Dr. Karlin Toner

Opportunities and Challenges for Technology Research and Development

ATCA Technical Symposium

May 18, 2011

Atlantic City, NJ

Good afternoon and thank you, Paul, for that kind introduction. I missed the Technical Symposium last year and I'm thrilled to be back in Atlantic City for the first time since I became Director of the Joint Planning and Development Office (JPDO).

I'd like to begin with a short story—one that continues to unfold today—a story about aviation and the power of research and innovation. I'll start by asking you to imagine aviation as it was 50 years ago—long before Google and the iPhone.

It's January 1956. Popular Mechanics magazine has a story about an air traffic jam in the skies over New York City. The author writes: "Planes were stacked up in every holding pattern around the city, with more roaring in from every direction. They were backed up halfway across the country. Disgruntled passengers in Miami and Chicago grumbled about delays while tense traffic controllers in New York guided all those planes onto cleared runways."

The article looked to research and technology as solutions for safe air travel in the future and a better means of using a limited resource—the crowded space above our heads. Long-range radars would allow controllers to know where the plane is and to follow it from far outside the landing area. Transponders, if installed on commercial planes, were expected to extend the usefulness of radar, easily identifying the plane. And simulations would be used to design new flight procedures. The advent of computers could perhaps quickly and constantly calculate the path that a plane would fly to land safely, at a rate of two aircraft per minute.

Let’s fast forward to today.

Years of fierce competition and advances in technology have brought us computing capabilities that enhance our daily lives. It’s a time when technology enables electronic flight bags, network-to-network communications, and real-time information from a variety of sources.

NextGen implementation is underway. The FAA's plans call for new infrastructure and key technology demonstrations for the mid-term. Indeed, government and industry have made progress in planning, testing, and deploying NextGen capabilities. These advances recognize user perspectives, introduce satellite-based tracking, and begin to maximize system performance using equipment that is already on board many aircraft.
For example, RNAV/RNP procedures will ease congestion in metroplex areas. And ADS-B is now in place in Philadelphia, Louisville, and Juneau, Alaska, as well as the Gulf of Mexico.

Today, air travel is evolving with significant growth and opportunity in Brazil, India, and China—all countries that aren't burdened with replacing aging infrastructure as they transform. That is why coordination on policy, system standards, and operational procedures is critical for the U.S. as we modernize our air traffic control system.

At this juncture, I must ask: Is there still a need for innovation? Can research and technology push our air transportation system to the next level, keeping travelers safe, providing more airspace capacity where it is needed, and allowing growth while being mindful of the environment?

Over the last several years, the JPDO has planned and championed the long-term vision for NextGen. At the heart of this vision is the concept of Trajectory Based Operations for flight planning, surface movement, climb, cruise, and arrival using 4D trajectory management.

The concept expands the value of flight planning—recognizing that traffic volume will exceed what the air traffic controller can handle today. It relies on automation to perform separation, based on a combination of the current and future position of each aircraft. With Trajectory Based Operations, conformance is monitored both in the cockpit and with the air navigation service provider. Separation must always work. While any change in the approach to separation represents a significant cultural shift, increased collaboration through net-centric operations to improve common situational awareness will increase predictability and reduce variability. This concept is about choices, negotiations, and precise execution.

As we take steps toward the long-term NextGen vision, Trajectory Based Operations provides an opportunity to improve noise performance by more closely defining flight tracks. Precise flight paths offer savings in fuel burn on the airport surface and in the air.

However, to really provide environmental protection that allows sustained aviation growth, we must integrate air traffic control and aircraft technologies.

The JPDO, with NASA and the FAA, are taking a multi-pronged approach: operations, technology, and policy. We've seen advances in modeling techniques for aviation and the environment. We're also seeing accelerated air traffic management modernization through new surface, arrival/departure, and cruise procedures in NextGen. Environment is highly influenced by fleet turnover: How fast can we introduce new efficient engines, lighter airframes, and advanced fuels? Investments in operations and technologies will need to be balanced with appropriate national policies, standards, and market-based research. In an effort to address these issues, the JPDO's Environment Working Group brings together government and industry to discuss energy and climate-change issues for aviation.

Five to 10 years into the future, validated system analysis and design methods, with known uncertainty bounds, will be needed for advanced aircraft—those called N+2 or N+3 by NASA. Further out, the metrics and design space trade-offs for these aircraft must be well-defined. Building these new aircraft requires innovation in airframes, engines, avionics, and subsystems.

By 2025, there will be a wider range of aircraft and operator capabilities in the National Airspace System. Consider the presence of Unmanned Aircraft Systems (UAS). It is a reality. They are here and they want in! This is particularly true for defense and border protection. Other applications include fire fighting, pipeline inspection, and law enforcement—often dirty, dangerous, or dull missions. A diverse fleet of large and small UAS will accomplish a range of commercial missions not yet considered.

To advance UAS integration into NextGen, the JPDO is developing a strategic plan that will guide research, development, and demonstrations. The Departments of Defense and Homeland Security, NASA, and FAA, both as regulators and researchers, are contributing to our effort. Our first step was to bring together the technical experts to take a composite snapshot of all the UAS research going on within these agencies. We'll take a look at all the needs—training, interdiction, and civil applications—and assess whether we need to rethink the NextGen airspace.

Let's assume that for regulatory purposes it is possible to treat UAS as just another class of vehicle. That's our hypothesis. In fact, if you look at the NextGen architecture, you won't find improvements aimed specifically at UAS—because they simply fly like aircraft.

That said, research is needed to understand human factors and design standards, communications, and safe operations in the event of a lost GPS signal and more. Demonstrations must investigate a full range of UAS sizes, beginning in low density airspace, considering mixed fleet interactions, and eventually including operations in high-density terminals or metroplex areas.

The FAA's NextGen Implementation Plan rolls out ADS-B. The ability to more rapidly and precisely broadcast an aircraft's position will improve situational awareness for controllers, pilots, and remote operators. While ADS-B-Out is working now, ADS-B-In standards are also in place in the U.S. The standards enhance situational awareness for pilots about aircraft around them for airborne and airport surface use. An Aviation Rulemaking Committee is working on recommendations to the FAA regarding strategies for proceeding with ADS-B-In. So far, it appears that Interval Management applications may have a high potential value in the future.

Additionally, activities are underway between the U.S. and Europe to develop joint standards for certain ADS-B-In applications, plus In Trail Procedures (ITP). ITP is unique because it will be the first operational use of an application that is integrated with both air traffic control operations and procedures.

There is a strong need to understand the safety implications of a more diverse fleet of aircraft, increased traffic levels, and new procedures enabled by NextGen. In the very long-term, it is anticipated that automation will play a greater role in Trajectory Based Operations. The expanded use of automation will only happen if research begins to study the safety case now.

Traditionally, Validation and Verification, or V&V, focused on the latter stages of system design and implementation. For NextGen, a system of systems, it must also play a large role in the early stages.

In the mid-term, many tools and techniques that are available now will work for systems on the implementation path. The challenge in this timeframe will be to fully integrate V&V into the system acquisition process with sufficient rigor to ensure that all components planned for implementation work well together.

NextGen is characterized by potential new roles for humans and greater automation. Prior JPDO work showed that current V&V tools and techniques will not be adequate to deal with such a complex socio-technical system. Today's tools make assumptions about the independence of different parts of the system—an assumption that falls apart when you consider the many interdependencies of NextGen components. The tools we have today are also insufficient in dealing with people as an integral part of the system of systems—again a fundamental characteristic of NextGen. Finally, the V&V tools for NextGen must be able to validate the resilience of the system design, something that is beyond today's state-of-the-art.

The JPDO sees V&V as a major risk to transformation. Therefore, our Safety Working Group, a team made up of public and private sector experts, has started planning for a NextGen/Trajectory Based Operations safety case.

So where does all this leave us? Let's think back to 1956 when Popular Mechanics viewed research and technology as the doors to the future. It is the same today: Innovation remains the key driver to moving our air transportation system to the next level of safety and efficiency.

There are challenges on the road ahead. I gave you several examples of particular interest in the interagency arena: integrating UAS into NextGen, developing applications for ADS-B-In, establishing V&V methods to prove the safety case in the long-term, and designing efficient aircraft. For NextGen to cause a real transformation, there is a critical need for research and innovation—closely coupled with appropriate policies and procedures. Finally, it's imperative that we keep an eye on our nation's strategic aviation investment and maintain our historic global leadership in air transportation.

Thank you.