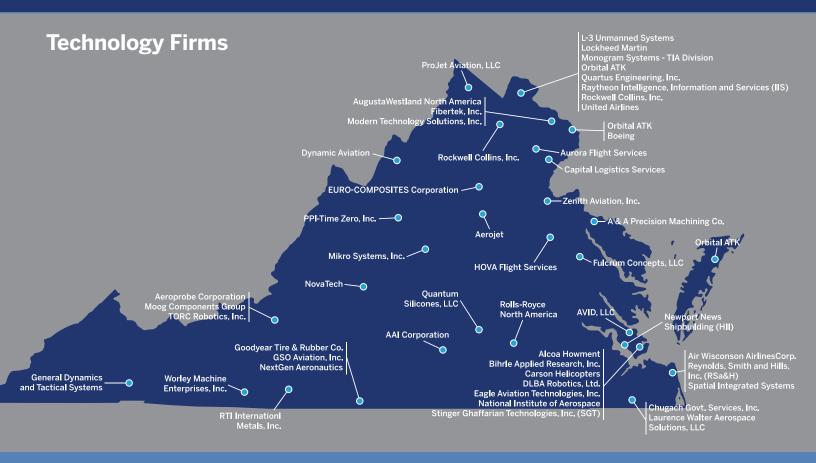
Virginia now boasts significant partnerships between NASA, DoD, and private companies. The Virginia Modeling and Simulation Center (VMASC) applies simulation techniques to solve problems and provides training for industry, military and governments. The Commonwealth Center for Aerospace Propulsion Systems (CCAPS) is a joint partnership between UVA, Virginia Tech, and Rolls-Royce research teams that lets students gain first-hand experience with advanced engineering principles and manufacturing directly with leading aerospace firms.

Virginia's unique partnerships also include the Defense Advanced Research Projects Agency (DARPA) that enables private companies and universities to respond to military proposals and startup oriented engineering labs all over the country. NASA conducts aeronautics and space research at the Langley Research Center (LaRC) and at the Wallops Flight Facility (Wallops). The importance of NASA programs and projects in aiding the UMS field cannot be overstated. NASA is leading the true integration of UAS into the National Airspace (UASNA) projects at the national level by enabling new technology developed at the state and local level. The Unmanned Traffic Management initiative (UTM) is being developed in conjunction with NASA Ames and NASA Langley and in cooperation with the Virginia Tech Test Site at MAAP.

Langley Research Center (LaRC), located in Hampton, Virginia, is home to the most important autonomy incubator for new technologies in the country. The goal of this incubator is to work with UMS stakeholders to share data, validate systems, and enable the future of robotic autonomous behaviors. <sup>20</sup> LaRC has over 35 registered unmanned aircraft that provide test beds for autonomous hardware and software. In order to provide ample test flight area, LaRC maintains and hosts a 100 acre flight range accessible to anyone interested

<sup>&</sup>lt;sup>17</sup>https://www.faa.gov/uas/legislative\_programs/uas\_roadmap/media/UAS\_Roadmap\_2013.pdf <sup>18</sup>Say Yes to Aerospace in Virginia, Yestovirginia.org.

<sup>19</sup> https://www.whitehouse.gov/startup-america-fact-sheet



in testing their autonomous vehicle, run by the NASA Langley UAS Operations Office and in conjunction with MAAP. Their goal is create the first "urban test complex," the first opportunity of its kind to test UMS usage in urban environments in, over, and around buildings.

NASA's Wallops facility is one of Virginia's greatest assets for the UAS industry and shows the historically forward thinking position of Virginia. Originally named the Pilotless Aircraft Research Stations in 1945, Wallops is taking steps to become the premier UAS flight test facility in the world by expanding its UAS test strip, originally created in 2003 for remotely piloted aircraft (RPAs), from 1500 feet long to 3,000 feet long, and 75 feet wide on the northern tip of Wallops Island<sup>21</sup>. This expansion, expected to be finished by the end of 2016, will create the longest UAS test specific runway in the nation, with easy terminal escape points into the Atlantic Ocean and free of external traffic.<sup>22</sup> This new airstrip is expected to increase UAS traffic tenfold upon its completion, and provide a much needed, data-driven test site for UAS manufacturers and operators.

#### **EDUCATION/WORKFORCE**

Aerospace industry leaders have recognized Virginia's workforce as one of the most important characteristics in the state as it is readily recruitable, highly productive, and comes with the benefits of a strong work ethic and reasonable cost. Virginia's population of over 8.2 million and a workforce of more than 4.2 million boasts the 8th highest education rate in the nation for those with a minimum of a bachelor's degree at 35%. More than 15,000 graduate students pursue advanced degrees in science and engineering and approximately 18,000 people leave Virginia military bases seeking civilian employment annually.

New initiatives such as the Aviation Academy in Newport News prepares high school students for aerospace careers.

Maintaining a highly skilled workforce is a fundamental component to ensuring future success in advanced manufacturing, engineering, and design fields. The Commonwealth Center for Advanced Manufacturing (CCAM) was developed to address

<sup>&</sup>lt;sup>20</sup>https://www.nasa.gov/langley/nasa-langley-drone-flying-site-open-for-testing <sup>21</sup>http://www.usatoday.com/story/news/nation/2015/09/29/wallops-drone-flights/73029294

<sup>--</sup>nttp://www.usatoday.com/story/news/nation/2015/09/29/waliops-arone-ilignts/73029294 <sup>22</sup>http://www.vaspace.org/index.php/8-news/17-nasa-wallops-looks-to-bump-up-drone-traffic

this important need directly and allows applied research to accelerate the transition of products from laboratory to commercial use. While developing the work force, CCAM also develops immediate technologies, allowing its member companies to own all funded IP developed in the CCAM institution or partner universities. The National Institute of Aerospace (NIA) conducts research and awards advanced degrees in aerospace engineering through a partnership with nine (9) universities to grow a workforce with commercialization and engineering experience necessary for today's lean-startup oriented small businesses and large firms alike.

For engineering firms looking to find the best students in the nation to innovate and succeed, Virginia leads the list. Aviation Week & Space Technology ranks Virginia Tech as "one of the best universities for recruiting skilled aerospace employees." Virginia Tech, the University of Virginia, and Old Dominion University all perform world-class advanced aerospace research and have mechanisms

advanced aerospace research and have mechanisms

for funding that include state and federal grants, as well as private partnerships. UMS programs in policy, law, entrepreneurship, and innovation also exist at the Virginia Commonwealth University, Liberty University, George Mason University, Hampton University and Averett University, among others.

Virginia has one of the most well-educated workforces to support the unmanned systems industry.

- Virginia currently supports the third highest concentration of technology jobs as a share of overall private-sector employment.
- More than 35% of Virginians have at least a bachelor's degree, the 8th highest rate in the country.
- More than 1,400 doctorate degrees in science and engineering are awarded annually by Virginia universities.
- More than 15,000 science and engineering graduate students pursue advanced degrees in Virginia.
- Approximately 18,000 people leave Virginia military bases each year and enter the civilian workforce.

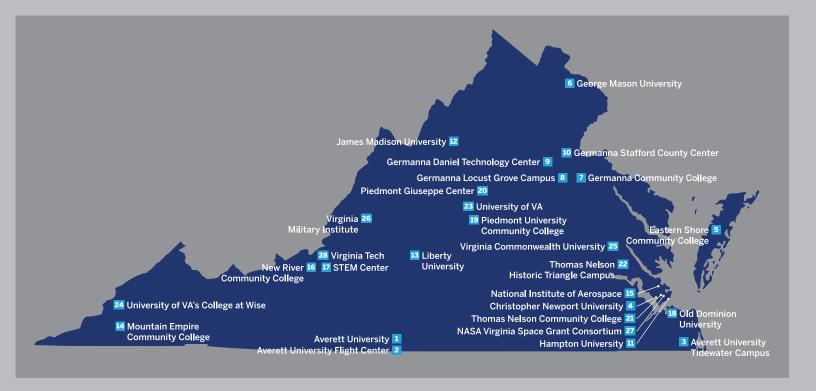
The education of the unmanned systems workforce from the researchers and engineers, to the operators, to maintenance, cyber security, applications software, and legal services is performed in Virginia's institutions.

This workforce includes those with high-tech skills found in our northern Virginia Technology Corridor, highly skilled veterans returning to civilian life from our many defense installations, and leading edge researchers at our universities and local federal laboratories.

Nineteen institutions of higher learning provide degrees directly relevant to the engineering, production, or operation of unmanned systems and related services. While Virginia has the quality of education and workforce required, the demand in this growing industry exceeds the supply in some areas, including the cyber-security aspects of unmanned systems.

School	Academic Programs	Overview	Number of Students
Averett University	Aerospace Management, BS	Averett University operates an FAA-approved Part 141 flight school as part of its Aeronautics degree, offering classes for various aircraft and pilot certificates. Its Bachelor of Science in Aerospace Management has two concentration options: Aviation Business and Flight Operations, in addition to a joint Aerospace Management/Criminal Justice degree program for students interested in law enforcement related aviation careers.	10-20
Christopher Newport University	Computer Engineering, BS; Electrical Engineering, BS; Computer Foundations, BS; Information Science, BS	CNU's Department of Physics, Computer Science and Engineering features an Unmanned Aerial Systems team of 10-12 students. About six more students are working on unmanned systems as their capstone projects, and the department features two computer science professors conducting research in ground-based, unmanned robotics.	10-20
Eastern Shore Community College		Eastern Shore Community College is located near Wallops Flight Facility, part of Virginia Tech's UAS test site program. In October 2014, ESCC hosted an Unmanned Aircraft System Technical Interchange between policy makers and industry executives. An Aerosonde aircraft donated to the school was the first unmanned aircraft to fly into a hurricane in 2005.	10-20
George Mason University	Systems Engineering and Operations Research Department; Applied and Engineering Physics, MS	George Mason University's Department of Systems Engineering and Operations Research has 150 students in bachelors, masters, and doctorate programs, 19 of whom have declared a concentration in Aviation and UASs. GMU's Center for Air Transportation Systems Research, chartered in 2003, also features several white papers, dissertations, and student projects dedicated specifically to UAS and UASs.	20-30
Germanna Community College		In October 2015, Germanna Community College's Center for Workforce and Community Development partnered with Cedar Mountain Stone, allowing Germanna to track progress at the company's quarry in Culpeper County. The school purchased two \$6,200 UASs, and is launching two noncredit classes in UASs at the Daniel Technology Center and Germanna's Fredericksburg Area Campus.	10-25
Hampton University	Department of Aviation (Air Traffic Control, Aviation Management, Flight Education programs); Aviation Computer Science, BS; Aviation Electronic Systems, BS; Electrical Engineering, BS; Computer Science, BS	Hampton University's Department of Aviation, housed within its School of Engineering and Technology, offers programs in Air Traffic Control, Aviation Management, and Flight Education. According to the most recent figures from the school's registrar, 19 students were enrolled in the department as of Fall 2012. The department is the only one of the 105 Historically Black Colleges and Universities in America with a FAA-approved Air Traffic Collegiate Training Initiative program.	20-30
James Madison University	Engineering, BS; Integrated Science and Technology, BS; Interdisciplinary Minor in Robotics; Information Systems Security Professionals Certificate; Information Security - INFOSEC, MS	JMU's UAS Project in Fall 2015 brought together students from seven majors and four professors to use "collaborative learning, design thinking, social entrepreneurial skills, and a variety of technologies to develop prototype uses for six UASs that were custom-built by JMU students." The project was sponsored by 4-VA, and hosted in their X-Labs facility on the JMU campus. Entrepreneurs from NOVALabs participate throughout the course.	10-20
Liberty University	Aeronautics: Unmanned Aerial Systems, BS	Liberty University currently has over 50 students that have declared the UAS program as their major and many more undeclared students that have mentioned UAS as a path of choice. They offer courses on UAS fundamentals, small UAS operations and medium UAS ground and flight courses which offer students the possibility of certification on the Aerosonde UAS with a partnership through Textron's UAS division. Liberty is growing their program to include courses that will teach students how to apply professional aviation concepts to UAS flights as well as provide them with the knowledge of the systems common to all types of UAS.	50-75

Mountain Empire Community College	Electromechanical Technology Specialization, Industrial Electronics Specialization	Mountain Empire Community College began offering the region's only college credit course in UAS technology in the fall of 2015. The class covers the "principles of building, programming, and flying UASs," and students receive "hands-on training in quadcopter design and construction as well as learn to fly both assisted and unassisted FPV (First Person View) quadcopters."	10-20
National Institute of Aerospace	M.S. and Ph.D. degrees available from nine member universities	NIA was formed by a consortium of leading research universities, including Hampton University, the University of Virginia, Virginia Tech, Old Dominion University, the College of William & Mary and the AIAA Foundation. NIA serves as a strategic partner with NASA Langley Research Center and the aerospace community to enable research creativity and expand technology development opportunities. The Institute integrates research and graduate education while creating new government/academia/industry partnerships.	n/a
New River Community College	NRCC Engineering Design	New River Community College students have worked in conjunction with many companies and universities on industry projects, including concept designs of UAV, UCAV, and UGVs. This year's concept design projects, which include three NRCC transfer engineering students on each team, are a fifth generation Unmanned Air Superiority Fighter and a modular tactical, reconnaissance, and crowd control UGV.	5-10
Old Dominion University	Aerospace Engineering, Engineering, MS/ME; Aerospace Engineering, Engineering, Ph.D./D.Eng.; Electrical & Computer Engineering, Engineering, Ph.D.	ODU's College of Engineering & Technology features the Unmanned Autonoumous Systems and Robots (UAS) Cluster, a group of leading engineering researchers promoting research and developing curricula in umanned systems, autonomy, and robotics. The Unmanned and Autonomous Vehicle Laboratory was created in Fall 2015 "to support ongoing work in ground and flight based unmanned and autonomous vehicle design. The laboratory provides a work space and tools for two major undergraduate competitions, SAE Aero Design East and AUVSI RoboBoat. In addition, the laboratory is used for design and support of air and surface vehicles used for graduate research projects." ODU also features an Unmanned Aerial Vehicle club, "currently geared toward the development of a fully autonomous aerial vehicle for International Competition" and is open to all majors and grade levels at the university.	80-100
Piedmont Virginia Community College		PVCC features an all-day introduction to UAS technology class covering "current local, state and federal regulations governing commercial and recreational use of UAVs, as well as what industries currently use them and what the future holds for other industries." Students are briefed on maintenance and safety requirements before an afternoon flight demonstration.	10-20
Thomas Nelson Community College	Mechanical Engineering Technology: Specialization in Marine Engineering, Mechanical Engineering Technology: Specialization in Mechanical Design, Computer-Aided Drafting and Design Technology, Electronics Technology: Specialization in Electrical Engineering Technology	In November 2015, TNCC Workforce Development hosted the Peninsula Entrepreneurship Forum, featuring keynote speakers from DividedSky. The company specializes in aerial emergency response, agriculture, mapping, and videograophy with small unmanned aerial systems. TNCC also hosted the Hover Games in August 2015 for middle and high school students, "a rodeo style competition that highlighted the work of four teams that had the opportunity to build, program, and fly quadcopters throughout the week David North, Aerospace Engineer at NASA Langley Research Center volunteered throughout the week to introduce flying terms, and the basics of the aircraft to campers."	n/a
University of Virginia	Electrical Engineering (Graduate), Mechanical and Aerospace Engineering (Graduate), Aerospace Engineering (Undergrad), Electrical Engineering (Undergrad), Cyber Security Management (Certificate)	"U.Va's System-Aware Cybersecurity concept and Secure Sentinel technology was part of a research project led by U.Va. engineers to detect and respond to cyber-attacks on unmanned aerial systems U.Va. recently licensed the technology to Mission Secure Inc., which is in the process of commercializing its security solutions for the military, intelligence, and civil sectors." U.Va. professor David Sheffler has also developed a 3D-printed, hand-launchable, fully autonomous UAV called The Razor in partnership with the Mitre Corporation, and the U.Va. Vision Group conducts theoretical and experimental research on computer vision, image processing, autonomous robotics, and planning. U.Va.'s School of Engineering has also launched a multi-million dollar initiative in "cyber-physical systems," which will include an international search for eight additional faculty members.	40-50



Virginia Commonwealth University	Mechanical Engineering, Computer and Information Systems Security	VCU's Department of Electrical and Computer Engineering conducts research in nanoelectronics, controls and communication, and computer engineering, with one of its nine laboratories specifically focused on Unmanned Aerial Vehicles. VCU students have participated in the Association for Unmanned Vehicle Systems (AUVSI) Foundation's Small Unmanned Systems Competition since 2003.	10-20
Virginia Military Institute	Aerospace Engineering Concentration, Mechanical Engineering Program, Electrical and Computer Engineering Program	VMI's Mechanical Engineering Department features the Cooperative Engineering Center, in which senior students are placed on teams and tasked with solving an engineering design problem submitted by local industrial clients. Students draft formal reports and present their findings to faculty and the client.	5-10
Virginia Space Grant Consortium	Umbrella organization, offers scholarships	The Virginia Space Grant Consortium (VSGC) is a coalition of five Virginia colleges and universities, NASA, state educational agencies, Virginia's Center for Innovative Technology, and other institutions representing diverse aerospace education and research. The VSGC acts as an umbrella organization, coordinating and developing aerospace-related and high technology educational and research efforts throughout the Commonwealth and connecting Virginia's effort to a national community of shared aerospace interests.	n/a
Virginia Tech	Aerospace and Ocean Engineering Program, Electrical and Computer Engineering Program, Materials Science and Engineering Program, Mechanical Engineering Program	Virginia Tech's College of Engineering houses the Virginia Center for Autonomous Systems (VaCAS), a research center facilitating interdisciplinary research in autonomous systems technology in water, land, air, and space. Its Kentland Experimental Aerial Systems (KEAS) Laboratory includes approximately 2000 sq ft of UAV hangar space and a 300 ft by 70 ft paved airstrip for small (R/C scale) aircraft. In August 2014, the FAA granted Virginia Tech authorization for its Mid-Atlantic Aviation Partnership's Unmanned Aircraft System test site program, headquartered within the school's Institute of Critical Technology and Applied Science. VT's Unmanned Systems lab also operates under the Mechanical Engineering Department, and has worked with sponsors such as Pacific Northwest National Labs (PNL), Savannah River National Labs (SRNL), the Defense Threat Reduction Agency (DTRA), the Air Force Research Lab (AFRL), and AAI corp.	100-200



# **Highlight:** Virginia Tech

While Virginia Tech's UAS leadership as a test site and important participant on the UAS Center of Excellence tends to steal the show, it is by no means a one trick pony, as the rest of its robotics programs continue to define the UMS field. Virginia Tech boasts one of the most advanced and diverse portfolios for unmanned systems and is greatly supported by the technology stakeholders in Virginia. Virginia Tech offers a great example of how students, government, and private firms interface to innovate and excel in UMS technologies.

#### TREC - Terrestrial Robotics Engineering & Controls Laboratory

The TREC laboratory was founded to study cutting edge mechanics and controls in order create robotic platforms to change the way the world is perceived. Command and control as well as human-machine-interface problems are core issues that this open laboratory endeavors to solve. TREC's projects allow students to operate along a wide swath of the vertical stack, from fundamental research to engineering manufacturing and operations.<sup>24</sup>

Perhaps the most important project is focused on the deployment of robots to novel field applications through a tightly integrated cross-disciplinary team. TREC's Team VALOR created and is fielding ESCHER, the Electric Series Compliant Humanoid for Emergency Response. ESCHER is a full-sized humanoid robot designed, fabricated, and assembled by Virginia Tech in cooperation with industry stakeholders in response to the DARPA Robotics Challenge. ESCHER was designed to support disaster relief response and search-and-rescue tasks allowing robots to command interfaces and transportation designed for humans. In collaboration with software development group Team

ViGiR—the Virginia-German Interdisciplary Robotics— TREC and ESCHER are a great example of how Virginian universities and companies work at an international level to create technologies needed by government, military, or the public.

#### **Extreme Environments, Robotics** & Materials Laboratory (ExtReMe) & Robotics and Automation (R&A) **Laboratory**

The ExtReMe laboratory allows for students and researchers to focus on using robotic systems in extreme environments and the impact of extreme environments on materials.<sup>25</sup> This includes research that involves fires. firefighting, and spaces with low visibility conditions. It is no wonder that this lab is in high demand by disaster relief and government contractors for partnerships. One such project is the Shipboard Autonomous Firefighting Robot (SAFFiR) program sponsored by the U.S. Navy. This robotic platform was showcased at the Laboratory for Autonomous Systems Research (LASR) located at the Naval Research Laboratory (NRL). Portions of this platform were created in the ExtReMe laboratory led by Professor Lattimer of Virginia Tech as the principal investigator of the program.

SAFFiR was developed to showcase how humanoid robots can be integrated with artificial intelligence to perform firefighting tasks such as turning valves, identifying and grasping a fire nozzle, and tracking fires with the nozzle using an advanced vision system. This project directly led to a number of follow-up robotic technology programs used in the 2013 DARPA Robot Challenge in Florida.

<sup>&</sup>lt;sup>24</sup>http://www.me.vt.edu/trec/ <sup>25</sup>http://www.me.vt.edu/extreme,

The R&A Lab at Virginia Tech is considered one of the national leaders in research and instructional labs in the country. By providing support to undergraduate and graduate courses while engaging NSF funding through grant development, the R&A lab allows students incredible insight into developing UMS technologies that require automation development and application.<sup>26</sup>

#### **The Virginia Tech Corporate Research Center & VT KnowledgeWorks**

VT KnowledgeWorks encourages and enables creative entrepreneurship world-wide, through innovative curriculum, local business resource centers, and a global network of cooperating regions, all focused on three essential contributors to success: clear understanding of fundamental business principles; access to timely, relevant information; and meaningful personal and corporate relationships. By providing planning and support, student and alumni companies can plan, launch, and grow their companies with the mentorship and investors needed for a small company. VT KnowledgeWorks is a subsidiary of the Virginia Tech Corporate Research Center (VTCRC).<sup>27</sup>

The VTCRC is the latest development in corporate entrepreneurship oriented business development and innovation. Nestled in the heart of Virginia's Technology Corridor and adjacent to the Virginia Tech (VT) campus, the Virginia Tech Corporate Research Center (VTCRC) is home to over 180 research, technology, and support companies. In collaboration with Virginia Tech, VTCRC advances the research, educational, and technology transfer missions of the university. Often this research center utilizes the various State of Virginia oriented incentives for funding by private firms, including the Small Business Innovative Research funds (SBIR).

The VTCRC aims to enhance the quality, stature, and reputation of VT by increasing corporate and government research relationships with VT through tenancy at the VTCRC. They provide facilities and support to the university and Virginia Tech Intellectual Properties, Inc., to help bring faculty research to commercial reality and transfer technology to the private sector.<sup>28</sup> VTCRC also provides research-related employment for VT undergraduate, graduate, cooperative students, faculty, staff, and spouses. Most importantly to new UMS technologies looking to be fielded, VTCRC assists with university research programs and initiatives that facilitate economic development activities throughout the university by matching the needs of businesses, facilities, and programs with the research and professional capabilities of VT thereby increasing the level of industry-sponsored research at VT.

#### **Mid-Atlantic Aviation Partnership** (MAAP)

The unmanned aircraft industry was pushed forward in 2013 when Virginia Tech and partners in Maryland and New Jersey were chosen to be one of only six test sites by the Federal Aviation Administration. This partnership group, named the Mid-Atlantic Aviation Partnership, MAAP, has been leading the country in providing meaningful flights for private organizations and students in a data-



rich and safe environment.<sup>29</sup> A number of private companies have conducted flights that move them toward certification and authorization for airframes and operations of UAS. MAAP offers unique ground test facilities and laboratories run by some of the greatest minds in aeronautics, automation, and sensing and are operated by some of the nation's brightest young minds. The research universities and the aviation universities in the mid-Atlantic region are a great reason to come here early in the development process.

Three of NASA's ten field centers and NASA Headquarters are in the mid-Atlantic region and offer their support to the users of the MAAP UAS Test Range. NASA Langley is the original NASA center and, as such, has a long legacy in aeronautics research and autonomous systems. NASA Wallops Flight Facility is the oldest launch facility in the nation and has been a NASA flight test range for many years. NASA Goddard Space Flight Center has extensive experience developing innovative solutions to remote sensing challenges.30

<sup>&</sup>lt;sup>26</sup>https://www.ise.vt.edu/ResearchFacilities/Labs/LabPages/RA\_lab.html

<sup>&</sup>lt;sup>27</sup>http://www.vtknowledgeworks.com

<sup>&</sup>lt;sup>28</sup>http://www.vtcrc.com

<sup>&</sup>lt;sup>29</sup>http://www.maap.ictas.vt.edu/members-2 <sup>30</sup>http://www.maap.ictas.vt.edu/

Ultimately these test sites provide a number of services that are otherwise unavailable anywhere else. Among these are:

- Airworthiness assessments by subject matter experts to assess suitability for flights
- Certification support
- Data collection, analysis, and management
- Development and processing of experimental and Section 333 requests
- Development of a pathway to commercial access in the national airspace system
- Flight testing
- Pilot training and currency development programs
- Registration assistance and sensors for UAS testing
- Standards and regulation support for operations and licensing



# The State of UAS Policy and Regulations in the United States

The biggest problem facing unmanned aircraft systems today is a lack of understanding of the current regulatory environment at the State and Federal levels by operators, regulators, law enforcement, and business all coming together to forge an environment of innovation and success in the national airspace.

While most states allow for UAS use, and none have outright banned flights, some have attempted to regulate the areas of operation in line with state interests, or prevent types of data acquisition in the forms of auditory, visual, or multi-spectral data. Many of these legislative efforts have failed due to their overbearing nature or lobbying efforts on the part of AUVSI and the small UAV Coalition. States are now realizing that data acquisition is the true benefit of UAS operations in management of mining, agriculture, real estate, forestry, pipelines, and other infrastructure.

Most recently, October 2015, the New Jersey legislature introduced Senate Bills 3174 and 3175. These bills have the potential to require small UAS sellers to "provide notice of FAA guidelines for flying UASs to consumers" and to "require certain UASs to contain geo-fencing

technology" and making a sale of a UAS that does not contain that geo-fencing technology a crime punishable by up to 18 months in prison and a \$10,000 fine. While 3174, the requirement to post safety guidance, seems like a reasonable step that already mirrors the FAA's negotiations with Amazon.com (the largest seller of DJI and other popular UASs) to include safety guidance materials, 3175 is an overly prescriptive and ultimately damaging approach to regulating UAS.

By necessitating one particular technology rather than training, education, or another measure and punishing the seller rather than the operator, New Jersey is creating a much larger problem than it is solving. Ultimately, these UAS laws at the state level should be evaluated based upon their effect on UAS and the nature of the industry specifically. Currently, UAS are highly modular and incorporate various technologies for control, safety, and management. Requiring one technology over the other, and using a vague term like "geo-fencing" to denote that technology, can only muddle the enforcement environment and continue to add uncertainty to the marketplace.

<sup>&</sup>lt;sup>31</sup> http://www.njleg.state.nj.us/2014/Bills/S3500/3174\_I1.PDF

As it stands 26 states have enacted laws addressing UAS issues and an additional six states have adopted resolutions in some ways limiting UAS use. North Dakota's HB 1328 provides limitation on the use of UAS for surveillance, greatly hindering the efficacy of law enforcement's effort involving UAS.32Tennessee's HB 153 prohibits the use of a "UAS" to capture images over open-air events or fireworks displays or near correctional facilities. Texas's HB 3628 permits the development and installation of rules governing UAS use in the Capitol Complex and provides for criminal misdemeanor classification of an infringement of that airspace, however it is silent about developing other airspaces for other locations within the state and therefore continues to add confusion for any interested UAS operator.<sup>33</sup> Any added confusion hinders the UAS community. The continued opaque nature of the regulatory environment has now become the main problem with developing a robust UAS economy. Any further confusion simply puts off investors, businesses, and diminishes innovation in a time where business propositions and "value-add" is still in question for many applications.

Perhaps the most in-depth and overbearing regulation has come in the forms of Louisiana's SB 183 that creates a number of hurdles to jump through for anyone operating UAS in an agricultural operation.<sup>34</sup> It requires that all operators go beyond FAA requirements for UAS operations; but this only applies to agricultural uses and assigns the Department of Agriculture and Forestry as the responsible regulator for UAS use—assigning certification and licensing to an office with little experience in flight safety.

This past year has also seen an increase in privacy protecting legislation at the state level that addresses malicious intent with UASs, rather than the functions or operations. California's AB 856 prohibits entering the airspace of an individual in order to capture an image or recording of that individual engaging in private, personal, or familial activity without permission. While this regulation is intended to prevent paparazzi use of UASs, it effectively prevents the use of UAS over private property without permission. California is risking the safe and clear regulation of airspace, uniquely governed by FAA authority, with this regulation.<sup>35</sup>

The initial legislation that was given to Governor Brown also classified the resulting offense of flying over private property without permission as trespassing, criminalizing airspace in an unprecedented state-based approach. Governor Brown did not sign this bill, but instead signed the bill mentioned above, AB 856, into law. Conversely, while prohibiting the use of a UAS to capture images of privately owned property or its owners, tenants, or occupants without consent, Florida's SB 766 is worded better and allows for easy interpretation by "the common user." 36

One approach that seems to be welcomed by the UAS community took place in May, 2015, in the state of Maryland. A new policy there will prohibit counties and municipalities from enacting their own laws on the use of UASs, giving the state and federal government exclusive jurisdiction to regulate the devices. The law also requires the state to study the benefits and concerns related to UAS use and propose rules by the end of 2018 for how they can be used safely. Codifying that the State recognizes good uses for UASs, and then empowering the Business and Economic Development branch of state government to interface directly with the test site at University of Maryland is having a direct effect on how Maryland is perceived as a partner to the UAS community.

Confusion in other states continues to grow as municipalities consider and pass their own airspace regulation, setting back the industry with every legislative initiative. Chicago recently attempted to pass rules that would criminalize certain components of unmanned flight. The legislators were forced to adhere to FAA regulatory approaches, but they continue to reduce the open access of recreational and research oriented UMS activities. Los Angeles Mayor Garcetti has likewise led the charge to criminalize violations of FAA activities to allow local law enforcement to apprehend anyone that violates FAA guidance. While not setting out new prohibitions on UAS use, LA attempts to police airspace solely granted to the federal government. Virginia, rather than work against the FAA but with the FAA, has ensured a much better adaptation of any new policies encountered in the new future, providing UMS companies a stable and consistent environment for flight.

<sup>&</sup>lt;sup>32</sup> http://www.legis.nd.gov/assembly/64-2015/documents/15-0259-05000.pdf?20150501154934

<sup>&</sup>lt;sup>33</sup> http://www.capitol.state.tx.us/tlodocs/84R/billtext/pdf/HB03628F.pdf#navpanes=0

<sup>34</sup> http://www.legis.la.gov/legis/ViewDocument.aspx?d=960033

<sup>35</sup> https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill\_id=201520160AB856

<sup>36</sup> http://www.flsenate.gov/Session/Bill/2015/0766

# Approach and Opportunity for State Governments

The Federal Aviation Administration recently announced that the timeline for having a final rule governing small unmanned aircraft systems had been accelerated such that June 2016 is the likely month of publication following the February 2015 NPRM<sup>37</sup>. Currently in the "Accommodate" phase of the 2013 UAS Roadmap, the FAA has seen the application and acceptance of Section 333 Exemptions (exemptions from 14 CFR 49 flight standards for airworthiness of an aircraft) skyrocketing.38 As of November 2, 2015, 2,134 petitions had been granted to the public along with Certificates of Authorization or Waivers to conduct commercial UAS operations.<sup>39</sup> Congressional and Executive branch pressure has been extreme for the publication of the final rule for Small Unmanned Aircraft Systems.

This rule, set for final publication in June 2016, will codify the requirements for commercial UAS use in the United States and begin the move away from "accommodation" and towards the second phase of the roadmap, "integration." This phase will see rapid growth of new technologies, the experimentation of unmanned traffic systems (UTM of NASA or Amazon/Google's recent announcements for airspace reassignment), and eventually entering into the "evolution" phase of NextGen air traffic management.



The UAS final rule, though unpublished in its final form, will include the following basic information that helps to guide the approach of any state to generating regulations. These basic requirements proposed in the NPRM are:

- 1. UAS must weigh less than 55 Lbs.
- 2. UAS must be within Visual Line of Sight
- 3. The operator must be able to see their aircraft always
- 4. UAS must not operate over people
- 5. Daylight only operations, and must yield the rightof-way to manned aircraft
- 6. First-person view does not satisfy see-and-avoid criteria
- 7. Maximum speed is 100 MPH
- 8. Maximum altitude is 500 Ft Above Ground Level
- 9. No Class A airspace operations. B, C, D allowed with ATC permission
- 10. Class G airspace allowed without ATC permission
- 11. No careless or reckless operations.
- 12. Preflight inspection mandatory by operator
- 13. Micro UAS (UAS that do not require any licensing or certification) may exist but have not yet been created yet
- 14. Pilots would be called operators, would need to pass an aeronautical test, be vetted by TSA, obtain an operator certificate with a UAS rating, be 17 years or older, and keep current on the certification
- 15. Airworthiness certification will NOT be required, however it must be maintained in safe operation condition.

Rule-in-2016 85307.html

<sup>8</sup>http://www.faa.gov/uas/media/uas\_roadmap\_2013.pdf

<sup>&</sup>lt;sup>39</sup>https://www.faa.gov/uas/legislative\_programs/section\_333/

These 15 conditions are the main points of the UAS rule to be published by FAA in 2016. Notably missing are any regulations concerning data management, data storage or usage, payload limitations, insurance requirements and coverage, or risk assessment. All of these topics may be targets for UAS legislation or protection. Ultimately, it is in the best interest of the UMS industry to remain system agnostic – precisely how the Virginia legislature has acted.



# Incentives & Supporting Unmanned Systems in Virginia

With much of the UMS industry gaining interest and industry participants internationally, it is important to recognize Virginia's success on the international field. Between 2010 and 2014, Virginia saw \$5.12 billion of international investment from 31 countries. 40 The top foreign nations investing in Virginia were China with \$2 billion, UK with \$469 million, and Germany with \$463 million. As Chinese company DJI is the clear leader in consumer UAS models, with well over 66% of all commercial operations including the DJI line of UASs and estimated to become the first \$1 billion UAS company in the world, it is important for UMS fields to operate in a Foriegn Direct Investment rich environment.<sup>41</sup> While it is the goal of all Virginian industries to support home grown manufacturing and engineering, foreign investment plays a crucial role in these developing new economies.

The Commonwealth Research Commercialization Fund and the Center for Innovative Technologies (CIT) are key players in promoting homegrown innovation for any investment opportunities. This center, developed as a flagship for the new Virginian economic development planning, thrives in the recognition that the availability of early-stage capital is a critical need of many emerging technology companies and that making connection with private, public, and international funding is a difficult step in the startup lifecycle.<sup>42</sup>

CIT has created for any early-stage startup the Commonwealth Innovation and Entrepreneurship Measurement Systems (IEMS); a web-based portal using key metrics to track the performance of Virginia's innovation economy, allowing angel investors and private equity firms and other stakeholders a unique insight into the lifecycles and stages of startup companies in Virginia along with opportunities to get involved very easily. This reduces the hurdles of engagement for investment for companies and investors alike.<sup>43</sup>

Small businesses have been rewarded significantly by beginning their journey in Virginia. The Small Business Innovation Research (SBIR) program and the Small Business Technology Transfer (STTR) program offer similar incentives for small business that partner with non-profit U.S. research institutions. Virginia based firms, because of the local and supported access to non-profit organizations such as universities, military and non-military government groups, and R&D laboratories received a total of \$109.6 million in SBIR/SBTT funds in 2014, the third highest amount of any US state.<sup>44</sup>

By focusing on all levels of a company's lifecycle, Virginia provides the perfect environment to start, grow, and commercialize any UMS related firm. By taking advantage of the unique characteristics and government support provided in Virginia, companies make a smart decision for their future.

New Virginian companies can be supported by a number of unique incentives geared toward enabling technologies in sub-markets. While this has created a friendly environment for all business development within the state for new or expanding firms, there are a number of UMS technology focused programs of which to be aware.

<sup>40</sup>http://www.theverge.com/2015/3/12/8196413/dji-drone-funding-billion-dollar-sales

<sup>42</sup>http://www.cit.org/service-lines/cit-entrepreneur

<sup>&</sup>lt;sup>43</sup>http://www.cit.org/initiatives/iems/measurement-system

<sup>44</sup> http://www.cit.org/initiatives/iems/research-and-development

## **INCENTIVES**

New Virginian companies can be supported by a number of unique incentives geared toward enabling technologies in sub-markets. While this has created a friendly environment for all business development within the state for new or expanding firms, there are number of UMS technology focused programs of which to be aware.

#### **Commonwealth's Opportunity Fund**

The Commonwealth's Opportunity Fund (COF) is a discretionary incentive available to secure a business location or expansion project for Virginia. Grants are awarded to localities on a local matching basis with the expectation that the grant will result in a favorable location decision for the Commonwealth.

#### **General Eligibility Thresholds:**

- 50 new jobs / \$5 million capital investment; or
- 25 new jobs / \$100 million capital investment

The average annual wage for the new jobs must be at least equal to the prevailing average annual wage in the locality, excluding fringe benefits

If the average annual wage is twice the prevailing average annual wage, the Governor may reduce the new jobs threshold to as low as 25

http://www. yesvirginia.org/ ProBusiness/ Business Incentives

#### Virginia Investment Partnership Act/Major Eligible Employer Grant

The Virginia Investment Partnership (VIP) Grant and the Major Eligible Employer Grant (MEE) are designed to encourage continued capital investment by Virginia companies. This is intended to add capacity, modernize, increase productivity, creation, development and utilization of advanced technology. UMS technologies are specifically being targeted for this type of investment.

To be eligible for a VIP grant, a minimum of \$25 million in capital investment is required by an eligible existing Virginia manufacturer or research and development service

http://www. virginiaallies. org/assets/ files/incentives/ VIPGuidelines.pdf

#### The Virginia Economic Development Incentive Grant

The Virginia Economic Development Incentive Grant Program ("VEDIG") assists and encourages companies to invest and to provide new employment opportunities by locating significant headquarters, administrative, research and development and/or similar service and basic sector operations in Virginia. This is a discretionary program in which grants are negotiated and offered to qualified applicants as an economic development incentive.

The VEDIG program has two separate eligibility requirements. Companies located in a Metropolitan Statistical Area with a population of 300,000 or more in the most recently preceding decennial census, must: (A) create or cause to be created and maintained (i) at least 400 jobs with average salaries at least 50% greater than the prevailing average wage, or (ii) at least 300 jobs with average salaries at least 100% greater than the prevailing average wage; and (B) make a capital investment of at least \$5 million or \$6,500 per job, whichever is greater. For all companies located elsewhere in Virginia, the company must create or cause to be created and maintained at least 200 jobs with average salaries at least 50% greater than the prevailing average wage, and make a capital investment of at least \$6,500 per job

http://www. virginiaallies. org/assets/files/ incentives/VEDIG Guidelines.pdf

#### Governor's Agriculture and Forestry Industries Development Fund

One of the most important incentive programs for UMS technologies focuses on agriculture as an industry best positioned for development. AFID grants are made at the discretion of the Governor awarded to a political subdivision that will result in a new or expanded processing/value-added facility for Virginia grown agricultural or forestry products, and with the expectation that the grant will be critical to the success of the project.

AFID grants are made at the discretion of the Governor with the expectation that grants awarded to a political subdivision will result in a new or expanded processing/value-added facility for Virginia grown agricultural or forestal products

Grants are made upon an application by both the locality and the business beneficiary for a project under the following conditions:

- The business beneficiary is a facility that produces "Value-added agricultural or forestal products"
- A minimum of 30% of the agricultural or forestry products to which the facility is adding value are produced within the Commonwealth of Virginia on an annual basis in normal production years
- The grant request does not exceed \$250,000 or 25% of qualified capital expenditures (whichever is less)
- The applicant provides a dollar-for-dollar matching financial commitment (cash or qualified in-kind)
- A performance agreement is executed between the applicant and the company to ensure fulfillment of promised job creation, capital investment and purchase of Virginia grown agricultural or forestry products
- Public announcement of the project is coordinated with the Governor's Office

http://www.vdacs. virginia.gov/ agribusiness/afid.

#### **Tobacco Region Opportunity Fund**

Tobacco producing regions assist with specific projects that result in the creation of new jobs and investment. Grants are made to the community at the discretion of the Tobacco Region Revitalization Commission. The goal of the Fund is to attract competitive projects expected to have a regional impact due to the magnitude of new employment and investment, and the possibility of followon industry.

- Evaluation of award amount is consistent throughout the region and is based on the following criteria: local unemployment rates, prevailing wage rates, number of new jobs, capital investment levels, industry type and the possibility of related economic multiplier effect
- TROF is the only Tobacco Commission grant program paid at the beginning of the project to help tobacco region localities be competitive in attracting new investment and jobs resulting in increased tax revenue and opportunity for quality employment in the tobacco region
- Intended to support the goal of the Commission to "revitalize the economies of tobacco dependent regions and communities." This goal is measured by job creation, workforce participation rate, wealth, diversity of economy, and taxable assets. All measurements listed are increased when a new or expanding business in the tobacco region creates new jobs that pay more than prevailing wage and adds taxable assets to the local tax rolls

http://www.tic. virginia.gov/ tobregionoppfund. shtml

#### Port of Virginia Economic and Infrastructure Development Grant Program

UUV and UAS focused companies should look to The Port of Virginia Economic and Infrastructure Development Grant Program (POV Grant), as it provides a grant to Qualified Companies to incentivize them to locate new maritime-related employment centers or expand existing centers in specified localities in order to encourage and facilitate the growth of the Port of Virginia.

POV Zone Grants are made at the discretion of the Executive Director of the Virginia Port Authority (VPA) with the expectation that grants awarded will be used to assist a Qualified Company to locate a new operation or expand an existing operation within the Commonwealth of Virginia

Subject to appropriation, a POV Grant is available from January 1, 2014 until June 30, 2020. The maximum amount of grant allowable per Qualified Company is \$500,000 and the maximum amount of POV Grants allowable among all Qualified Companies in any given fiscal year is \$5 million. For Fiscal Year 2015, the maximum amount of POV Grants allowable among all Qualified Companies is \$2 million

http://www. portofvirginia. com/stewardship/ economicdevelopment/edinfrastructure-grantprogram/

#### CENTER FOR INNOVATIVE TECHNOLOGY INCENTIVES

#### **Commonwealth Research Commercialization Fund**

The Commonwealth Research Commercialization Fund (CRCF) accelerates innovation and economic growth in Virginia by advancing solutions to important state, national, and international problems through technology research, development, and commercialization. UMS has been identified as a critical field of study.

Proposals submitted to CRCF undergo a multi-stage review process, which includes award recommendations made by the Research and Technology Investment Advisory Committee (RTIAC) to the CIT Board of Directors and culminates with award decisions made by the Board. CRCF awards contribute to the Commonwealth's overall plan to enhance economic development through technology research and commercialization and, as such, CRCF awards must further the goals set forth in the Commonwealth Research and Technology Strategic Roadmap. In addition to identifying research areas worthy of economic development and institutional focus, the Roadmap provides a framework for aligning key industry sectors within the state, as prioritized by the research community, which includes but is not limited to the private sector, academia, and economic development professionals

http://www.cit.org/ initiatives/crcf/

#### **GAP Tech Fund**

CIT GAP Tech Fund makes seed-stage equity investments in Virginia-based technology companies with a high potential for achieving rapid growth and generating significant economic return.

CIT GAP Funds invests exclusively in companies headquartered, and with an express desire to grow in, the Commonwealth of Virginia.

Sectors (includes UMS)

- · Software, Telecommunications
- Semiconductors
- Security
- Information and Communication Technologies
- E-Commerce
- Networking and Equipment
- Electronics/Instrumentation
- Computers and Peripherals
- Sensors
- Materials

http://www.cit.org/ service-lines/gaptech-fund/

#### **GAP Venture Funds**

CIT GAP Funds is a family of seed- and early-stage investment funds placing near-equity and equity investments in Virginia-based technology, life science, and cleantech companies. CIT GAP Funds invests in companies with a high potential for achieving rapid growth and generating significant economic return for entrepreneurs, co-investors and the Commonwealth of Virginia.

CIT's family of funds includes:

- GAP Fund I A vintage 2004 fund fully invested in a broad array of seed-stage technology companies
- GAP BioLife Fund A seed fund investing exclusively in life science companies
- GAP Tech Fund A seed fund investing in IT and technology companies
- Commonwealth Energy Fund (CEF), a seed fund investing in energy efficiency and renewable energy companies

http://www.cit.org/ service-lines/cit-gapfunds/

#### **BUSINESS DEVELOPMENT TAX CREDITS**

#### **Enterprise Zone Tax Credit**

Provides state and local incentives to businesses that invest and create jobs within Virginia's enterprise zones, which are located throughout the state.

http://www.tax. virginia.gov/ content/tax-credits# enterprise

#### Major Business Facility Job Tax Credit

Qualified companies locating or expanding in Virginia receive a \$1,000 income tax credit for each new full-time job created over a threshold number of jobs.

- Companies locating in Enterprise Zones or economically distressed areas are required to meet a 25-job threshold; all other locations have a 50-job threshold. The threshold number of jobs must be created within a 12-month period
- The \$1,000 credit is available for all qualifying jobs in excess of the threshold and is taken in equal installments over two years (\$500 per year) through 2014. Credits earned after 2014 will be taken in equal installments over three years
- Non-qualifying jobs include seasonal positions shifted within Virginia, building and grounds maintenance, security, and other positions ancillary to the principal activities of the facility
- Credits are available for taxable years before January 1, 2020. Unused credits may be carried over for up to 10 years

http://www.tax. virginia.gov/content/ tax-credits#Major\_ Business\_Facility\_ Job\_Credit

#### **Qualified Equity And Subordinated Debt Investments Credit**

The Qualified Equity and Subordinated Debt Investments Tax Credit offers angel investors a 50% tax credit for pre-qualified small business ventures involved in technology fields. The state also offers individual and corporate income tax subtractions for long-term capital gains attributable to qualified investments in early stage technology, biotechnology, and energy startups. technology, nanotechnology, or any similar technology-related field, which includes UMS.

The credit is equal to 50% of the qualified business investments made during the taxable year. If total annual requests for the credit exceed \$5 million for tax year 2015, the Department of Taxation will prorate the credit for each taxpayer

The credit a taxpayer may claim per taxable year may not exceed the credit authorized by the Department of Taxation, \$50,000, or the income tax liability on that year's return, whichever is less. The credit is nonrefundable. Unused credits may be carried forward up to 15 years

http://www.tax. virginia.gov/ content/taxcredits#Qualified\_ Equity\_And\_ Subordinated\_Debt\_ Investments\_Credit

#### **Telework Expenses Tax Credit**

Allows a tax credit to employers for eligible expenses incurred for allowing employees to telework pursuant to a signed telework agreement for taxable years beginning on or after January 1, 2012, but before January 1, 2017. An employer may be eligible for a credit of up to \$1,200 per teleworking employee and/or a maximum of \$20,000 for conducting a telework assessment.

The amount of credit shall not exceed \$50,000 per employer for each calendar year. The telework assessment can only be allowed once. The aggregate amount of tax credits that will be issued is capped at \$1 million annually. An employer shall be ineligible for a tax credit pursuant to this section if such employer claims a credit based on the jobs, wages, or other expenses for the same employee under any other provision of this chapter. Additionally employers are not allowed to deduct expenses that are deducted for federal purposes

http://www.tax. virginia.gov/content/ tax-credits#Telework Expenses Tax Credit

#### **Worker Retraining Tax Credit**

This credit allows an employer to claim a tax credit for the training costs of providing eligible worker retraining to qualified employees for taxable years beginning on or after January 1, 1999.

The credit may be applied against individual income tax, estate and trust tax, corporate income tax, bank franchise tax, and taxes imposed on insurance companies and utility companies.

#### **Eligible Worker Retraining**

Eligible worker retraining includes noncredit courses that are approved by the Virginia Economic Development Partnership. For information on noncredit course approval, call (804) 545-5706. It also includes credit or non-credit retraining courses undertaken through an apprenticeship agreement approved by the Commissioner of Labor and Industry

#### **How Much is the Credit?**

Generally, the credit is 30% of all classroom training costs but is limited to up to \$200 annual credit per student if the course work is incurred at a private school or \$300 per qualified employee with retraining in a STEM or STEAM discipline. The Department of Taxation is authorized to issue up to \$2,500,000 of retraining credits annually. If total requested credits exceed this amount, the Department of Taxation will prorate the authorized credits

Credits taken may not exceed your tax liability in any one taxable year. Unused credits may be carried forward for three years

http://www.tax. virginia.gov/content/ tax-credits#Worker\_ Retraining\_Credit

#### **Agricultural Best Management Practices Credit**

This credit is available to individuals and corporations that are engaged in agricultural production for market and have a soil conservation plan in place to provide significant improvement to water quality in Virginia's streams, rivers, and bays. To be eligible for the credit, your plan must be certified in advance by your local Soil and Water Conservation District.

The credit is 25% of the first \$70,000 you spend for approved agricultural best management programs. The maximum credit is \$17,500 or the taxpayers' tax liability, whichever is less. Unused credits credits credits#agricultural may be carried forward for five years

http://www.tax. virginia.gov/ content/tax-

#### Research and Development Tax Credit

Businesses may claim a tax credit equal to 15 percent of the first \$234,000 in Virginia qualified research and development expenses incurred during the taxable year or they may claim a tax credit equal to 20 percent of the first \$234,000 in Virginia qualified research and development expenses if the qualified research was conducted in conjunction with a Virginia college or university.

• There is a \$6 million cap on the total amount of credits allowed in any fiscal year

http://www.tax. virginia.gov/ content/tax-credits #Researchand Development **TaxCredit** 

#### Fertilizer and Pesticide Application Equipment Credit

Individuals and corporations may claim this credit for equipment purchased to provide more precise pesticide application. You must be engaged in agricultural production for market and have a nutrient management plan approved by your local Soil and Water Conservation District in place.

The credit is 25% of the cost of the certified equipment, or \$3,750, whichever is less. The allowable credit may not exceed your tax liability. Unused credits may be carried forward for five years

http://www.tax. virginia.gov/content/ tax-credits# fertilizer

#### **Credit for Tax Paid to Another State**

The Code of Virginia makes out-of-state tax credit provisions for income that is taxed by more than one state. The credit is restricted to certain types of income. The intent of the law is to address double taxation when income is generated in more than one state; however, the credit does not eliminate double taxation in all cases. For example, taxes paid to another state on non-qualifying income would not be subject to the credit provisions.

Generally, Virginia will allow taxpayers filing resident individual income tax returns to claim credit for income tax paid to another state on qualifying income derived from sources outside of Virginia, provided the income is taxed by Virginia as well as the other state. If the income is from one or more of the following states, you should claim the credit on the nonresident income tax return of the other state instead of the Virginia return: Arizona; California; District of Columbia; Oregon

credits#Credit for\_Tax\_Paid\_to\_ Another\_State

#### **SSBCI Virginia Capital Access Program**

This program provides loan loss insurance to a bank to cover a portfolio of enrolled loans. It is designed to be a quick, efficient means of obtaining a credit enhancement from the VSBFA. Under most circumstances, the bank determines whether or not a loan will be enrolled in the program without VSBFA's involvement.

The Program is designed to assist financial institutions in making small business loans by mitigating some of the risk associated with the loan. The Program offers lenders a flexible, non-bureaucratic tool to expand their market base and enhance their ability to meet the financing needs of Virginia's businesses

http://www. vabankers.org/ ssbci-virginia-capitalaccess-program

#### **Small Business Microloan Program**

This is a direct loan from the VSBFA to the business client that does not require a bank's participation in the transaction. It is an ideal tool for bankers who are faced with business loan requests for very small amounts where the bank would prefer to refer the client to an alternative source of funds.

The Virginia Small Business Financing Authority (VSBFA) is the Commonwealth of Virginia's economic development and business financing arm. We help banks make loans to businesses that can demonstrate repayment ability, but where the bank needs additional collateral support or a more robust secondary repayment source by providing:

- cash collateral
- subordinate companion loans
- · guaranties
- · loan loss reserves

http://www. vabankers.org/

#### **Environmental Compliance Assistance Fund**

This is a direct loan from the VSBFA to a business that seeks to finance equipment that will have less impact on the environment or the business is seeking to implement voluntary agricultural best management practices (BMPs). This is extremely useful for UAS technologies focused in agricultural industries.

The Virginia Small Business Environmental Compliance Assistance Fund (ECAF) provides Virginia businesses with financing for 1) equipment to comply with the federal Clean Air Act, 2) equipment to implement voluntary pollution prevention measures, or 3) equipment or structures to implement voluntary agricultural best management practices (BMPs)

http://www. vabankers.org/ environmentalcomplianceassistance-fund

#### **Economic Development Access Program**

Administered by the Virginia Department of Transportation, this program assists localities in providing adequate road access to new and expanding basic employers.

These funds may be used for financing the construction or improvement of secondary or local system roads within all counties and cities, and certain towns that are part of the Urban System, hereinafter referred to as eligible localities. Ancillary improvements, such as turn lanes or intersection modifications may also be warranted as part of the access project, but are not to be considered as the primary objective of the project

http://www. virginiadot.org/ business/resources/ local\_assistance/ access\_programs/ Economic Development Access Program Guide.pdf

#### **Rail Industrial Access Program**

Provides funds to construct railroad tracks to new or substantially expanded industrial and commercial projects. The Rail Industrial Access Program promotes truck diversion by providing grant assistance to connect new or expanding businesses to the freight railroad network. The program supports localities, businesses, or industries seeking access to a common carrier railroad. Applications are accepted throughout the year

http://www.drpt. virginia.gov/grantees/ rail-arants/

#### Transportation Partnership Opportunity Fund

POF is a discretionary grant available for transportation-related issues related to unique economic development projects.

The financial assistance may be used for transportation capacity development, on and off site; road, rail, mass transit or other transportation access costs beyond the funding capability of existing programs; studies of transportation projects including, but not limited to environment analysis, geotechnical assessment, survey, design and engineering, advance right-of-way acquisition, traffic analysis, toll sensitivity studies, financial analysis, or any other transportation development activity permitted by law. Transportation aspects of economic development projects that are also eligible for funding through the Revenue Sharing Program, the Industrial Road Access Program, the Industrial Rail Access Program, the Rail Preservation Program or the Rail Enhancement Program, may be eligible to receive financial assistance from the Fund. However, it must be demonstrated that such additional funding is necessary. Amounts received from these other funding sources, or used to leverage additional monies from the Fund, may not also be used for the required non-state match

http://www. virginiaallies. org/assets/ files/incentives/ TPOFOverview.pdf

#### **ZONES**

#### **Enterprise Zones**

The Virginia Enterprise Zone (VEZ) program is a partnership between state and local government that encourages job creation and private investment. VEZ accomplishes this by designating Enterprise Zones throughout the state and providing two grant-based incentives, the Job Creation Grant (JCG) and the Real Property Investment Grant (RPIG), to qualified investors and job creators within those zones, while the locality provides local incentives.

State incentives are available to businesses and zone investors who create jobs and invest in real property within the boundaries of enterprise zones

http://www.dhcd. virginia.gov/index. php/communitypartnerships-dhcd/ downtownrevitalization/ enterprise-zone.html

#### **Enterprise Zone Job Creation Grant**

Job Creation Grants are based on net new permanent full-time job creation exceeding a four-job threshold. Positions over the four-job threshold must meet wage and health benefits requirements to be eligible for the JCG. Firms can receive grants for up to 350 positions per year.

The business firm must be located in a Virginia Enterprise Zone.

- The business firm must create at least four net new permanent fulltime positions over the base calendar year
- The net new permanent full-time positions created over the four-job threshold must meet wage (at least 175% of the Federal Minimum Wage 150% in High Unemployment Areas) and health benefits requirement (at least 50% of employee's premium paid for by employer).
- Term Grants are available for a five-consecutive-year qualification period
- To be eligible for the JCG in years two through five of the grant cycle, a business firm must maintain or increase the number of eligible permanent full-time positions (above the four-job threshold) over base year employment. Base year employment levels are established during the first grant year and will remain consistent throughout the 5-year grant period
- Firms can continue to receive grants for any net new permanent fulltime positions created over base year employment levels that meet wage and health benefits requirements
- Firms may apply for a subsequent five-year period given they meet the grant eligibility requirements. Grant Year 2011 was the first year firms were eligible to begin subsequent five-year periods

http://www.dhcd. virginia.gov/images/ VEZ/JCG-Instruction-Manual.pdf

#### **Enterprise Zone Real Property Investment Grant**

Real Property Investment Grants are available for investments made to industrial, commercial, or mixeduse properties located within the boundaries of Enterprise Zones. Grants are available to qualified zone investors in amounts up to 20% of the qualified real property investment, not to exceed \$200,000 per building or facility within a five-year period.

The property (building or facility) must be located within the boundaries of a Virginia Enterprise Zone

- The building or facility must be commercial, industrial, or mixed-use. o Mixed-use is defined as a building incorporating residential uses in which a minimum of 30% of the useable floor space is devoted to commercial, office, or industrial use
- For the rehabilitation or expansion of an existing structure, the zone investor must spend at least \$100,000 in qualified real property investments to be eligible
- For new construction projects, the zone investor must spend at least \$500,000 in qualified real property investments to be eligible
- Term Grants may not exceed \$200,000 per building or facility in a fiveconsecutive-year period. Five-year periods being with the qualification year in which a grant was first awarded
- After the conclusion of a five-consecutive-year period, the property beings another eligibility period and the grant cap of \$200,000 is restored

ttp://www.dhcd. virginia.gov/images/ VEZ/RPIG-Instruction-Manual.pdf

#### **Technology Zones**

Virginia authorizes its communities to establish technology zones to encourage growth in targeted industries. Presently, 30 cities and counties and 6 towns have created zones throughout the state. s. Qualified businesses locating or expanding operations in a zone may receive local permit and user fee waivers, local tax incentives, special zoning treatment, or exemption from ordinances. Once a local technology zone has been established, incentives may be provided for up to 10 years.

Localities that have established technology zones include the counties of Amherst, Arlington, Bedford, Caroline, Chesterfield, Culpeper, Fauquier, Frederick, Halifax, Henry, Page, Roanoke, Rockingham, Russell, Smyth, Spotsylvania, Stafford and Warren; the cities of Buena Vista, Charlottesville, Chesapeake, Falls Church, Franklin, Fredericksburg, Harrisonburg, Lynchburg, Manassas, Manassas Park, Newport News, Poquoson, Suffolk and Winchester; and the towns of Ashland in Hanover County, Bridgewater in Rockingham County; Cape Charles in Northampton County, Front Royal in Warren County, Kilmarnock in Lancaster County, Marion in Smyth County and Wytheville in Wythe County

http://www. virginiaallies. org/assets/ files/incentives/ techzonewriteup.pdf

#### **Foreign Trade Zones**

Foreign Trade Zones (FTZ) are areas which are geographically inside the United States, but are legally considered outside its Customs territory. Companies that locate in FTZs can benefit by using special procedures to encourage U.S. activity by reducing, eliminating, or delaying duties.

Virginia offers six foreign trade zones designed to encourage businesses to participate in international trade by effectively eliminating or reducing customs duties. Also, numerous subzones are provided and additional ones can be designated to enhance the trade capabilities of specific companies and technologies such as UMS http://www. yesvirginia.org/ ProBusiness/ BusinessIncentives

#### **Defense Production Zones**

Virginia's cities, counties, and towns have the ability to establish, by ordinance, one or more defense production zones to attract growth in targeted industries. Establishment of a defense production zone allows localities to create special incentives and certain regulatory flexibility for qualified businesses locating or expanding operations in a zone. These incentives may include: a reduction of user and permit fees, special zoning treatment, exemption from local ordinances or other incentives adopted by ordinance. Virginia authorizes its communities to establish local defense production zones to benefit businesses engaged in the design, development, or production of materials, components, or equipment required to meet the needs of national defense. Companies deemed ancillary to or in support of the aforementioned categories would also apply.

Once a defense production zone has been established, incentives may be provided for up to 20 years. Each locality designs and administers its own program. The establishment of a defense production zone shall not preclude the area from also being designated as an enterprise zone. Two localities currently have an established Defense Production Zone: Fauquier County and the City of Manassas Park. Henrico County will create individual defense production zones based around individual projects on a case by case basis

http://www.vaallies. org/assets/ files/incentives/ defense production zoneswriteup.pdf



# FOR FURTHER INFORMATION PLEASE SEE HTTPS://VUS.VIRGINIA.GOV OR EMAIL US AT VUS@GOVERNOR.VIRGINIA.GOV