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Statement of
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before the

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House Committee on Transportation & Infrastructure
U.S. House of Representatives

Chairman Costello, Ranking Member Petri, and Members of the Subcommittee, thank you for the opportunity to appear before you today. I am here to discuss NASA's Aeronautics Research program, how we in NASA Aeronautics work with the Joint Planning and Development Office (JPDO), and how our research efforts support the development of technologies that will be necessary for the realization of the Next Generation Air Traffic Management System (NextGen).

Through interagency cooperation, NextGen will provide key tangible benefits. Advancements to aircraft and aircraft operations produce dollars and jobs for the U.S. economy, improve the environment, and support energy independence through efficiency as well as the development of alternative fuels. Aviation is also a major contributor to U.S. exports. Since operating costs and environmental constraints are impediments to the future growth of aviation, NextGen efforts will focus on more efficient aircraft and aircraft operations to facilitate this growth.

Specifically, a significant issue facing our nation and the world is the increase in air traffic congestion and the noise and emissions generated by aircraft as they operate in the National Airspace System (NAS) and around the globe. Current air traffic management processes and procedures do not provide the flexibility needed to allow for the types of innovation through which the system could provide for the growing demand. In order to meet the need for increased capacity and efficiency while improving safety, new technologies and processes must be implemented. Addressing this problem will require research and development in both efficient air traffic operations and in new vehicle concepts.

Interagency Cooperation and Coordination

Although the current economic climate has slowed the growth in air traffic demand, only through a coordinated interagency research and development effort will the nation be able to accommodate predicted air traffic growth in the NAS and the integration of near-term innovations in a timely manner. The intricate, crosscutting nature of the NAS requires cooperation and coordination among federal agencies in order to achieve both the near-term improvements and the NextGen vision. The coordinated efforts of the JPDO partners including the Federal Aviation

Administration (FAA), NASA, the Departments of Defense (DoD), Homeland Security, and Commerce, as well as the aerospace industry have resulted in the NextGen Concept of Operations, Enterprise Architecture, and Integrated Work Plan.

To realize the ideas captured in the NextGen Concept of Operations requires a coordinated and extensive research and development effort. The Federal Government's investments and expenditures in aeronautics research and development are guided by the National Aeronautics Research & Development Policy (Policy) and its related National Aeronautics Research and Development Plan (Plan). Under the direction and leadership of the White House's Office of Science and Technology Policy, this Policy was issued by the President in 2006 and its corresponding Plan was released to the public in 2007 and updated in February 2010. The goals and objectives defined in the Plan fall broadly under the categories of mobility, national security and homeland defense, aviation safety, and energy and the environment. The NASA aeronautics research programs align with these categories, or areas of emphasis. Through the Plan, coordination of the Federal Government's research efforts and programs is starting to take shape. A great number of the goals and objectives defined in the National Aeronautics Research and Development (R&D) Plan directly address the development of the NextGen.

From the earliest days of the JPDO, NASA has made significant contributions to the vision and plans for NextGen and, along with other partner agencies and industry, continues to make vital science and technology (S&T) investments with the goals of realizing near-term improvements and enabling the long-term NextGen vision. The need for increased levels of coordination is ever present if the U.S. is to leverage each federal agency's areas of expertise, ensure coordination of research programs, and recognize mutually beneficial and well informed S&T investments. This will ensure that as new technologies and processes are developed, they can be implemented in the near term and in the longer term future.

To date, the JPDO documents mentioned previously have been valuable for integration and coordination. NASA's research and analysis aided in their development. Specifically, NASA participates in the Trajectory Based Operations (TBO) study. In this way NASA research is linked to both near and far term TBO efforts and will remain consistent with the vision. The TBO holds out the potential to significantly increase the efficiency of routing and spacing aircraft in the NAS. NASA has also worked with the JPDO to incorporate the results from the NASA *Integration of Advanced Concepts and Vehicles in NextGen* study into the Integrated Work Plan (IWP). This broadens the NextGen architecture described in the Work Plan to allow achievement of the full benefit that could be derived from future aircraft.

NASA Aeronautics Research

NASA Aeronautics participates as the lead Agency for 32 research elements within the Integrated Work Plan. These elements span the four research programs within the NASA Aeronautics Research Mission Directorate (ARMD): the Fundamental Aeronautics Program, the Airspace Systems Program, the Aviation Safety Program, and the Integrated Systems Research Program.

The **Airspace Systems Program** closely aligns with the goals of NextGen. NASA's research in this area is multi-faceted, from near-term improvements to innovative concepts and technologies covering gate-to-gate operations on the airport surface, on runways, in the dense terminal area, and in the many en route sectors of the NAS. However, achieving the benefits that can result from NextGen, including increased NAS operational throughput, efficiency, and capacity, and a reduction in environmental impacts, will require contributions from all NASA research programs.

The Environmentally Responsible Aviation (ERA) Project within the **Integrated Systems Research Program** supports the JPDO research element that calls for technologies that reduce noise and emissions in the future generation large transport aircraft. In order to achieve these goals, ERA is coordinating with and building upon the near-term efforts of the FAA's Continuous Lower Energy, Emissions and Noise (CLEEN) program and mid-term efforts of DoD's Adaptive Versatile Engine Technology (ADVENT)/ Highly Efficient Embedded Turbine Engine (HEETE)/AD-HEETE programs.

The **Fundamental Aeronautics Program** includes foundational research in the disciplines of materials and structures, propulsion systems, and airframe systems in order to reduce fuel burn, noise, and emissions for subsonic fixed wing aircraft as well as develop revolutionary vehicle concepts and tools. It also includes fundamental research to increase the performance and lower the environmental impact of rotorcraft (i.e. helicopters and tilt-rotors) along with environmentally compatible and economically viable supersonic cruise aircraft that can fly at supersonic speeds over the land.

NASA is a member of the Commercial Aviation Alternative Fuels Initiative (CAAFI), a consortium of federal, academic, and industrial organizations that is working on the development of alternative aviation fuels. These fuels hold the promise of providing energy independence from foreign sources and also reducing the environmental footprint of aviation. Specifically, the Fundamental Aeronautics Program's Alternative Aviation Fuel Experiment (AAFEX) is teaming with 11 other research groups to measure and document the emissions characteristics of synthetic fuels and biofuels and blends of these alternative fuels. Through these tests, researchers are evaluating the fuels' impact on engine performance and aircraft emissions and building a publicly available database of fuel properties and emissions characteristics.

The **Aviation Safety Program** builds upon the unique safety-related research capabilities of NASA to develop tools, methods, and technologies that will improve the intrinsic safety attributes of current and future aircraft in the air and on the ground, and to overcome aircraft safety technological barriers that would otherwise constrain the full realization of NextGen. The Aviation Safety Program has provided close collaboration and support to the FAA for the development of the Aviation Safety Information Analysis and Sharing (ASIAS) system, which enables FAA and industry to proactively identify, analyze, and correct safety issues in a protected environment.

Research Transition Teams

The ARMD research program is not limited to research activities focused solely on low technology readiness levels, or TRLs. In the recent past, fundamental research at lower TRLs has certainly been the focus of our research efforts. With the advent of the Integrated Systems Research program in FY 2010 and through a new structure of the Airspace Systems Program, NASA is committing to develop advanced technologies and applications that target NextGen needs and support maturity of those applications for transition to implementing organizations. NASA's experience has been that the aeronautics community has been adept at making use of our research results and technologies across the spectrum of technology readiness levels. The new structure of our Airspace Systems Program (ASP) will support and enhance existing efforts to initiate integrated system research in key areas of R&D gaps identified by JPDO. ASP's activities will also include the collaborative engagement with the FAA as planned within the recently created Research Transition Teams (RTTs), accelerating progress for NextGen

advancements, and effectively transitioning advanced capabilities to the FAA for certification and implementation. The explicit intent of these cross-agency RTTs is to help bridge the maturity gap between advanced concept development and the validation of such concepts in relevant operational environments enabling the FAA to make informed investment and deployment decisions.

Integrating NASA's Research and Development activities with FAA's role in the deployment of operational capabilities in the National Airspace System, the efforts being coordinated through the RTTs clearly address technology readiness level activities that demonstrate the use of technologies in relevant environments. The RTTs build upon the FAA's prior successful deployments of NASA-developed technologies, such as the Traffic Management Advisor with enhancements for major metropolitan areas and surface management tools. To date there are four RTTs that cover near-, mid-, and long-term capabilities stretching from the en route airspace to the terminal and surface including traffic flow management. The near term focus is the technology transfer of mature concepts and research. For the mid-term, the FAA and NASA are jointly engaging earlier in the research to develop the products needed for transfer; and for long-term research, FAA is providing NASA with subject matter expertise to support the research.

NASA Aeronautics has contributed significantly to the JPDO driven effort to identify high-value focus areas and R&D gaps revealed upon creation of the NextGen Concept of Operations and the complementary Integrated Work Plan (IWP). As mentioned previously, NASA has taken the lead in addressing research for 32 critical elements of the IWP. This includes new or ongoing support for focus areas such as air/ground functional allocation, integrated surface/arrival/departure management, closely-spaced parallel runways, integration of weather information in Air Traffic Management (ATM) decision support, and verification and validation of flight critical, complex systems. The work of the aforementioned restructured Airspace Systems Program and the RTTs also serve to move promising advanced capabilities faster and farther along the path to maturity. Close and collaborative engagements with the FAA are defining research deliverables, evaluations, and field trials in relevant environments, and enabling subsequent implementation decisions. NASA appreciates that the RTT process is viewed by the stakeholder community as a positive joint activity with the FAA. NASA is encouraged to build on these successes as technologies mature to the point where transition considerations are warranted. It is fully expected that these decisions will be made jointly with NASA and FAA senior leadership and facilitated by the JPDO to enable the most effective investment of government resources.

Demonstrations of Advanced Technology Benefits

Effective collaboration, cross-agency leadership, and strategic partnering have provided for several recent and upcoming demonstrations of advanced technology benefits. For example, NASA has been developing concepts, technologies, and procedures to support Continuous Descent Arrival (CDA) projects for improved efficiency and reduced environmental impact. A complementary project, the Enroute Descent Advisor (EDA) combines scheduling of high-density flows in terminal approach airspace with a concept known as Tailored Arrival (TA) and Airborne Precision Spacing (APS). Tailored arrivals allow aircraft to fly a continuous gliding descent at low engine power from cruise altitude to the runway, thereby minimizing fuel consumption, environmental emissions, and noise pollution.

Airborne Precision Spacing is a technology that allows the aircraft to merge and maintain spacing (and high throughput) behind other aircraft during their arrival phase while on continuous or near-continuous descent. The combinations of these capabilities, in the civil aeronautics arena, have

obvious significant user benefits. Studies from the San Francisco trials indicated that continuous descents enabled by tailored arrivals during busy traffic conditions can reduce fuel consumption by as much as 3,000 pounds (approximately 450 gallons) per flight for large aircraft, with a corresponding reduction of carbon dioxide of up to 10,000 pounds per flight.

United Airlines, Qantas Airlines, Air New Zealand and Japan Airlines are early implementers of the tailored arrivals concept at San Francisco and Los Angeles airports. UPS has determined that Merging and Spacing operations with CDAs will allow for a savings of 1 million gallons of fuel per year. A field evaluation conducted in the fall of 2009 was jointly executed by NASA and the FAA through the Efficient Flow Into Congested Airspace RTT.

The San Francisco Stratus and Flow Scheduling decision tool, scheduled for demonstration in the summer of 2010 uses a probabilistic forecast of dense fog burn-off at San Francisco International Airport to enable traffic managers to make more informed decisions on Ground Delay Programs (GDPs). Benefits include reducing the overall ground delay, unused arrival slots, and the number of aircraft affected by the GDPs. This decision support tool, if approved and implemented, allows traffic managers to more accurately plan the termination of GDPs and release aircraft for flight. Preliminary studies anticipate substantial reductions of ground delay and millions of dollars of estimated savings in fuel cost and time to airlines per year.

Another technology development focused on operational efficiency is the Oceanic In-Trial Climb and Descent Procedures using Automatic Dependent Surveillance-Broadcast (ADS-B) in non-radar airspace. These are procedures which allow participating aircraft to safely conduct climbs and descents outside radar coverage in closer proximity to nearby traffic. The procedures benefit both airlines and the traveling public by providing long-haul oceanic flights with easier access to fuel-efficient, turbulence-free altitudes. The ADS-B-based procedure has been approved by International Civil Aviation Organization, and field trials with the FAA and United Airlines are planned for 2011. Potential fuel savings are projected to be over $100,000 per airplane per year.

By providing advanced data mining tools to the aviation community, NASA collaborates on improving the ability to manage and portray vast amounts of data available from many sources. Enabled by the Aviation Safety Program, NASA has open-sourced key data mining algorithms used to analyze data from flight recorders through DASHlink, a collaborative website with over 300 members. Recently, Southwest Airlines acquired ORCA, one such advanced data mining tool. The airline plans to incorporate this tool into their daily operation quality reviews.

Conclusion

NASA has many examples of the innovative and relevant research results produced by ARMD's fundamental research programs for the past several years. NASA appreciates that the Congress has reacted favorably to the progress and contributions of the Agency's research program and has appropriated funding to support programs and projects that will develop integrated systems capabilities, higher TRL products, and technology transition processes to deliver advanced concepts to NextGen. These funds have and will allow NASA to establish a sustainable balance of robust, innovative R&D and advanced development activities that transition capabilities to industry for implementation and broad systems benefit. NASA and interagency NextGen activities continue to support U.S. economic growth and environmental improvement through advancements to aircraft and aircraft operations.

The continued close coordination of research and development activities among the JPDO member agencies will be a key to addressing the dual concerns of traffic congestion and environmental impact. Through the JPDO, the United States is now situated to perform collaborative efforts necessary to improve the level of safety, security, efficiency, quality, and affordability of the Next Generation Air Transportation System.