STATEMENT OF
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Good morning, Chairman Diaz-Balart, Ranking Member Price, and Members of the Subcommittee. Thank you for the opportunity to discuss the integration of unmanned aircraft systems (UAS), also commonly called drones, into the United States airspace.

I am a professor in the Department of Aeronautics and Astronautics at Stanford University and a third-generation pilot. In this testimony, I am speaking solely for myself.

My research for over ten years has involved statistical estimation of risk and the development of technology for enhancing aviation safety and the safety of other transportation technologies. While at MIT Lincoln Laboratory, I developed a collection of airspace models, jointly funded by the FAA, DHS, and the Air Force. These models have since been used to estimate collision risk for manned and unmanned aircraft by government, academic, and commercial organizations around the world. My work has also led, in part, to the technology underlying the FAA's next generation airborne collision avoidance system called ACAS X that is currently undergoing international standardization. The FAA is developing and flight testing a version for unmanned aircraft. My students at Stanford have been supporting this effort and the effort of NASA to build a UAS Traffic Management (UTM) system. In addition, my graduate students have also been involved in advancing the theory and application of technologies relevant to automated driving.

I will begin by outlining the motivation for building a system for enabling the safe and efficient operation of drones. This new wave of unmanned aircraft technology has the potential to save lives and create jobs. Drones are able to assist in the inspection of infrastructure, such as communications towers, wind turbines, and bridges, with the potential to save worker lives every year. They are also able to assist in search-and-rescue operations, where finding victims is time critical. They support agricultural surveillance, allowing farmers to increase yields, more efficiently use water resources, and reduce crop damage. Amazon, Google, and other companies have been exploring the possibilities of using drones for package delivery. In the medical space, drones can enable the swift transport of organs for transplants and the delivery of medicine and defibrillators in emergencies.

The transformative nature of unmanned aircraft technology and the benefits they bring to society are difficult to deny. However, there are significant worries about the reckless use of drones and the risks they pose to other air traffic participants as well as people and property on the ground. There are also concerns about the violation of privacy, given that many drones are equipped with cameras, and landowner rights

to the airspace immediately above their property. These are all valid concerns, but I will focus my opening remarks on the challenges associated with airspace integration.

The airspace in the United States is the safest and most complex in the world. The FAA is charged with the responsibility for ensuring that this impeccable safety standard is maintained, even with the proliferation of new airspace users, platforms, and applications. The FAA required the registration of small drones by February 2016, and by June 2016 there were 495,000 registered, considerably higher than the 320,000 registered piloted aircraft. Many of these aircraft are hobbyist. The FAA forecasts that the commercial drone sector will continue to accelerate, with the commercial fleet growing by a factor of ten from where it was in 2016.

The UTM appears to be the best way forward for integrating these new users, allowing for the flexible use of the airspace while preserving the ability of the FAA to regulate the traffic as needed to preserve safety. The UTM is an air traffic management ecosystem for uncontrolled airspace. NASA has led the effort in developing the concept and prototyping the system with broad participation from industry, government, and academia, along with coordination with the FAA and the FAA test sites. The focus has been on the band of uncontrolled airspace between 200 ft and 500 ft above ground, high enough to avoid buildings and privacy concerns, but low enough to avoid interference with manned aircraft. The development has also focused on flights within line of sight, but the UTM can provide the capability for enabling beyond-visual-line-of-sight operations. The UTM may also be able to provide future support for other areas of uncontrolled airspace, such as above 60,000 ft, as well as support for passenger-carrying, mobility-on-demand concepts.

The development of the UTM has aimed to identify the relevant services, responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements. The vision that has emerged from these research activities over the past few years is that the FAA maintains regulatory and operational authority for airspace and traffic operations. The UTM would be used by the FAA to issue directives, impose constraints, and modify airspace configurations, but air traffic controllers are not required to actively control drones in uncontrolled airspace. The FAA maintains situational awareness through the UTM. Operational concepts for drones that must transition into controlled airspace is an area of future research.

The FAA manages the Flight Information Management System (FIMS), which interacts with various UAS Service Suppliers (USS). A private entity can apply to become a USS, and the various service suppliers coordinate with each other to provide services such as real-time position information and notifications to drone operators. The concept is that participation in UTM may allow, with FAA concurrence, exceptions from the the current Part 107 requirements, enabling operations above 400 feet, beyond line of sight, or within 5 miles of an airport.

I would like to conclude by saying that there is an opportunity for the United States to be a leader in the deployment of the UTM and ushering in the next generation of aviation, bringing with it the benefits I mentioned earlier. Private industry has played an important role in developing the UTM concept and prototype, and many of the development activities have been supported by their own investment. Many of

the air traffic research concepts that NASA has been exploring for decades are making their way into the UTM system. NASA should continue to be funded to work with the FAA to transition this research prototype to a deployed system. In addition, appropriate resources should be allocated to the FAA to support the interface with UTM. There are still open research questions related to establishing risk-based separation standards, micro-weather prediction, communication standards, and robust algorithms for sequencing and spacing. Addressing these research questions will require close collaboration between government, industry, and academia. It is in the interest of our nation to support the research needed to ensure aviation safety and efficiency as our technology evolves. The future of unmanned aviation is bright and has the potential to flourish into an entirely new industry with applications yet to be imagined.

Thank you for this opportunity, and I am happy to be a resource to this subcommittee.