

Statement of
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Chairman Lucas, Ranking Member Lofgren, and distinguished members of the committee, I want to thank you for the opportunity to speak to you about the future of uncrewed aircraft systems (UAS) and advanced air mobility (AAM).

My name is Parimal Kopardekar. I am the director of the NASA Aeronautics Research Institute and am located at the agency’s Ames Research Center in Mountain View, California. I also serve as the chair of the International Civil Aviation Organization’s (ICAO) advisory group on uncrewed aircraft systems.

Aviation is fundamental to the future of the U.S. economy. The aeronautics enterprise annually generates 4.9 percent of the U.S. gross domestic product—\$1.9 trillion in total economic activity in 2019—and more than 10 million jobs.¹ According to Aerospace Industries Association (AIA), more than 57 percent of that employment comes from an extensive network of suppliers composed of thousands of medium- and small-sized businesses.² The aeronautics sector also is the second largest manufacturing export sector in the United States, generating \$148 billion in exports in 2019.³ These staggering numbers do not include a thriving UAS and AAM industry.

U.S. leadership in aviation today can be traced to one critical enabler – a culture of innovation. NASA research and development has been a critical contributor to this legacy of innovation for over 100 years. U.S. companies continually bring new products and services that underpin the global air transportation system, enabling faster, quieter, and more sustainable flight across the U.S. and around the world.

We are at the beginning of the next major transformation of the global aviation industry. Growing consumer demand, combined with innovative technologies and disruptive thinking, is transforming aviation in ways we could hardly imagine just a few years ago. New technologies and business cases are unlocking new opportunities

¹ Federal Aviation Administration. “The Economic Impact U.S. Civil Aviation: 2020”. https://www.faa.gov/sites/faa.gov/files/2022-08/2022-APL-038%202022_economic%20impact_report.pdf. Released August 2022

² Aerospace Industries Association. “2021 Facts and Figures U.S. Aerospace & Defense: <https://www.aia-aerospace.org/wp-content/uploads/2021-Facts-and-Figures-U.S.-Aerospace-and-Defense.pdf>

³ International Trade Administration. “Leading Economic Indicators Aerospace Industry”. Accessed February 21, 2023. <https://www.trade.gov/leading-economic-indicators-aerospace-industry>

for mobility. Global competition is fierce, as companies and governments around the world seek to bring new capabilities to market. The United States must continue to innovate in aviation while maintaining the highest standards of safety. NASA is committed to collaborating with other government agencies, academia, and industry to foster the spirit of innovation and develop new technologies that will be beneficial for society at large and generate jobs here at home.

Outlook of America’s Commercial UAS and AAM Enterprises

Small UAS vehicles can be used in a broad range of applications such as agriculture, surveillance, cargo delivery, law enforcement, and firefighting. These new markets are expected to grow rapidly over the next ten years, and forecasts estimate the global UAS market to reach nearly \$3 billion.⁴ In recent years there has been an emergence of transformative vehicle technologies, commonly referred to as AAM, meaning a transportation system that transports people and property by air between two points using aircraft, including electric aircraft or electric vertical take-off and landing aircraft (eVTOL), in both controlled and uncontrolled airspace. Expected AAM applications include cargo delivery, medical and emergency services, as well as passenger carrying operations. According to a 2021 AIA and Deloitte study⁵ the U.S. AAM market could reach \$115 billion annually by 2035, potentially creating 280,000 jobs.

Federal Research on UAS and AAM

Domestic advancements in UAS and AAM have benefited from focused and deliberate investment to date by federal agencies. NASA works with the U.S. aviation community and government partners to create opportunities for American businesses. The Agency sets the vision of what is possible, based on deep insight into the goals and needs of the aviation community, and engages with U.S. industry early in the technology development cycle. We first invest in aeronautics research to address the most critical challenges and collaborate with our partners to demonstrate the most promising technologies. NASA then collaborates with industry to develop key concepts and technologies and finally transfers them to the private sector.

NASA also works closely with the FAA to align our research and their long-term needs, so the results can be transitioned to the FAA to support certification or implementation. Data from our research results are used to develop standards and regulations through rulemaking committees and domestic and international standards bodies.

⁴ Global UAS Traffic Management (UTM) System Market: Focus on Stakeholders Analysis, Key Technologies Enabling UTM, and Country-Wise UTM Concepts (2019) <https://www.researchandmarkets.com/reports/4763844>

⁵ Advanced Air Mobility: Can the United States Afford to Lose the Race? (2021) <https://www.aia-aerospace.org/news/aia-deloitte-study-us-advanced-air-mobility-market-could-reach-115b-by-2035/>

Over the last several years, NASA has developed and transitioned concepts and technologies related to UAS and their integration in the National Airspace System (NAS). One example of this is NASA conducting early research in Detect and Avoid (DAA) and communications technologies and sharing that work with standards committees and the FAA. We also developed an airspace management concept called Uncrewed Aircraft System Traffic Management (UTM). NASA had 85 small, medium, and large-sized traditional aviation and emerging industry partners during the development of UTM, including many startups that are now market leaders in the UAS and AAM businesses. These include drone manufacturers, airspace service providers, and surveillance capability providers. The resulting advancements will be instrumental in safely enabling high-scale operations of smaller drones in low altitude airspace.

NASA is building on this experience to address critical research needs for AAM. We are researching vehicle characteristics, noise measurements, and acceptance of operations. We are developing technologies to safely enable AAM operations without overloading the current air traffic management system. Research is underway to develop new safety methods and collect data to assure safety of these operations. We are gaining industry insight and sharing NASA plans through AAM ecosystem working groups to ensure we are focused on the highest priority challenges. Through collaborations, we are leveraging expertise of AAM partners to jointly research and validate concepts of operation and core technologies such as on-board hazard avoidance, safety analysis, airspace integration needs, and aircraft flight deck design.

Over the next several years we will conduct integrated operational demonstrations, called National Campaigns, of aircraft, airspace, and enabling capabilities to examine how the entire system and information exchanges will work together. The first National Campaign involved more than 10 entities consisting of original aircraft manufacturers, airspace services providers, and the community.

NASA is leveraging our Small Business Innovative Research Program to advance UAS and AAM capabilities through understanding weather information needs, and development of tools needed for safe operations, and alternative position, navigation, and timing technologies. NASA has given multiple grants through the University Leadership Initiative and the Minority University Research and Education Program to conduct foundational research in key areas like autonomy and concepts of operations for AAM, to build curriculum, and to promote industry collaborations. These grants will develop technology and enable the high-volume aeronautics manufacturing needed to support the UAS and AAM industries while building our new generation of workforce to support the growth in this sector. Separately, NASA is working with Department of Defense's Agility Prime to analyze AAM supply chain needs, gaps, and opportunities for the U.S. manufacturing sector to grow.

In short, NASA Aeronautics is committing significant resources to ensure that UAS and AAM concepts and technologies will continue to mature, will be scalable, and can be safely operationalized.

Competition and Coordination

Nonetheless, U.S. leadership in this sector cannot be taken for granted. Other countries are closely following our progress and seeking to surpass us.

While the United States airspace and operations are far more complex than rest of the world, we are committed to supporting U.S. leadership in these critical new markets. The FAA continues to make progress towards enabling UAS operations while NASA continues to support FAA with the required research.

Our work with the FAA and other federal agencies will be further strengthened through the Advanced Air Mobility Leadership and Coordination Act, which became law last year. Additionally, NASA is an active member of the Department of Transportation's recently formed AAM Interagency Working Group. This working group will bring together 19 federal agencies and play an important role in the coordinated government efforts necessary to bolster the AAM ecosystem in the U.S.

Through coordinated community effort, continued strong performance in this sector will benefit the U.S. through manufacturing jobs, innovation, and increased trade as this burgeoning aviation sector comes to fruition.

Wildland Firefighting R&D and Opportunities to Transform the State-of-the-Art

We have an early opportunity to apply UAS and AAM technology to a current critical challenge – wildland fires. As members of the Committee are all too aware, there has been a surge in large fires across the state of California, as well as in other Western states, in recent years. The top five fires within the United States in 2021 cost over \$1.7 billion⁶, and all lasted for more than a month. Four lasted more than two months.

NASA is actively working to assess how UAS and AAM capabilities developed at NASA can be applied to the challenge of wildland fire. Through workshops and studies, we have identified opportunities to apply existing NASA technology in and near flight restricted areas during active wildland fires to enhance safety, enable expanded operations, and improve communication. We successfully demonstrated initial capabilities in active wildland fire management operations with the United States Forest Service and CAL FIRE, and we continue to explore how to further the use of these technologies during firefighting training sessions. NASA is conducting research on a portable UTM system to provide situational awareness and is investigating use of UAS capabilities

⁶ National Interagency Coordination Center Wildland Fire Summary and Statistics Annual Report 2021, https://www.predictiveservices.nifc.gov/intelligence/2021_statsumm/intro_summary21.pdf

for continuous 24-hour aerial suppression. Should such capabilities be transitioned to operation, fires could be extinguished more rapidly, thus reducing economic and environmental impact.

NASA is also working with other government agencies to create an interagency concept of operations to describe how advances in UTM, AAM, remote sensing, satellite, and other technologies could be leveraged for wildland fire management. Use cases being explored include 24-hour firefighting operations, air cargo dispatch of equipment, prescribed burn activities, and enhancing the safety of current piloted operations. Furthermore, NASA's Aeronautics Research, Science, and Space Technology Mission Directorates are collaborating to develop end-to-end system-level concepts and technologies that include fire prediction and modeling, remote sensing and detection, tracking, aerial suppression, and remediation efforts.

Conclusion

In summary, NASA looks forward to driving innovation for a strong UAS and AAM industry by collaboratively conducting research and transferring technologies to the industry and other government agencies. These efforts will strengthen U.S. competitiveness and leadership in this important growing area of aviation with many societal benefits to come.

Thank you once again for allowing me to address this body and to share my expertise in this area. I would also like to thank this Committee for its continued support of NASA's aeronautics research. I look forward to answering any questions.