COMMITTEE ON
SCIENCE, SPACE AND TECHNOLOGY
CHAIRMAN FRANK LUCAS

FULL COMMITTEE

HEARING CHARTER

"Advanced Air Mobility: The Future of Unmanned Aircraft Systems and Beyond"

Thursday, March 23, 2023
10:00 a.m.
2318 Rayburn House Office Building

Purpose

On March 23, 2023, the Committee on Science, Space, and Technology will hold a hearing titled *Advanced Air Mobility: The Future of Unmanned Aircraft Systems and Beyond*. The purpose of the hearing is to examine the status and outlook for unmanned aircraft systems (UAS) and advanced air mobility (AAM) as well as serve as a legislative hearing for the National Drone and Advanced Air Mobility Act. The hearing will examine the impact of UAS and AAM research and development (R&D) and identify priority areas for next-generation R&D to ensure supply chain integrity and facilitate safe integration in the National Airspace System (NAS). The hearing will also explore ways to enhance domestic competitiveness and ensure United States leadership in UAS and AAM.

Witnesses

- **Dr. Jamey Jacob**, Executive Director, Oklahoma Institute for Research and Education; Williams Chair in Energy and Professor of Aerospace Engineering, Oklahoma State University
- **Dr. Parimal Kopardekar**, Director, NASA Aeronautics Research Institute
- **Ms. Lisa Ellman**, Executive Director, Commercial Drone Alliance
- **Mr. Sean Casey**, Chief Research and Development Engineer, AirWise Solutions; Adjunct Professor, System Safety and Reliability Analysis at Tinker Air Force Base, Oklahoma State University Institute of Technology

Overarching Questions

- What is the current state and future outlook for America's commercial UAS and AAM enterprises?
- Why is it important for the United States to lead in R&D and manufacturing of UAS? What are the consequences of not leading in this space?
- What is the role of the federal government in supporting UAS R&D, innovation, and domestic manufacturing? How can the federal government partner with the private sector and research community?
- How is the federal government coordinating to identify AAM and UAS R&D gaps?

Unmanned Aircraft Systems

Unmanned aircraft systems (UAS), often referred to as drones, encompass aircraft as well as supporting ground, air, and communications infrastructure. Statute defines "unmanned aircraft" as "an aircraft that is operated without the possibility of direct human intervention from within or on the aircraft."[1] UAS come in a variety of shapes and sizes and are viable for a broad range of recreational or hobby, commercial, and military applications. They can have wingspans as large as commercial airliners or be smaller than remote-controlled model airplanes. Typical domestic commercial applications of UAS include public safety, weather forecasting, and border security.

Though military and civil government will likely dominate large UAS operations in the near term, the UAS market is dynamic and the commercial sector is growing significantly, particularly within the small UAS sector. The UAS services market is expected to grow to more than $63 billion by 2025.[2] Statute defines "small unmanned aircraft" as "an unmanned aircraft weighing less than 55 pounds, including the weight of anything attached to or carried by the aircraft."[3] Any small UAS used for commercial purposes must be registered with the Federal Aviation Administration (FAA).

Integration of UAS into the National Airspace System (NAS) is challenging, as unmanned aircraft are fundamentally different than crewed aircraft. UAS will need to be integrated into some of the busiest and most complex airspaces, and, as UAS technologies continue to evolve, policies and regulations will need to be flexible to accommodate next-generation UAS technologies.

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[1] Title 49 U.S.C. §44801

[2] MarketsandMarkets, Drone Services Market Worth $63.6 Billion by 2025 - Exclusive Report by MarketsandMarkets™, *PR Newswire,* April 9, 2019, https://www.prnewswire.com/news-releases/drone-services-market-worth-63-6-billion-by-2025--exclusive-report-by-marketsandmarkets-300827904.html

[3] *Supra* note 1

Congress directed that federal agencies accelerate the integration of UAS into the NAS. The FAA Modernization and Reform Act of 2012 contained provisions designed to promote and facilitate the use of civilian UAS, including the development of an integration plan and a five-year roadmap for achieving integration objectives. [4] The FAA Reauthorization Act of 2018 required an update to the integration plan and directed the UAS R&D roadmap to be sent to Congress on an annual basis.[5]

Advanced Air Mobility

The National Aeronautics and Space Administration (NASA) and FAA are the lead agencies on AAM R&D and AAM integration into the NAS. NASA's vision for advanced air mobility (AAM) is a safe, accessible, automated, and affordable new air transportation system for passengers and cargo in urban and rural locations not served or underserved by aviation.[6] Aircraft operating within this new airspace may range anywhere in size from cargo-carrying UAS to passenger-carrying air taxis to small UAS (sUAS) delivering packages and inspecting infrastructure. Many of these aircraft would be self-flying or autonomous. One component of AAM is electric vehicle takeoff and landing (eVOTL) aircraft that are short-range, runway independent, and primarily automated to enable new complex missions previously served by ground vehicles, traditional helicopters, and fixed-wing aircraft. Several aspects of AAM would have dual-use applications of UAS for national defense and civilian use, but they must be readily available, secure, cost-effective, scalable, and adopted by communities.

NASA-commissioned market studies estimate by 2030 there could be as many as 500 million package delivery services flights and 750 million air metro service flights per year.[7] The market for AAM for passenger and cargo mobility in the U.S. is estimated to reach $115 billion by 2035, creating more than 280,000 new jobs.[8]

UAS Traffic Management (UTM)

UAS traffic management (UTM) is a collaborative, automated, and federated airspace management approach that enables safe, efficient, and equitable UAS operations. UTM is a key enabler to manage, integrate, and expand the scope, scale, and speed of existing air traffic management by allowing UAS to safely participate in national airspace. The UTM ecosystem is complex, requiring regulatory frameworks and developing operating rules and performance requirements. Successful UTM R&D, field demonstrations, and initial operations capabilities have sparked major investments from Fortune 500 companies, which could help pave the way for an AAM ecosystem.

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[4] P.L. 112-95
[5] P.L. 115-294
[6] National Aeronautics and Space Administration, Advanced Air Mobility: What is AAM? (Student Guide), *NASA*, n.d., https://www.nasa.gov/sites/default/files/atoms/files/what-is-aam-student-guide_0.pdf
[7] *Id*
[8] Hussain, Aijaz and Silver, David, "Advanced air mobility: Can the United States afford to lose the race?," *Deloitte*, January 26, 2021, https://www2.deloitte.com/us/en/insights/industry/aerospace-defense/advanced-air-mobility.html

FAA and NASA, along with other federal partners and industry, have collaborated on R&D and testing to work to transform traditional, human-centric air traffic management to a modern, machine-centric approach. FAA and NASA developed a joint UTM research plan to document research objectives and map out the development of UTM.[9] Additionally, FAA established a UTM Pilot Program to help define an initial set of capabilities required to support UTM operations.[10] According to the FAA, UTM will ultimately identify services, roles and responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude uncontrolled UAS.[11]

Federal R&D Activities

Federal Aviation Administration (FAA)— The FAA is the main agency responsible for safe integration of UAS into the NAS. The FAA collaborates across government, academia, and industry on R&D to support development of regulations, policies, procedures, guidance, and standards for UAS. FAA R&D activities include light tests, modeling and simulation, technology evaluations, risk assessments, and data gathering and analysis, which provides the FAA with information related to Detect and Avoid (DAA) capabilities, UAS Command and Control (C2) systems with continuous spectrum for Communications, Human Factors, System Safety, and Certification. The FAA also operates the Alliance for Systems Safety of UAS Through Research Excellence (ASSURE) Center of Excellence, which focuses on research, education, and training in areas critical to safe and successful integration of UAS into the NAS.[12] In addition to the UAS Implementation Plan and the UAS Roadmap, FAA also produces and updates the UAS Research Plan. FAA's FY2024 budget requests $21,128,000 for UAS and AAM integration research.[13]

National Aeronautics and Space Administration (NASA)— NASA leads R&D on autonomous aviation through the Aeronautics Research Mission Directorate (ARMD). ARMD's 2019 Strategic Plan outlines research aimed for 2025-2035 to fully integrate UAS into the NAS.[14] NASA also operates UAS to support Earth science missions and advanced aeronautical technology development.[15]

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[9] Federal Aviation Administration, Unmanned Aircraft System Traffic Management (UTM), *FAA*, last updated August 16, 2022, https://www.faa.gov/uas/research_development/traffic_management

[10] Federal Aviation Administration, UTM Pilot Program (UPP), *FAA*, last updated May 27, 2022, https://www.faa.gov/uas/research_development/traffic_management/utm_pilot_program

[11] *Supra* note 9

[12] Federal Aviation Administration, Alliance for System Safety of UAS through Research Excellence, *ASSURE*, n.d., https://www.assureuas.org/

[13] Department of Transportation, Budget Estimates Fiscal Year 2024: Federal Aviation Administration, *DOT*, March 2023, https://www.transportation.gov/sites/dot.gov/files/2023-03/FAA_FY_2024_President_Budget_508.pdf

[14] National Aeronautics and Space Administration, NASA Aeronautics: Strategic Implementation Plan 2019 Update, *NASA*, https://www.nasa.gov/sites/default/files/atoms/files/sip-2019-v7-web.pdf

[15] National Aeronautics and Space Administration, NASA Armstrong Fact Sheet: Ikhana Predator B Unmanned Science and Research Aircraft System, *NASA*, April 23, 2019, https://www.nasa.gov/centers/armstrong/news/FactSheets/FS-097-DFRC.html

From 2011-2020, NASA led a project on UAS integration in the NAS, which identified, developed, and tested technologies and procedures to help enable routine access for UAS to the NAS.[16] NASA's Aeronautics Research Institute (NARI) partners with industry, government, and academia to meet aviation demands and opportunities consistent with ARMD.[17] NARI is home to NASA's AAM Ecosystem Working Groups, which are divided into five aspects of AAM: vehicle development and production; individual vehicle management and operations; airspace system design and implementation; airspace and fleet operations management; and community integration. NASA's FY2024 budget requests $158,700,000 for ARMD's Airspace and Operations Safety Program, which supports UAS and AAM R&D.[18]

Department of Energy (DOE)— DOE, along with its seventeen national laboratories, has produced cross-cutting research on UAS. Idaho National Laboratory (INL), home of the UAS Program and DOE's UAS Center of Excellence, is a premier testing bed for DOE. With 890 square miles of high-altitude desert, INL researchers have employed UAS to obtain geographic and environmental data, monitor facilities, and inspect energy infrastructure. [19] UAS have played an integral role in INL's unique national security missions as well as its nuclear facilities. In December of 2022, engineers used UAS to map and secure radiological data inside a high-level radioactive waste storage vault.[20] At Oak Ridge National Laboratory, researchers are using drones for wildfire prevention and grid resiliency.[21] With the attachment of sensors, UAS can better detect and identify faulty transmission lines. In addition, the DOE's Office of Science is driving innovation in UAS fundamental research, which include areas such as advanced sensor technologies, autonomous operation, wireless charging, precision positioning, fuel cells, and tracking.[22]

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[16] National Aeronautics and Space Administration, NASA Facts: Unmanned Aircraft Systems Integration in the National Airspace System, *NASA*, n.d., https://www.nasa.gov/sites/default/files/atoms/files/fs-075-afrc-07-19.pdf
[17] NASA Aeronautics Research Institute, NASA Advanced Air Mobility Ecosystem Working Groups Portal, *NASA*, n.d., https://nari.arc.nasa.gov/aam-portal/
[18] National Aeronautics and Space Administration, FY 2024 Budget Estimates, *NASA*, March 2023, https://www.nasa.gov/sites/default/files/atoms/files/nasa_fy_2024_cj_v2.pdf
[19] Idaho National Laboratory, Autonomous Systems, *INL*, n.d., https://cet.inl.gov/SitePages/Autonomous%20Systems.aspx
[20] Department of Energy, Historic Drone Mission Delivers Data for Calcine Retrieval at Idaho Site, *DOE*, December 13, 2022, https://www.energy.gov/em/articles/historic-drone-mission-delivers-data-calcine-retrieval-idaho-site#:~:text=IDAHO%20FALLS%2C%20Idaho%20%E2%80%93%20An%20EM,level%20radioactive%20waste%20storage%20vault.
[21] Oak Ridge National Laboratory, Sensor research helps fight wildfires, *ORNL*, April 15, 2022, https://www.ornl.gov/news/sensor-research-helps-fight-wildfires
[22] H.R. 9376 – 117th Congress (2021-2022): The National Drone and Advanced Air Mobility Act (December 1, 2022) https://www.congress.gov/117/bills/hr9376/BILLS-117hr9376ih.pdf

National Science Foundation (NSF)—NSF supports R&D for a wide array of applications including data modeling and validation; natural hazards; disaster reconnaissance; species monitoring; and infrastructure monitoring. NSF supports the Industry-University Cooperative Research Center (IUCRC) for UAS.[23] The Center contributes R&D to advance autonomous capabilities for UAS; human and technology interfaces or UAS; multiagent cooperative control of UAS; UAS-based communication networks; and UAS integration into the NAS. NSF also supports UAS R&D within the Directorate for Computer and Information Science and Engineering (CISE). Additionally, NSF supports workforce development, education, and training for UAS.

National Institute of Standards and Technology (NIST)—NIST supports the development of measurement and standards infrastructure to evaluate robotic capabilities for first responders and military organizations addressing national security challenges through the Engineering Laboratory, Intelligent Systems Division. This includes the development of standard test methods and performance metrics to quantify the capabilities of response robots, including mobility, manipulation, sensors, energy, communications, operator proficiency, logistics, and safety. These test methods also support operator proficiency training and help develop and harden advanced robot capabilities. NIST includes small UAS in the working definition of "response robot."[24]

Department of Homeland Security Science and Technology Directorate (DHS S&T)—DHS S&T leads research, development, test, and evaluation (RDT&E) of ways to protect against potential threats posed by UAS. DHS S&T's Counter Unmanned Systems (C-UAS) Program assesses counter-UAS technologies and guides the development of new capabilities. The Program also supports requirements documentation, rapid development, system integration, and specification and performance testing for law enforcement components of DHS. DHS S&T collaborates with national labs, industry, federally funded research and development centers, DHS and Department of Defense (DOD) technical labs, and other interagency partners on C-UAS projects. DHS S&T's FY2024 budget requests $24,996,000 for C-UAS R&D.[25]

National Oceanic and Atmospheric Administration (NOAA)—NOAA supports innovative R&D of unmanned aircraft and maritime systems concepts and technologies to better understand and predict changes in climate, weather, oceans, and coasts to yield societal and economic benefits. NOAA also operates unmanned systems to support Earth science missions.[26]

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[23] Industry–University Cooperative Research Centers, Center for Unmanned Aircraft System (C-UAS), NSF, n.d., https://iucrc.nsf.gov/centers/center-for-unmanned-aircraft-system/

[24] Intelligent Systems Division, Aerial Program Overview, *NIST*, last updated August 5, 2022, https://www.nist.gov/el/intelligent-systems-division-73500/standard-test-methods-response-robots/aerial-systems/aerial

[25] Department of Homeland Security, Science and Technology Directorate Budget Justification Fiscal Year 2024, *DHS*, March 2023, https://www.dhs.gov/sites/default/files/2023-03/SCIENCE%20AND%20TECHNOLOGY.pdf

[26] National Oceanic and Atmospheric Administration, New NOAA program to support and expand agency's use of unmanned systems, *NOAA*, March 31, 2020, https://www.noaa.gov/media-release/new-noaa-program-to-support-and-expand-agency-s-use-of-unmanned-systems

GAO Report on FAA Integration of Drones into the NAS

On January 26, 2023, the Government Accountability Office (GAO) released the report *"Drones: FAA Should Improve Its Approach to Integrating Drones into the National Airspace System."*[27] GAO reviewed FAA's UAS integration efforts and found that while the FAA has developed several planning documents and reports, they have yet to develop a comprehensive strategy for UAS integration. GAO found these documents lacked goals and objectives for integration, and only partially mentioned milestones and performance measures.

FAA officials have stated a UAS integration strategy is underway, however, the release of the strategy has been delayed several times and it is unclear if the strategy will provide a comprehensive approach to UAS integration. GAO also found that the FAA has not clearly communicated with stakeholders and operators on the requirements and processes for advanced UAS operations. GAO made the following four recommendations for the FAA:

1. Develop a drone integration strategy that includes all seven elements of a comprehensive strategy;
2. Evaluate its current documentation to identify options to more clearly communicate how applicants can satisfy drone operational request requirements, and communicate FAA's internal process for reviewing and approving operational requests;
3. Develop and document a formal lessons-learned process for its drone integration activities that includes all six key practices for a lessons-learned process; and
4. Implement the formal lessons learned process it develops for its ongoing drone integration activities, including Part 107 waiver reviews and the BEYOND program.

GAO Report on AAM Issues

On May 9, 2022, the Government Accountability Office (GAO) released the report *"Transforming Aviation: Stakeholders Identified Issues to Address for 'Advanced Air Mobility.'"*[28] GAO found several key issues that will need to be addressed by industry and the federal government for AAM to be widely implemented. These issues include approving aircraft designs with new capabilities such as electric propulsion and vertical takeoff, which FAA regulations currently do cover; cultivating acceptance with the general public that AAM aircraft are safe, reliable, quiet, and commercially viable; and developing new ground infrastructure such as landing facilities and the electrical infrastructure needed to charge large quantities of yet to be developed aircraft batteries.

[27] Government Accountability Office, "FAA Should Improve Its Approach to Integrating Drones into the National Airspace System," GAO, January 2023, https://www.gao.gov/assets/gao-23-105189.pdf
[28] Government Accountability Office, "Transforming Aviation: Stakeholders Identified Issues to Address for 'Advanced Air Mobility'," *GAO*, May 2022, https://www.gao.gov/assets/gao-22-105020.pdf

GAO also identified several issues affecting AAM workforce needs, which includes new skills training that pilots and maintenance technicians will need for AAM aircraft, which would require investment in new curriculums; workforce supply issues similar to those facing the aerospace industry more broadly related to high education costs, lack of diversity, lack of awareness of opportunities, and limited training capacities.

Other Issues to Consider

Lagging International Competitiveness and National Security Concerns—According to Drone Industry Insights, Chinese-based technology company DJI is the top producer of commercial UAS with an estimated 70 to 80 percent global market share.[29] DJI accounts for the vast majority of consumer UAS in the United States, with approximately 77 percent of the hobbyist market and approximately 90 percent of UAS used by public safety, including state and local law enforcement, fire and emergency services.[30]

In addition to concerns over DJI's control of the commercial UAS market, they also pose several national security concerns. In 2017, the Department of Homeland Security (DHS) stated with "moderate confidence" that DJI was "Providing U.S. critical infrastructure and law enforcement data to the Chinese government."[31] In 2019, DHS issued another warning that Chinese UAS are a "potential risk to an organization's information" and "contain components that can compromise your data and share your information on a server accessed beyond the company itself."[32]

DJI requires users to download their proprietary software and utilize their mapping databases, which have demonstrated the potential to be monitored remotely. A Wall Street Journal article from November 30, 2022, points out additional risks associated with DJI's capacity for geofencing, stating "using GPS and satellite data, DJI can decide whether one of its drones will function in a given area, allowing the company to down an entire fleet if it chooses. The ability to deactivate government-owned drones shouldn't be entrusted to any foreign entity—least of all one under the thumb of the Communist Party."[33]

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[29] Singh, Ishvenna, "The top drone manufacturers of 2021," *Drone DJ*, November 3, 2021, https://dronedj.com/2021/11/03/top-drone-manufacturers-2021/

[30] Cadell, Cate, "Drone company DJI obscured ties to Chinese state funding, documents show," *Washington Post*, February 1, 2022, https://www.washingtonpost.com/national-security/2022/02/01/china-funding-drones-dji-us-regulators/

[31] Department of Homeland Security, (U) Da Jiang Innovations (DJI) Likely Providing U.S. Critical Infrastructure and Law Enforcement Data to Chinese Government, *Public Intelligence*, August 9, 2017, https://info.publicintelligence.net/ICE-DJI-China.pdf

[32] Shortell, David, "DHS warns of 'strong concerns' that Chinese-made drones are stealing data," May 20, 2019, *Cable News Network*, https://www.cnn.com/2019/05/20/politics/dhs-chinese-drone-warning

[33] Schönander, Lars Erik, "The U.S. Government Keeps Buying Chinese Drones," *The Wall Street Journal*, November 30, 2022, https://www.wsj.com/articles/us-government-keeps-buying-chinese-drones-dji-surveillance-national-security-ccp-pla-fleet-interior-army-agriculture-11669817289

On January 18, 2021, the Trump Administration issued an Executive Order directing U.S. agencies to assess security risks from Chinese-made UAS in U.S. government fleets.[34] Later, on July 23, 2021, the Department of Defense (DOD) issued a press release that DJI drones "pose potential threats to national security."[35] On October 5, 2022, DOD prohibited DJI products for suspected close ties to China's military.[36]

Manufacturing and Supply Chains—Unlike an automobile which contains thousands of parts, UAS are simpler to build. UAS may be constructed out of several different materials including aluminum and composites, making them lightweight and durable. Traditionally, UAS were made out of components of molded plastics, but the use of additive manufacturing or 3-D printing has enabled the ability to print parts. As the commercial UAS industry continues to evolve, UAS will become more sophisticated, and demand for reliable, trustworthy, safe, and cost-effective systems will increase. Securing supply chains in domestic manufacturing and developing innovative manufacturing techniques for UAS will be critical for economic and national security. Additionally, addressing existing manufacturing gaps will increase U.S. capacity and scalability, which would allow the U.S. to compete with foreign-made systems currently saturating the market.

Detect and Avoid Capabilities (DAA)— Detect and Avoid (DAA) capabilities could enhance safe UAS to integration into the NAS by reducing collisions with other aircraft, buildings, powerlines, and other obstacles. These technologies would observe the surroundings of a UAS through sensors, artificial intelligence, or image recognition to determine whether or not a collision may occur and direct a new flight path to avoid a collision. Reliable DAA technologies will be critical to enable commercial beyond visual line of sight (BVLOS) UAS operations.

Test Sites— Test sites are currently the most common means for the private sector to test UAS. R&D conducted at test sites helps provide information on UAS performance, capabilities, and technologies, which could support UAS integration efforts into the NAS. While data is collected from test sites, they are currently not adequately leveraged to advance UAS integration.[37] However, due to funding challenges, FAA indecision about the specific data test sites need to obtain from users, and private sector concerns about protecting intellectual property, the test sites are not being fully utilized. The long approval process to use a UAS test site has led some researchers to take their testing to non-FAA-designated test sites. Alternatively, private testing is occurring at other federal test facilities such as NASA Armstrong Flight Research Center and high-quality university-

[34] Executive Order 13981
[35] Department of Defense, Department Statement on DJI Systems, July 23, 2021, *DOD,* https://www.defense.gov/News/Releases/Release/Article/2706082/department-statement-on-dji-systems/
[36] , Department of Defense, DOD Releases List of People's Republic of China (PRC) Military Companies in Accordance With Section 1260H of the National Defense Authorization Act for Fiscal Year 2021, October 5, 2022, *DOD,* https://www.defense.gov/News/Releases/Release/Article/3180636/dod-releases-list-of-peoples-republic-of-china-prc-military-companies-in-accord/
[37] Government Accountability Office, "Unmanned Aircraft Systems: FAA Could Better Leverage Test Site Program to Advance Drone Integration," *GAO*, January 2020, https://www.gao.gov/assets/gao-20-97.pdf

designated, state-designated, and tribal-designated test site facilities are being utilized to achieve the same result.

National Drone and Advanced Air Mobility Initiative Act

On December 1, 2022, Chairman Lucas introduced the National Drone and Advanced Air Mobility Initiative Act.[38] The bill provides for a coordinated federal initiative across research and mission agencies to support UAS R&D activities and ensure U.S. leadership in UAS and AAM technologies. Additionally, the bill authorizes a Network of Drone and Advanced Air Mobility Research Institutes to be supported by federal research agencies; promotes the development of voluntary standards for UAS, mitigates risks to supply chains, public safety, and national security, supports and expands the U.S. workforce to integrate UAS across all sectors of the economy; increases environmental observations and establish a data management strategy for scientific data; establishes a counter-UAS center of excellence to support the work necessary to improve our abilities to respond to threats from adversaries using UAS; and supports R&D activities at NIST, NSF, NASA, DOE, DHS, NOAA, and FAA. The bill is modeled after the Quantum and Artificial Intelligence Initiative Acts and Chairman Lucas plans to reintroduce an updated bill this Congress.

[38] Supra note 22