



# Civil Aviation Growth in the 21<sup>st</sup> Century

*Meeting Capacity and  
Environmental Challenges*



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**AIA**  
AEROSPACE INDUSTRIES  
ASSOCIATION





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## **Civil Aviation Growth in the 21st Century: Meeting Capacity and Environmental Challenges**

Civil aviation has always played a vital role in the health of the world's economy and the well-being of its inhabitants. It facilitates commerce and connects families, friends and cultures across borders and oceans the way no other mode of travel can. Civil aviation is also vital to global humanitarian missions, bringing lifesaving equipment and personnel to disaster zones around the world.

By competitive necessity, the companies that make aircraft, engines and aircraft parts have always been on the cutting edge of technological developments that make their products safer and more fuel efficient. Civil aviation manufacturers not only design the planes that fill our skies, they design and build the air traffic management infrastructure used around the world to monitor, guide and communicate with hundreds of thousands of aircraft. The global economy cannot grow without a safe and efficient civil aviation industry.

And yet, there are serious challenges to civil aviation's continued contributions toward economic success and cultural connectivity. Looming capacity constraints and growing concern over aviation's contribution to climate change have the potential to clip civil aviation's wings if not addressed.

The AIA paper herein lays out the fundamental challenge of sustainable aviation growth and offers recommendations to safely expand capacity while simultaneously reducing aviation's carbon footprint. The civil aviation industry is firmly committed to the synergistic goals of growth and environmental stewardship, but industry cannot do it alone. Governments must commit the necessary resources to implement 21st century air traffic management systems that complement and enhance private sector efforts.

We strongly believe that the policy recommendations offered here can make the skies safer and cleaner while responding to the demands of 21st century air transportation.

Sincerely,

A handwritten signature in black ink that reads 'Marion C. Blakey'. The signature is written in a cursive style with a large, prominent 'M' and 'B'.

Marion C. Blakey

President and Chief Executive Officer

## *Executive Summary*

The U.S. civil aviation industry is a keystone of the U.S. economy whose success and strength has always been tied to global economic productivity. The global recession of the past few years has reduced demand for leisure and business travel and the shipment of just-in-time goods. Many of our national aviation system's limitations—so obvious just a few years ago—have been masked by the economic slowdown. Delays are down. Carbon dioxide emissions from aircraft engines are 10 percent lower today than they were five years ago. However, as the global economy recovers, these limitations will resurface and overwhelm our national aviation infrastructure unless significant improvements are made.

Full economic recovery requires a strong civil aviation sector. Airspace capacity must meet rising demand. As civil aviation grows to meet that demand, it must do so in an environmentally sustainable way. There is general agreement that transforming our decades-old radar control system to the satellite-based Next Generation Air Transportation System (NextGen) will add capacity and dramatically improve system efficiency. It is also widely accepted that improved capacity and efficiency will produce economic and environmental benefits.

While the push for an expedited implementation and roll-out of NextGen is ongoing, hurdles remain. Funding for the required technology remains a vigorously debated issue. The transition period during which the NextGen system is brought online also presents a unique set of challenges, including what to do with legacy infrastructure once NextGen is fully implemented. Global implications also come into play, as other nations are also developing transformational air traffic management systems. All of these systems must be woven together to provide a seamless, global system based on compatible technology, standards and procedures.

Given these opportunities and challenges, AIA supports eight key recommendations and policy initiatives designed to maximize the potential benefits engendered by a vibrant civil aviation industry. Most focus on strategies that would fully deploy NextGen as quickly and economically as possible. Some of these recommendations are not new, but need renewed attention.

**Cash for carbon.** One unifying policy initiative that has the potential to simultaneously accelerate NextGen while reducing aviation's carbon footprint is the "cash for carbon" program. Developed by the FAA, the proposed program would provide grants or loans for NextGen equipage, in exchange for carbon-neutral growth (CNG) and other environmental commitments.

**Address the impending issue of FAA ground infrastructure consolidation and modernization.** Congress needs to establish a mechanism that allows for the consolidation of FAA facilities in a fair and rational way. While consolidation has raised concerns over potential air traffic controller job losses, the FAA does not envision the transition to NextGen requiring fewer controllers.

**Ensure solid integration of the requirements of the National Environmental Policy Act with NextGen-related airspace redesigns.** The FAA must develop strategies to integrate NEPA review into the NextGen implementation planning process, thereby making these important environmental reviews less costly and time-consuming.

**Extend Airport Improvement Program grant eligibility to cover NextGen enabled approaches.** Allowing AIP funds to apply to the development of new approaches employing NextGen technologies and procedures could significantly reduce expenditures on noise mitigation projects, while simultaneously accelerating NextGen deployment. This would further incentivize aircraft equipage and provide environmental benefits, and it has the potential to increase aircraft and passenger throughput, thereby generating additional airport revenue.

**Expand the FAA's Organization Designation Authorization program to include designers and installers of Performance-Based Navigation procedures.** Thousands of PBN procedures must be installed as part of NextGen's deployment, yet the FAA lacks the resources to design and install all these procedures. Consequently, there is a need to enlist the support of third parties who specialize in the design and deployment of PBN procedures.

**Ensure that the U.S. civil aviation industry has a significant voice in NextGen/SESAR harmonization.** The United States and Europe must collaborate on the technical and operational standards for their respective ATM modernization programs. Further, to achieve real progress on interoperability, industry must have a prominent role in the process and one that extends beyond technical matters.

**Encourage international forums such as the International Civil Aviation Organization to create comprehensive, global environmental standards.** To mitigate conflict over differing regional priorities and preferences, and remove the possibility of duplicative levies, fees and taxes on CO<sub>2</sub> emissions, the global civil aviation community must work through the International Civil Aviation Organization (ICAO) to develop a single, comprehensive global approach to reduce civil aviation emissions that will drive the global industry to carbon neutral growth from 2020 (CNG 2020+).

**Foster partnerships between industry and government across multiple technology areas that would help the industry achieve carbon-neutral growth by 2020.** The U.S. government should actively augment the civil aviation industry's efforts to reach CNG 2020+ by continuing to make targeted, meaningful investments in the areas of aircraft engine design, airframe design and the development of sustainable alternatives to jet fuel.

The future of civil aviation depends on the entire industry—manufacturers and operators alike—advancing technologies and procedures that will allow aircraft to operate in a more efficient and environmentally-friendly way, without compromising the outstanding safety record the industry has built for itself. In order to achieve that goal, timely and targeted contributions are required from every stakeholder that benefits directly or indirectly from a safe, efficient and environmentally responsible air transportation system.





## Introduction

Civil aviation underpins the world's social and economic infrastructure. As a vital component of the global transportation system and a major source of employment, civil aviation provides countless travelers and workers with a better way of life on a daily basis. Looking forward, such benefits will multiply dramatically as air transportation services respond to strengthening demand from around the world. However, creating an environment that fosters growth and employment, with all the benefits of a thriving aviation system, first requires addressing a number of key industry challenges. ***Safely expanding the capacity of our national airspace system and addressing growing environmental and energy concerns are the two most significant challenges facing the U.S. civil aviation industry today.*** This report will establish the relevant impact of each challenge and make policy recommendations that will ensure the least interruption to the growth of this important sector.

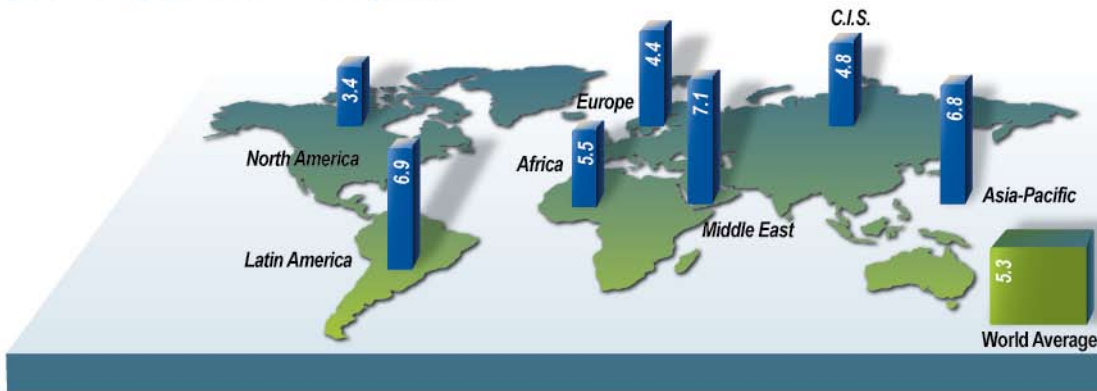
While both of these challenges pose unique technological, financial, regulatory and political hurdles, they are, in fact, inextricably linked. Modernizing the nation's air transportation system so it can safely and efficiently accommodate greater numbers of aircraft—including both manned and, increasingly, unmanned systems—is also vital to reducing the environmental impact and energy use of civil aviation and ultimately realizing the goal of a broad coalition of aviation stakeholders of carbon-neutral growth from 2020 and beyond (CNG 2020+). Indeed, growing pressure to reduce carbon dioxide (CO<sub>2</sub>) emissions, oxides of nitrogen (NO<sub>x</sub>) emissions and noise associated with aircraft operations is one of several compelling rationales for investing in air traffic management (ATM) modernization.

The imperative to overcome capacity and environmental challenges could not be stronger for the U.S. civil aviation industry, a vital contributor to the nation's economy. In the most recent economic impact survey published in December 2009, the Federal Aviation Administration (FAA) found that the sale of goods and services tied directly or indirectly to civil aviation constituted \$1.3 trillion, or about 5.6 percent of the nation's total gross domestic product (GDP). Moreover, the industry sustains nearly 12 million jobs, including many high-skilled, high-technology positions. The U.S. civil aviation manufacturing industry remains the single largest contributor to the nation's balance of trade, exporting \$70.5B and importing \$22.2B in relevant products in 2009, for a net surplus of \$48.3B.<sup>1</sup>

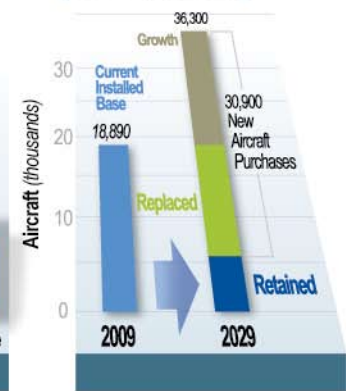


<sup>1</sup> US Census Bureau, Merchandise Trade Exports/Imports Quarterly 2009

**Projected Revenue per Passenger per Kilometer (RPK) Growth**  
by percentage from 2010 through 2029



**Installed Base**  
(2010 vs. 2029)



Source: Boeing 2010 Commercial Market Outlook

As strategically important as the industry is to the United States now, it will become even more significant as demand for air travel increases and international competition intensifies. Despite flagging air travel in the wake of the 2008 financial crisis and a global recession that persisted throughout 2009, long-range forecasts from a wide spectrum of sources indicate robust demand for air travel over the next two decades. Some regions of the world will fare better than others, as changing wealth demographics and the build-out of aviation infrastructure in emerging markets make air travel more accessible to greater numbers of individuals. Even in mature markets like the United States and Europe, moderate but consistent growth in air travel demand is projected. These mature markets also have the persistent need to recapitalize aging fleets with newer, more fuel-efficient aircraft, generating replacement demand on top of growth for fleet expansion.



Worldwide growth in demand for aviation goods and services will not be limited to the large commercial transport sector. As the global economy recovers and a number of new aircraft models enter the market, demand for general aviation products—from the large-cabin, global business jet to the single-engine piston-powered aircraft—should slowly and steadily improve.

Regulatory policies and other initiatives that seek to address the substantial but surmountable hurdles posed by an aging, ground-based air traffic management system and increasingly stringent environmental standards will help foster the health and competitiveness of the U.S. civil aviation industry. This will ensure the nation can capitalize on projected growth in demand for aviation products and related services over the coming years.

## Capacity and the Importance of NextGen

The United States' ability to safely and efficiently handle more aircraft of all types will not be achieved through incremental modernization but by a significant transformation of the U.S. national airspace system. The FAA's Next Generation Air Transportation System (NextGen) is the program to achieve that transformation.

**“More than a single system, NextGen is a portfolio of technology, equipment, procedures and policies aimed at facilitating the largest airspace transformation in the history of aviation.”**

*– the late William DeCota, former Aviation Department Director, The Port Authority of New York and New Jersey*

will ultimately enable new procedures that will allow more aircraft to fly closer together on more direct routes. The safer, more efficient use of airspace through NextGen will reduce delays and provide significant economic and environmental benefits through reduced carbon emissions, fuel consumption and noise.

A fundamental enabling technology of NextGen is Automatic Dependent Surveillance-Broadcast (ADS-B), which uses GPS technology to pinpoint an aircraft's precise location and constantly broadcast that information and other critical data (altitude and air speed, for example) to nearby aircraft and air traffic controllers. With ADS-B, for the first time, both pilots and controllers will see the same real-time displays of air traffic. This breakthrough in the provision of common, situational awareness in the cockpit and the control tower will enhance safety and enable more efficient use of airspace.

ADS-B is undergoing a phased implementation. Installation of 794 ADS-B ground-based transmitters—largely achieving coverage throughout the continental United States—has a contracted completion date of 2013. The project is currently on schedule and under budget. The operational system is being deployed on a limited basis around the nation, with four test sites in geographically diverse areas with unique airspace environments demonstrating the service.<sup>2</sup> Operators in these regions are already reporting significant, tangible benefits directly attributable to the system, including fuel cost savings and reduced delays.

Under development for a number of years, NextGen will move the nation from reliance on an aging, radar-based system of air traffic control to a satellite-based system of air traffic management. By leveraging Global Positioning System (GPS) technology—along with breakthroughs in everything from weather forecasting to data networking to digital communications—the NextGen system

**NextGen is the satellite-based communications, navigation and surveillance system (CNS) that will integrate performance-based navigation (PBN) routes and procedures like tailored arrivals and departures, required navigation procedures (RNP), Area Navigation (RNAV), Continuous Descent Arrivals (CDA), and 4-Dimensional Trajectories (4DT).**



<sup>2</sup> Test sites located in Alaska, the Houston / Gulf of Mexico region, Louisville, KY, and Philadelphia, PA.

For the full benefits of ADS-B to be realized in a given area, however, a “critical mass” of operators must be equipped with the capability.<sup>3</sup> For example, proximate spacing is only possible if all aircraft have improved position reporting, as an aircraft not equipped with ADS-B would be “invisible” to the traffic receiver of another aircraft. Not surprisingly, the timing and financing of the equipage of aircraft with ADS-B capability is a core concern of both the FAA and aircraft operators, including airlines and the general aviation community, as well as equipment manufacturers.

## The Equipage Challenge



The FAA estimates its own costs associated with full implementation of ADS-B and the broader NextGen architecture by 2025 will total between \$15B and \$22B. The agency also acknowledges an additional \$14B to \$20B will likely be incurred by the airlines and other users of the national airspace system who must retrofit their aircraft to make them NextGen compatible. Leading avionics manufacturers and other industry players believe the FAA's equipage estimates are too high. Industry experts have estimated the cost to equip the entire civil aviation fleet of commercial and general aviation aircraft with ADS-B will be significantly less than \$12B. Moreover, these estimates could drop substantially once mass production of the required equipment is achieved. Whether the final price to equip is under \$12B or over \$20B, it is clearly a sizable investment for an airline industry that continues to struggle to return to profitability and for a general aviation community that counts individual aircraft owner-operators who fly recreationally among its core constituency.

In the near-term, aircraft equipage for ADS-B and other NextGen technologies will remain largely voluntary, with individual airlines and system users conducting internal cost-benefit analyses to support or reject the business case for investment. But because the maximum potential value of the system can only be realized for all operators and the public with full deployment and equipage, this fragmented, individualized approach will ultimately give way to a full equipage mandate.

In March 2010, the FAA issued a final rule to require installation of ADS-B “Out” equipment by 2020 for all aircraft flying in Class A, B and C airspace.<sup>4</sup> ADS-B “Out” refers to equipment that allows the broadcast of information from the aircraft to ground stations and aircraft equipped with complementary receiving equipment, known as ADS-B “In.” Because ADS-B “In” capability provides additional user benefits—equipped aircraft will eventually be able to self-separate—but adds substantially to the cost of equipage, the FAA has thus far chosen not to mandate its installation.

While the FAA mandate of ADS-B “Out” effectively settles the timing of the equipage issue, it leaves the more contentious issue of how to fund the build-out of the airborne component of the system unresolved. The user community remains divided, with some airlines already moving aggressively to equip their fleets and others making public declarations that the costs of the system clearly precede the benefits by years. Nevertheless, government support for equipage—either through direct funding or by some other, more creative financial incentives—would obviously be welcomed by the majority of the user community.

<sup>3</sup> Gerald L. Dillingham, Ph.D., *Government Accountability Office (GAO), House Transportation and Infrastructure Subcommittee on Aviation. “Hearing on ATC Modernization and NextGen: Near-Term Achievable Goals.” Testimony given May 20, 2009*

<sup>4</sup> *This effectively covers all large commercial transports, business jets and turboprops, but largely excludes the lower-end, piston-powered portion of the general aviation fleet that does not tend to use the more complex airspace.*

## The Infrastructure Challenge

The FAA has yet to provide a plan for the disposal of legacy air traffic management infrastructure once NextGen is fully implemented. Such a plan is vital to realizing the full efficiencies of the new system. It is also essential to reduce the overall cost to the government, which must maintain both systems until the old one can be decommissioned.

The issue of facilities consolidation and closure is nearly always a politically sensitive one, since the rationalization of assets and infrastructure in other sectors often portends job losses and other potentially negative impacts on local economies. But in the case of our national aviation infrastructure, many believe as NexGen is implemented and system capacity doubles or triples, the same or an even larger number of air traffic controllers and technical employees<sup>5</sup> will be needed. Moreover, the economic case for FAA facilities rationalization is compelling, as the cost of operating redundant systems beyond what is necessary to ensure a safe transition to NextGen will be increasingly prohibitive to FAA, drawing resources from other pressing aviation safety and infrastructure needs and further burdening the taxpayer.

The Department of Defense (DOD) has a process used to close excess military installations and realign assets to reduce its overall operations and maintenance budget and achieve efficiencies mandated by both the department and Congress. The process removes politics from the equation by using an independent panel of experts whose only criterion for deciding what bases to close or realign is military need. Its recommendations are binding unless Congress passes a joint resolution of disapproval.

DOD has used this approach several times, and for the most part it has been widely regarded as a successful, apolitical and objective approach to facilities consolidation. Although Congress has not yet seen the need to legislate a mechanism to rationalize FAA facilities and resources, agency funding constraints and the growing imperative to realize the full efficiencies of NextGen may be the impetus to address the issue.

## The International Harmonization Challenge

NextGen will be international in scope, ultimately necessitating harmonization with other air traffic management systems around the world. The importance of harmonization and coordination on ATM modernization programs, particularly between the United States and Europe, cannot be overstated. The regions constitute the world's two most complex and congested airspace blocks and there is significant traffic between the two continents.

To extend the full benefits of NextGen to international operations requires a seamless, global system, using compatible equipment and procedures. To achieve such a harmonized system, the FAA is working with various organizations in Europe to address the issue of interoperability between NextGen and its European counterpart, the Single European Sky Air Traffic Management Research (SESAR) program. The International Civil Aviation Organization (ICAO) has a forum dedicated to NextGen/SESAR harmonization, reflecting the importance of the issue to the international aviation community.

**“We must make sure that interoperability is the order of the day.”**

– J. Randolph Babbitt,  
FAA Administrator

<sup>5</sup> The relevant technical workforce includes systems specialists, electronics technicians and computer specialists who install, maintain, repair, and certify the hardware and software that comprise the air traffic control system.



Though the NextGen and SESAR systems need not be identical, harmonization through the development of common technical and operational standards will ensure that similarly equipped aircraft can safely fly in both systems, a concern obviously paramount to both operators and regulators. Harmonization is also a critical issue for the manufacturing base who will ultimately build out the ground and airborne components of the new systems. Manufacturers of advanced communications, navigation and surveillance systems and other components that form the backbone of ATM modernization programs would clearly benefit from being able to offer solutions that meet the requirements of both systems, increasing the total size of their addressable market and driving down costs. Ensuring interoperability between the two systems will remove yet another obstacle cited by operators to moving forward with equipage. Manufacturers will likewise be able to design and produce systems compatible with both programs, which may offer economies of scale that should ultimately drive down the overall cost of equipage.

On the other hand, the cost of delaying the critical issue of harmonization could be substantial, stalling modernization efforts on both sides of the Atlantic, with negative impacts around the globe. Aircraft operators will be reluctant to retrofit aircraft with new systems without the assurance they will work safely and seamlessly across both systems. This will forestall the realization of capacity and environmental benefits expected from the deployment of both systems and further burden airspace managers, operators and manufacturers alike.

A Memorandum of Cooperation (MOC) in civil aviation research and development (R&D) was signed in June 2010 between the FAA and the European Commission (EC) in response to the user community's demands for additional coordination in the area of NextGen/SESAR interoperability. Considering the comparable goals of both programs, airspace users are especially keen to avoid costly duplication of airborne equipment. In order to facilitate interoperability between both future ATM systems, the MOC establishes a binding framework for meaningful technical cooperation in this area.

While nearly all relevant parties agree on the importance of harmonization, the proverbial "devil is in the details." NextGen and SESAR may be working towards strategic alignment, but on a tactical level, there remain significant disconnects between the two programs. For example, there is a five-year gap between the NextGen and SESAR implementation timelines, with the latter targeting an earlier date of 2020 for full operation and NextGen slated for full deployment in 2025. This gap has a cascading effect on other important milestones like ADS-B

### USA's NextGen vs. EU's SESAR: Additional Disconnects

Technology or Operational Area	United States/NextGen 	European Union/SESAR 
<b>Surveillance Systems</b>	Plans to maintain SSR as primary system, with phase-in of ADS-B	Plans to use enhanced Mode-S surveillance systems to supplement existing SSR
<b>Approach Procedures</b>	Moving aggressively to adopt LPV, RNP AR, and RNAV	Has not evolved as quickly with these approaches
<b>Terminal Procedures</b>	Aggressive movement with RNAV-2 and RNAV-1 for terminal RNAV procedures	Much slower introduction of precision RNAV into terminal management areas

“Out” equipage. Europe has put in place regulations requiring all new aircraft operating in its airspace to be ADS-B “Out” equipped by 2015, five years earlier than the FAA mandate.<sup>6</sup> Under this scenario, U.S. carriers operating to and from Europe would be forced to equip early, with potentially less sophisticated technology.

The differences between the two systems extend well beyond timelines and equipage mandates. On a fundamental level, NextGen is a more comprehensive program designed to improve the “curb-to-curb” air travel experience by covering the areas of capacity, safety, security and environment. SESAR addresses these areas, but is more narrowly-focused on “gate-to-gate” activity.

Moreover, the U.S. has two and a half times as many general aviation aircraft as the rest of the world combined. This presents a unique challenge in terms of equipage mandates as many of these aircraft operate exclusively in clear weather, away from congested airspace and without the need for sophisticated instrumentation. This distinctive feature of the U.S. national airspace system amplifies the other variances between the United States and Europe, which include different technology and procedural preferences, implementation and adoption rates.

Not since the transition from visual to instrument flying has the timing and coordination of new technology implementation been more important. Even if all satellite navigation and surveillance systems around the world had identical standards and were installed at the same time, the challenge of equipping more than 28,000 commercial aircraft—and many multiples of that in the general aviation community—would still be daunting. Accomplishing that monumental task when systems like NextGen and SESAR have different standards and installation mandates becomes exponentially more complex and significantly more expensive.



## Potential Lessons from Reduced Vertical Separation Minima (RVSM)

There is, however, precedent for successful harmonization and implementation of a smaller-scale airspace modernization-related initiative from which relevant stakeholders in the Next-Gen/SESAR process may derive some “lessons learned.” With the advent of more sophisticated aircraft equipment—including advanced air data computers and autopilots which enable aircraft to maintain a set altitude with more precision—ICAO proposed in the mid-1990s that the standard vertical separation required between aircraft flying at levels between FL290 (29,000 feet) and FL410 (41,000 feet) be reduced from 2,000 feet to 1,000 feet. Between 1997 and 2008, there was an internationally coordinated rollout of RVSM. The result has been that operators around the world went to RVSM on time, seamlessly, and with significant capacity and environmental improvements.

<sup>6</sup> For aircraft already in operation, Europe is allowing an extra three years for retrofit. The FAA mandate for equipage by 2020 covers all aircraft, both new deliveries and those in the existing installed base.

## The Safety Benefits of NextGen

NextGen is a comprehensive overhaul of the nation's air traffic management system. As such, it poses significant opportunities to improve upon the excellent safety record of the industry. As NextGen is implemented, government and industry must systematically manage the inherent risks associated with introducing new technology into an existing operating system. There are opportunities to greatly improve safety through more reliable and accurate technology, better operational procedures, and the use of information—particularly regarding weather conditions—as NextGen expands our capacity and efficiency. For example, the improved navigational, surveillance, and communications capabilities—all of which improve pilot and controller situational awareness—can be leveraged to reduce vertical, lateral and in-trail separation standards while also improving the level of safety provided today. Similarly, airport surface management systems, that will be part of NextGen, will inherently enhance surface safety while simultaneously improving the efficiency of surface movements of aircraft and ground vehicles at airports. The FAA will need to put mechanisms and processes in place that will ensure these safety enhancements are part of the upfront design and deployment.

## *Aviation and the Environment: Towards Cleaner, Quieter Skies*

Environmental concerns related to civil aviation typically fall into one of two major categories: emissions and noise. While noise and NO<sub>x</sub> are generally thought of as “local” environmental issues—and CO<sub>2</sub> and other greenhouse gas (GHG) emissions more “global”—all are complex and all have at one time or another engendered intense international discussions. Emissions—particularly CO<sub>2</sub>, a major contributor to climate change—has attracted global attention in recent years. Efforts to reduce CO<sub>2</sub> emissions require as a first step an effective way to quantify and monitor its presence. In the end, both noise and emissions are equally challenging to address from both a technological and political perspective.

**“Today we have taken a major step forward by committing to a global cap on our emissions in 2020. After this date, aviation’s emissions will not grow even as demand increases. Airlines are the first global industry to make such a bold commitment.”**

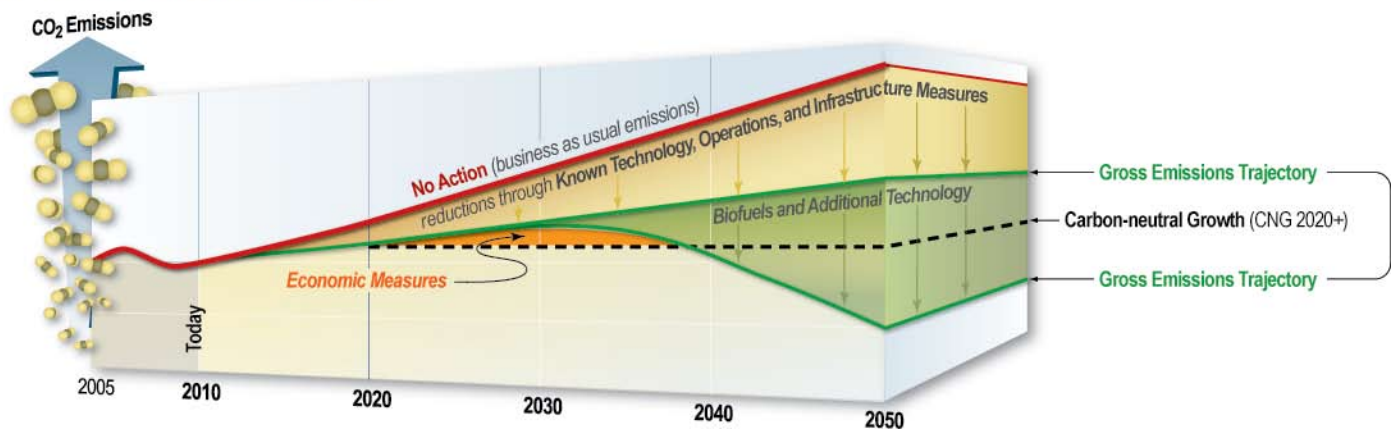
– Giovanni Bisignani,  
IATA Director General and CEO

While the science around civil aviation's role in global climate change continues to evolve, it is widely accepted by industry participants and environmental stakeholders alike that the sector globally contributes a relatively modest two percent of total man-made carbon emissions. Nevertheless, the aviation industry in 2009 voluntarily set for itself the ambitious goal of CNG 2020+, demonstrating a strong commitment to environmental stewardship.<sup>7</sup>

Achieving such an aggressive goal for reduced emissions demands a multi-faceted approach that covers four key areas: more fuel-efficient operational practices; more efficient ATM systems like NextGen and SESAR; technological improvements in aircraft fuel efficiency, including new engine, airframe and alternative fuel technologies; and market-based mechanisms, such as carbon trading schemes and other, more innovative approaches.

<sup>7</sup> Data provided by the Air Transport Action Group, May 2009

## Emissions Reduction Roadmap



## Operational Improvements and ATM Modernization

While many airlines have long-standing operating policies and procedures with the objective of conserving fuel, record high oil prices during the spring and summer of 2008 prompted even more aggressive adoption of such approaches. Operational changes that reduce aircraft fuel burn and associated emissions include: taxiing on one engine when weather permits; using super tugs on the ground to reposition aircraft in lieu of powering up an engine when feasible; the redistribution of belly cargo to change weight-and-balance to improve fuel performance; and the use of ground power to provide electricity and air conditioning to the aircraft when parked, rather than using the aircraft's auxiliary power unit (APU).

The use of more sophisticated flight-planning software has helped reduce en route fuel consumption and enabled airlines to avoid burning extra fuel while awaiting a gate. Some airlines have added life vests on certain domestic routes, adding modest weight but ultimately generating fuel burn and emissions reductions by enabling more direct over-water routings. Other airlines have deployed decision-support tools that provide pilots with coordinated speed adjustments, allowing more evenly spaced landings and fuel efficient continuous decent arrivals (CDAs).

## Environmental Benefits of NextGen

While all of these operational and procedural changes can add up to sizable reductions in emissions, the system-wide operational improvements ultimately afforded by NextGen will take emissions and noise reduction to a new level. By fostering more efficient aircraft operations through all phases of flight, literally from gate to gate, FAA analyses indicate that full implementation of NextGen could reduce aircraft GHG emissions up to 12 percent by 2025—the equivalent of taking 2.2 million cars off the road for one year.<sup>8</sup>

NextGen also offers promise in addressing noise, the other pressing environmental issue associated with aircraft operations. The precision of the technology that allows for CDAs and required navigation performance (RNP) departures and arrivals enables flight routing along precise ground paths that minimize an aircraft's noise signature on takeoffs and descents.

<sup>8</sup> Figure cited by Dr. Gerald L. Dillingham in May 2008 testimony before the House Transportation and Infrastructure Subcommittee on Aviation.

## The Role of the NEPA Process

The environmental benefits of NextGen—including both reduced emissions and noise—are obvious and compelling, but require innovative policy solutions to embedded obstacles before those benefits can be fully realized. The redesign of terminal airspace by the FAA—which is necessary to accommodate CDAs, tailored arrivals and quieter RNP and area navigation (RNAV) departures—requires compliance with the National Environmental Policy Act (NEPA). NEPA is effectively the nation’s charter for considering potential environmental impacts before an action is implemented. It requires consideration of lower-impact alternatives and it stipulates disclosure of environmental information for all federal agency actions with the potential to impact the human or natural environment. Public and other government agency involvement is required in the process and concerns raised by the public or other agencies must be addressed prior to any federal agency reaching a decision on a proposed action.

The level of environmental review required to comply with NEPA has been established by the President’s Council on Environmental Quality (CEQ) and falls into four general categories: emergency procedures, categorical exclusion, environmental assessment (EA) and environmental impact statement (EIS). Emergency procedures cover highly exceptional circumstances where immediate action may be taken by the FAA (or any other federal agency) without first meeting NEPA requirements. With the exception of

a Temporary Flight Restriction, airspace-related actions typically do not fall within the emergency procedures category.

The FAA also possesses the authority to determine that actions involving the establishment, modification, or application of airspace and air traffic procedures fall under what is known as a “categorical exclusion,” sometimes referred to as CATEX. With this authority, the FAA can determine—based on past experience with similar actions—that the airspace redesign in question does not have an adverse impact on the

environment, thereby limiting the need for a more time-consuming environmental review as long as there are no extraordinary circumstances. The FAA’s experience with airspace redesigns indicates that, while there may be overall environmental benefits, there are typically potentially negative impacts to some areas that must be assessed. Moreover, most airspace redesigns have historically not been aimed at reducing noise and emissions, but rather at alleviating air traffic congestion. Improving safety and efficiency, while limiting environmental impacts, has been the primary driver. In short, the FAA has been appropriately judicious in its use of CATEX for airspace redesigns.

More often than not, airspace redesigns require an EA—which applies to a project or proposal not initially thought to have the potential to cause significant environmental



**“[The problem is] the bureaucracy and red tape surrounding the administration of NEPA. Current application of the environmental review process at FAA makes it practically impossible to implement meaningful change—even if that change improves the quality of the environment.”**

– Lorraine Bolsinger,  
GE Aviation Systems President and CEO

impact—or an EIS, for proposals that do rise to the level of a major federal action with the potential to cause significant environmental impact. An EIS thus requires a detailed assessment of environmental impacts, consideration of reasonable alternatives to the proposed action and extensive public involvement. EAs require reviews by other agencies, as well as public comment, but they are significantly less time-consuming and less costly than the lengthier EIS. Every EA must result in a “finding of no significant impact” (FONSI); otherwise, the more detailed EIS will be required to move forward with the project.

Based on 2009 data, the average duration of NEPA reviews for FAA actions involving EAs was 1.5 years. The duration for NEPA reviews involving EISs was four to five years. The costs of such reviews can also be substantial, depending on the type of NEPA review and the complexity of the proposal. The EA submitted for the Houston Area Air Traffic System redesign, for example, took 1.2 years for approval at a cost of roughly \$1M. In contrast, the EIS required for the proposed New York/New Jersey/Philadelphia Metropolitan Airspace Redesign Project took eight years and cost \$17M.<sup>9</sup> In some cases, congressional input can result in additional options to the proposed action being considered, thereby increasing the number of public meetings and extending the length of the review process.

While industry stakeholders in NextGen implementation agree on the importance of the NEPA process, many are frustrated with the time-consuming and costly nature of the reviews and consider it a major impediment to the timely rollout of the system. Given the volume of expected airspace redesigns required to maximize the benefits of the system, and the potential for NextGen-related NEPA reviews to strain FAA resources, industry would like to see additional efforts to expedite the process.

## Technology Developments

Technological breakthroughs in airframe and engine design can also spur the development of more environmentally-friendly aircraft. Indeed, the aircraft entering today’s fleet that constitute the cutting edge of both airframe technology and engine design are 70 percent more fuel efficient than 40 years ago, a remarkable testament to the innovation of the civil aviation manufacturing base and its responsiveness to its customer community.

Industry continues to work on new propulsion solutions that afford both cleaner and quieter aircraft engines and new airframe concepts using new designs and materials that will make aircraft lighter, quieter and more environmentally-friendly. This work is being pursued both internally at individual companies—Boeing, Bombardier, GE, Pratt & Whitney, and Honeywell, among others—and in collaboration with various government agencies like the FAA, DOD and NASA.



<sup>9</sup> Data provided by the Air Transport Action Group, May 2009

One such collaborative effort between industry and government is the FAA's Continuous Lower Energy, Emissions and Noise (CLEEN) program, which was created to help industry develop and demonstrate new technologies to meet a set of environmental goals, including: the reduction of fuel burn by 33 percent, which will also reduce CO<sub>2</sub> emissions; the reduction of landing and takeoff NO<sub>x</sub> emissions by 60 percent relative to 2004 ICAO standards; the reduction of noise levels by 32 decibels relative to the current noise standard; and the increased use of more sustainable jet fuels, with transition strategies that do not require significant aircraft or engine modification.

**“The FAA is contracting with the aviation community to aggressively meet critical environmental and energy goals...The CLEEN program is a central piece of the NextGen air traffic modernization environmental strategy.”**

– J. Randolph Babbitt,  
FAA Administrator

The FAA recently awarded \$125M in contracts to five companies—including Boeing, GE, Honeywell, Pratt & Whitney, and Rolls-Royce North America—all of whom will commit internal R&D funding that matches or exceeds that provided by the FAA to advance a number of relevant technologies. CLEEN is ultimately aimed at projects and technologies that could be introduced into aircraft as early as 2015.

Boeing's work on the CLEEN program focuses

on the development of adaptive wing trailing edges, which would allow an aircraft's wing configuration to be optimized for different phases of flight, not just cruise. The technology could also enable quieter takeoffs and landings. Pratt & Whitney will match its CLEEN funding to support ongoing development of its geared turbofan technology, which has already been selected as the powerplant of choice for several new aircraft platforms, including the Mitsubishi Regional Jet (MRJ) and the Bombardier CSeries. The engine, scheduled to enter service in 2013, is expected to provide double-digit improvements in fuel efficiency and emissions with a 50 percent reduction in noise over today's engines.

GE will also direct some of its CLEEN funding at existing engine technology development programs, including the new CFMI LEAP-X engine for narrowbody aircraft, and a next-generation engine for regional and business jets. GE projects the development of a new core for both engines will offer up to 16 percent better fuel efficiency than its best engines in service today. GE will also match additional CLEEN funding to support demonstrations of advanced Flight Management System–Air Traffic Management (FMS-ATM) technology in partnership with Alaska Airlines. The technology can enable aircraft to fly more optimum trajectories that result in less fuel burn, emissions and noise.

GE is also pursuing open rotor engine designs, as it did in the 1980s. The company believes open rotor technology has the ability to reduce fuel burn by 26 percent over current generation conventional engines. But the designs still pose significant noise and aircraft integration challenges. GE will use CLEEN funding to support blade aero-acoustic and pitch change mechanism research to find solutions to these noise issues.



In addition to breakthroughs in engine technology, new airframe technology—particularly the development and use of advanced composite materials—promise significant environmental benefits. The use of composites in aerostructures has grown significantly over the last 10 years, as confidence in the technology has grown and manufacturing methods have improved. With the design of the 787, Boeing has ushered in a potential sea-change in the use of composites for future aircraft, replacing traditional aluminum alloys with carbon-fiber and other advanced composite materials in critical applications including the fuselage and wings. The chief environmental benefit of the latest generation of composites is that they offer similar strength of traditional metallic materials like aluminum, but with significant weight savings. Reduced aircraft weight translates into less fuel burn and fewer emissions over the same route of flight.

There will doubtless be further breakthroughs in engine and airframe designs—and the development and incorporation of new, lightweight materials—that will help the civil aviation industry reach its ambitious environmental targets. However, another, relatively new area of technology development—one focused on the creation and use of sustainable alternatives to traditional jet fuel—may hold even more promise in dramatically reducing the amount of CO<sub>2</sub> and other emissions generated by aircraft.

## The Promise of Sustainable Biofuels

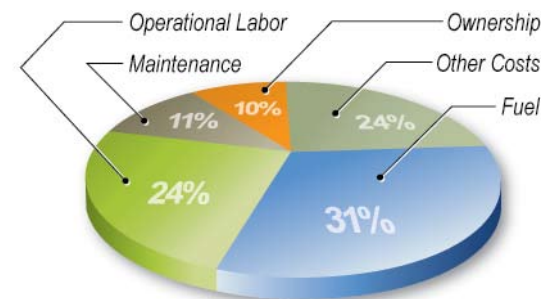
Fuel is one of the largest operating expenses incurred by the aviation industry and the volatility of crude oil prices makes it particularly challenging for large airline operators to manage and budget for this critical cost component. The development of sustainable, secure biofuels—produced from renewable, globally abundant biological resources rather than traditional fossil fuels like coal, oil and natural gas—may reduce the industry’s exposure to oil price fluctuations and have far-reaching environmental benefits, while at the same time enhancing U.S. energy security. And due to the lack of alternative propulsion sources, aviation—unique among transportation modes—has a clear need for biofuels development.

Biofuels are generally derived from feedstocks from one of two key sources: plants with high sugar content (corn and sugar cane, for example) and plants that are rich in bio-derived oils (including soybeans, algae and other less well-known species like jatropha and camelina). Biofuels produced from the first source of feedstocks, including ethanol, are generally referred to as first-generation biofuels and they tend to be ill-suited for high-performance applications like aviation. On the other hand, second-generation biofuels made from bio-derived oil can be converted through chemical processes to make high-quality jet and diesel fuel.

## Percent Materials by Weight

	Boeing 777	Airbus A380	Boeing 787
Aluminum	70%	61%	20%
Composites	12%	22%	50%
Titanium & Steel	16%	10%	25%
Misc.	2%	7%	5%

## Aircraft Operational Costs



Source: International Air Transport Association (IATA)

**“We’re dealing with technologies that can contribute on a significant level to achieving carbon neutral growth—it’s happening and it’s happening now.”**

– Richard Altman, *Commercial Aviation Alternative Fuels Initiative (CAAFI) Executive Director*



Another important distinction between first- and second-generation biofuels is that the former rely on food crop sources and raise potentially contentious issues of land resource allocation, impact on food prices and local environmental concerns. In contrast, many second-generation biofuels have the potential to be grown in a range of

locations—from salt water to arid desert climates—and can be derived from sources that do not directly compete for resources with food supplies.

While biofuels are not entirely carbon-neutral, over their lifecycle they have the potential to reduce CO<sub>2</sub> emissions by up to 85 percent over conventional jet fuel depending on the feedstock selected and processing methodology. Because they contain fewer impurities, they also have the ability to reduce other emissions like sulfur dioxide and soot that have local air quality impacts.

While each of the second-generation biofuels being researched and demonstrated for aviation use has the potential to deliver “greener” and potentially less expensive fuel in sufficiently large quantities, it is unlikely aviation will rely on just one type of feedstock. The best alternative fuel will likely depend on location (chiefly, geographic proximity to a particular feedstock) and the availability of processing technology. However, a diversified supply base may be a substantial positive for the airline industry, offering a fuel source with significantly less price volatility than jet fuel.

It will take many years, more investment in R&D and scaling up of production and refinery capacity before biofuels can completely supplant traditional, kerosene-based jet fuel for large scale use in civil aviation. Public policy initiatives aimed at growers, processors and end users are important in enabling this nascent industry to commercialize at the rate needed to enable the industry to meet its aggressive CO<sub>2</sub> reduction goals. But airlines are already showing signs of commitment to advancing their development. Nearly 20 major carriers—including several of the United States’ largest passenger and cargo airlines—have entered into nonbinding purchasing commitments with producers of alternative fuels. Assuming successful development, production and certification of these fuels—including biofuels derived from camelina oils and other feedstocks as well as other synthetic fuels—the airlines would then enter into more formal contractual arrangements to source at least a portion of their fleet fuel requirements from these suppliers.

Most experts agree that airlines would only need to transition 1 to 1.5 percent of their total fuel consumption to biofuels in order for biofuels to attain commercial viability, the point at which there is estimated to be sufficient demand to entice suppliers to make necessary investments in scalability and infrastructure to meet airline needs. On the latter point, one of the most attractive aspects of aviation applications for biofuels is that the distribution system for transporting fuel from its original source to the fuel tank of an

aircraft is much smaller and infinitely less complex than the fuel distribution system for other modes of transportation. For example, there are nearly 162,000 retail gas stations in the United States, whereas roughly 35 airports handle more than 90 percent of the world's airline operations. In short, the integration of biofuels into the aviation system is substantially easier than it would be for a less centralized public fuel delivery system.<sup>10</sup>

## Market-Based Mechanisms

The use of market- or economic-based solutions like “cap-and-trade” to address environmental issues has been discussed for many years. In theory, the cap-and-trade approach appears simple and effective—and, therefore, highly attractive. It is an environmental policy whereby the government sets an annual cap on CO<sub>2</sub> emissions, then creates a financial market in which companies can trade permits to emit those gases. The concept is based on the fundamental premise that businesses that can cut their emissions most cheaply will be incentivized to do so and will sell their permits to businesses that cannot.

Cap and trade, like all market mechanisms, is intended to provide operators an economic incentive to be more energy efficient. Civil aviation has not needed an artificial market incentive because fuel efficiency has always been a first tier market motivation. In fact, in its 1999 Special Report, “Aviation and the Global Atmosphere,” the United Nations’ Intergovernmental Panel on Climate Change (IPCC) said that while some economic instruments could successfully contribute to enhanced fuel efficiencies, “[t]here is uncertainty about the appropriate level at which any environmental levy should be set.”<sup>11</sup> That is why the global aviation industry has steadfastly maintained that the first three pillars of environmental improvements—technology, operational efficiency and ATM improvements—must be pursued before market measures are put in place for civil aviation.

In practice, cap-and-trade schemes have proven far more complicated and their overall effectiveness in achieving the goal of reducing CO<sub>2</sub> emissions remains questionable. The European Union (EU) instituted an Emissions Trading Scheme (ETS) in 2005 that remains the most comprehensive CO<sub>2</sub> trading program in the world—covering roughly 12,000 installations primarily in the power generation, iron and steel, glass and cement manufacturing industries, representing approximately 40 percent of total EU CO<sub>2</sub> emissions—but its efficacy has yet to be proven. According to a 2008 report by the Government Accountability Office (GAO), Phase I of ETS was to establish a robust market for carbon emissions allowances, but the initial supply of allowances exceeded demand, which resulted in a price collapse. Moreover, a lack of baseline emissions data makes it impossible to know if emissions have actually been reduced by Phase I implementation.<sup>12</sup> In short, the question of whether ETS is achieving its overall environmental objectives has yet to be definitively answered.

In the United States, cap-and-trade approaches are further complicated by domestic political considerations, with lawmakers struggling to balance environmental goals with a

<sup>10</sup> Data provided by the Air Transport Action Group, May 2009

<sup>11</sup> April, 1999, IPCC Special Report, “Aviation and the Global Atmosphere”, chapter 10.4.5.

<sup>12</sup> The U.S. General Accountability Office report. *International Climate Change Programs: Lessons Learned from the European Union’s Emissions Trading Scheme and the Kyoto Protocol’s Clean Development Mechanism discusses three main lessons that can be learned from the ETS scheme: 1) accurate emissions data is needed to set effective caps; 2) trading programs should influence technology investment; 3) the method of allocating allowances has economic effects.*



desire to protect and promote nationally or locally important industries like coal and avoid driving energy prices higher for the public. In the end, a comprehensive climate bill failed to advance in 2010 and cap-and-trade has fallen out of favor among many lawmakers on both sides of the political spectrum.

## The Problem with Regional Solutions to Climate Change

Further adding to the complexity of the environmental issue is a myriad of organizations at the domestic, regional and international levels involved in the shaping of aviation environmental policies and regulations. As aviation environmental policy continues to evolve, it is becoming increasingly clear that a patchwork of regional schemes is ill-suited to addressing this inherently global industry. The current situation with the European Union's ETS perhaps best exemplifies the problems with regional approaches to mitigating the environmental impact of aircraft operations.

As noted, the ETS is the most expansive carbon trading program in existence today; and in 2008, the European Union voted to further expand its coverage to aviation. Although the expansion does not take effect until 2012, its anticipated negative economic impact on foreign air carriers has already provoked one lawsuit and more are sure to follow. The measure will impose a cap on aircraft emissions in EU airspace and penalize aircraft operators that exceed their allowance, regardless of the operators' country of origin. Moreover, airlines will have to buy allowances for the carbon emitted during the entire distance of flights that land or take off in the European Union. Airlines object to the plan, arguing that on a flight from Los Angeles to London, for example, the majority of the emissions would occur outside EU airspace. Equally worrisome is the fact that there are no protections against a multitude of levies from other countries—including the European Union's own individual member states—on the same emissions.

The EU ETS clearly poses a financial threat to U.S. airlines that, following the conclusion of the initial EU-U.S. Open Skies agreement in 2007, have dramatically increased their flights to and from Europe.<sup>13</sup> The United States Air Transport Association (ATA) estimates that U.S. airlines would pay several billion dollars in carbon credits in 2012 under the scheme.

**“The unilateral extension of the EU ETS to international aviation is contrary to international law both as an extraterritorial action and an improper tax or charge. It also clearly stands in the way of an appropriate and effective global solution.”**

– Nancy Young,  
ATA Vice President, Environmental Affairs

The ATA and three of its member airlines have challenged the legality of the unilateral extension of the EU ETS to international aviation, arguing that it violates international law as established by the Chicago Convention, along with the Kyoto Protocol and the terms of the U.S.-EU Open Skies agreement. The suit, originally filed in the United Kingdom in December 2009, has been referred by the English High Court of Justice to the European Court of Justice (ECJ). The ATA and individual airlines serving as plaintiffs in the case consider the referral a small victory, as the ECJ has the authority to rule on the Europe-wide directive. Regardless of the ultimate outcome of the case, the issues it raises provide perhaps the most compelling rationale for a global approach to aviation emissions monitoring.

<sup>13</sup> The actual agreement took effect in March 2008. It replaced and superseded previous open skies agreements between the United States and individual European countries.



## ***Key Recommendations and Policy Initiatives***

The challenges associated with modernizing airspace and addressing increasingly stringent global environmental concerns offer few simple or obvious solutions. There are, however, a number of actions that can be taken by government and industry stakeholders and policymakers—some small and tactical in nature, others more substantial and strategic—that hold significant promise in helping position the U.S. civil aviation industry for a bright, sustainable future. At the same time, the flying public will enjoy the benefits of a substantially improved air travel experience, with fewer delays and other costly and inconvenient travel disruptions. The general public will reap the benefits of the improved system, too, in the form of safer, cleaner, quieter skies.

### **1. Design and implement a “cash for carbon” program to fund aircraft equipage.**

Historically, less than a quarter of total funding for FAA operations comes from federal tax dollars. The nation’s aviation infrastructure and related R&D is funded almost entirely by the users of the system, in the form of taxes and fees levied on passengers, fuel and freight. These monies are placed into the Aviation Trust Fund, which are then distributed in support of relevant capital improvements, including air traffic control facilities and equipment and FAA operations. However, even as NextGen effectively puts aviation infrastructure into the cockpit, the FAA and Congress have not acted on calls for spending federal dollars on aircraft equipage. Manufacturers and many operators generally favor federal funding for equipage, particularly in light of clear acknowledgements by the government that early equipage will accelerate NextGen and bring substantial economic and environmental benefits to all Americans.

For a variety of reasons, the issue of NextGen funding may require a more pragmatic approach, including a deviation from past assumptions about the appropriate mix between government and private sector funding for transportation infrastructure and the mechanisms for financing such investments. On a practical level, the FAA is already fiscally constrained, bearing much of the cost to fund the ground-based infrastructure required for NextGen. Having the FAA directly and exclusively fund the airborne segment of the system seems unlikely, given government-wide budgetary pressures and the dire need to keep the agency on track with investments in the critical ground segment of the system. On the other hand, to ask the user community—including financially-challenged airlines and a general aviation community still buffeted by the impact of economic recession—to bear the burden of airborne equipage is also impractical. Clearly, the equipage funding issue needs more creative approaches that balance the concerns and constraints of government and industry.

One such creative approach is the so-called “cash for carbon” concept, in recognition of the significant environmental benefits associated with NextGen. “Cash for carbon” is fundamentally a contract between government and industry, with both parties held accountable to measurable commitments. For operators, such commitments would include reduced CO<sub>2</sub> emissions. For the FAA, progress might be measured through achievement of agreed metrics for improved system performance, or the completion of certain milestones such as specific airspace redesigns or air traffic controller training. Though the concept is still evolving at FAA—and relevant stakeholders continue to provide input to help shape the program—“cash for carbon” funding would likely support three key objectives: aircraft equipage, prioritized airspace redesigns and additional R&D activities under the CLEEN program.

With respect to aircraft equipage—the largest and most important component of the program—“cash for carbon” could fund ADS-B In/Out, RNP and RNAV equipment for the airline industry, plus an additional 22,000 “high-end” general aviation platforms, including business jets and pressurized turboprops which typically operate in the same airspace with large commercial transports. The funding could come from government grants, government-backed loans, simple loans or a combination of the three. The administration’s recently announced “Transportation Infrastructure Bank” proposal would be an excellent source of funding for the “cash for carbon” initiative. Industry estimates that the equipment noted above could be purchased and installed over a four-year period beginning in 2012 for a cost of roughly \$6B. The president’s infrastructure bank is a six year initiative that would be front loaded. Such a plan would be ideal for funding NextGen-enabling infrastructure as the economic and environmental benefits would be almost immediate and would help pay for later investments. Ideally, an infrastructure bank construct would dedicate NextGen related funds to the FAA for distribution based on specific criteria.

In order to receive grants or loans from the transportation infrastructure bank, operators would have to sign on to the aviation industry’s commitment to CNG 2020+. For those operators who fail to achieve CNG 2020+, the program would require repayment of grant money, higher interest rates on loan repayments and/or the purchase of carbon offsets. As noted, the FAA would also have measurable responsibilities under the program, as investments in aircraft equipage will not yield operational or environmental benefits without corresponding investments by the FAA in ground infrastructure, airspace redesigns and other key implementation milestones. Under the “cash for carbon” program, the FAA would also continue to pursue airspace redesign projects that will further enhance the financial and environmental benefits of equipage for operators. Likewise, the agency would use a portion of the program’s funding to enhance its CLEEN program. By continuing to fund cutting-edge R&D in quieter, more environmentally-friendly engines, airframe designs and alternative fuels, the FAA will complement its investment in NextGen and help industry move closer to CNG 2020+.

While the “cash for carbon” program would ultimately be voluntary, it addresses a number of operator concerns regarding the costs and benefits of equipage and aligns the goals of ATM modernization and environmental stewardship. Initial reaction from key groups representing the U.S. civil aviation industry—including aircraft equipment manufacturers and most operators—has been generally positive.

One potential shortcoming of the “cash for carbon” program is its lack of funding for the general aviation piston fleet. A significant number of operators in this category are individual recreational pilots, for whom the financial benefits of equipage are not especially strong and the environmental benefits on an individual aircraft basis do not appear significant. Nevertheless, the added safety margins afforded by ADS-B and PBN procedures may be especially compelling to these pilots, particularly those operating in marginal VFR flying conditions. An expansive ADS-B trial and demonstration program involving general aviation pilots in Alaska—notorious for its harsh flying conditions in terms of both weather and terrain—has shown dramatic improvements in safety. The FAA-sponsored program known as “Capstone” involved testing a suite of advanced avionics, including ADS-B, in the Yukon-Kuskokwim Region of Alaska. A 2004 study by MITRE and the University of Alaska found that, during the four-year period from 2000 to 2004, the rate of accidents for Capstone-equipped aircraft was reduced by 47 percent.

As manufacturers work to make affordable ADS-B equipment tailored to the lower-end of the general aviation market, more individual owner-operators will make the investment, not just to improve safety, but also to receive better air traffic control coverage and service. Moreover, insurance premiums—a significant component of individual aircraft ownership costs—may be driven down across the industry as the new equipment proliferates.

## **2. Establish a mechanism for addressing the issue of FAA ground infrastructure consolidation and modernization.**

Congress needs to establish a mechanism to consolidate FAA facilities. Depoliticizing the process will ensure the best possible outcome for the agency, the user community and the flying public. Expediting the removal of redundant systems and facilities will establish an appropriate architecture for investments in NextGen.

Concern about potential air traffic controller job losses has been one of the primary stumbling blocks in past efforts to establish an independent commission for FAA facilities consolidation. However, the agency does not envision the transition to NextGen requiring fewer controllers. Rather, the same number of controllers (albeit in potentially fewer physical facilities) would be better equipped through NextGen infrastructure to handle more air traffic. With the potential for NextGen to add capacity to accommodate significant increases in traffic, there may, in fact, be a net increase in controllers, even as new technology allows them to perform their vital jobs more efficiently and with even greater safety margins.

### **3. Better integrate the NEPA process for NextGen-related airspace redesigns.**

**“It’s absolutely imperative that we find a way to help FAA streamline its environmental review process. We must find a way to expedite environmental approval for navigation procedures that provide clearly defined environmental benefits based on clearly defined metrics.”**

– Lorraine Bolsinger,  
GE Aviation Systems President and CEO

The FAA must develop strategies to integrate NEPA review into the NextGen implementation planning process, thereby making these important environmental reviews less time-consuming and less costly. As part of that effort, the agency should continue to develop enhanced modeling tools specifically designed to support environmental impact analyses, including the Aviation Environmental Design Tool (AEDT) that is currently in beta testing. AEDT should ultimately replace existing tools that are focused on analyzing one emission type (noise or air) and facilitate evaluating trade-offs among all emissions produced by airspace alternatives at the national, regional and local level.

Top priority should be given to ongoing efforts by the FAA’s Office of Environment & Energy (AEE) to review the agency’s current NEPA practices and documentation to identify areas for improvement. Recommendations for improvement should be implemented quickly and focused on combining effective environmental review with reducing overall NEPA analysis time and level of required documentation.

Efforts to further fast-track the NEPA process and move towards cleaner and quieter skies could potentially be facilitated by increased National Aeronautics and Space Administration (NASA) involvement. There is clearly a need for continued research on the health effects of noise and emissions from aircraft. As the nation’s lead agency in civil aeronautics R&D, NASA maintains an Airspace Systems Program (ASP) that performs relevant, foundational research in support of NextGen-related efficiency and environmental objectives. The excellent work of the ASP could have real, positive and immediate impacts on the civil aviation industry if it could more directly support FAA in the NEPA process.

### **4. Extend Airport Improvement Program (AIP) grant eligibility to cover the development of RNAV, RNP and other NextGen technology-enabled approaches.**

The Airport Improvement Program (AIP) provides federal grants to airports, with funding typically limited to construction projects (runways, taxiways and aprons, for example) and expenditures on safety, emergency or snow removal equipment. The FAA has also spent over \$5B in AIP funds since 1982 on the study and implementation of noise compatibility projects, including home and business soundproofing, land acquisition and noise monitors.<sup>14</sup> This raises a potentially compelling economic argument for allowing AIP funds to cover the development of new approaches employing NextGen technologies and procedures, including RNAV, RNP and ground-based augmentation system (GBAS) approaches. Many of these procedures can be designed to avoid noise-sensitive areas and CDAs are significantly quieter than standard approaches. Using AIP funds for new approach development could reduce expenditures on physical noise mitigation projects, while simultaneously accelerating NextGen deployment.

If airports can partner with tenants to build more efficient approaches and departures, it will not only further incentivize aircraft equipage and provide

<sup>14</sup> Figures provided by the FAA and cover expenditures through December 2009.

environmental benefits in the form of reduced noise and emissions, it has the potential to increase aircraft and passenger throughput, thereby generating additional revenue for the airport. The economic benefits of a more efficient, better served airport extend well beyond the airport perimeter to the broader community. Whether a business is looking to relocate its corporate headquarters or an airline is seeking to expand its service, the efficiency of the airport in question plays a critical role in the decision.

**5. Expand the FAA’s Organization Designation Authorization (ODA) program to include designers and installers of PBN procedures.**

Under the Organization Designation Authorization (ODA) program, the FAA has the ability to delegate a number of its statutorily-authorized functions to qualified, third-party organizations. ODA status has been generally limited to aircraft and related equipment manufacturers, air carriers, repair stations and other maintenance organizations. The ODA program does not extend to firms that design and install PBN procedures.

However, because NextGen implementation is predicated on the installation of literally thousands of PBN procedures and the FAA lacks the resources to design and install these procedures in a timely fashion on its own, the agency recognized the need to enlist the support of third parties who specialize in the design and deployment of PBN procedures.

In September 2009, GE Naverus and Jeppesen—both leaders in the development and certification of PBN procedures around the world—were granted approval by the FAA to design and validate RNP flight paths under what is known as an Other Transaction Agreement (OTA). While the OTA does not allow the same latitude and responsibilities as an ODA, it does effectively engage the private sector in the development of navigation procedures.

Even with the assistance of capable third parties, the FAA still faces a daunting task in installing thousands of PBN procedures needed throughout the nation for full NextGen implementation. For this reason, extending full ODA status to qualified companies is still a worthy policy objective. Although the existing OTA process allows the FAA to contract with individual providers, it is a lengthy process undertaken only on a case-by-case basis. For example, the FAA-GE Naverus OTA took three years to produce its first public RNP approach.

As a matter of policy, the busiest corridors and airports should receive top priority when it comes to installing and certifying RNAV and PBN procedures, a seemingly obvious recommendation, but one that is still not strictly adhered to as the build-out of the system moves forward. Finally, consistent with the recommendation above, contracting with third party PBN providers using AIP funds should be permitted.

**“This is an important milestone in the deployment of RNP in the U.S. ... FAA and operators agree that this technology can provide significant environmental and economic benefits. The task before us now is to work together to integrate and deploy these advanced navigation procedures into the national airspace.”**

*– Steve Forte,  
GE Naverus, General Manager*

## 6. Ensure industry has significant involvement in addressing NextGen/SESAR harmonization challenges.

Civil aviation is an inherently international enterprise, with its global reach continuing to grow as new markets for aviation products and services emerge and as new players seeking to address those markets increase. Long-term solutions to the industry's most pressing problems must therefore be predicated on increased international cooperation.

In the area of ATM modernization, it is vital that the United States and Europe continue to work together to harmonize technical and operational standards for their respective programs—NextGen and SESAR—as expeditiously as possible. While other high-growth regions of the world, particularly the Middle East and China, should be monitored and consulted on ATM modernization initiatives, it is highly likely that the United States and European Union efforts will set the pace for ATM improvements worldwide.

The recently signed Memorandum of Cooperation (MOC) between the FAA and the European Commission is a positive step in fostering government-to-government coordination in the area of NextGen/SESAR harmonization. The efforts extending

**“Both programs [NextGen and SESAR] aim to expand airspace capacity, ensure safety, protect the environment and improve service for aviation customers. Problems faced by the aviation industry require a global interoperability solution.”**

– Nigel Makins,  
EUROCONTROL, SESAR-NextGen Liaison

from this MOC need to focus not just on technical cooperation, but also on finding practical solutions to bridge the gap between the programs' respective implementation and equipage timelines.

Moreover, for real progress to be made on interoperability, industry must have a more prominent role in the process and that role needs to extend beyond technical matters. The FAA and the Joint Planning and Development Office (JPDO) have created the NextGen Institute Management Council, an organization of industry and private sector aviation leaders, to support NextGen development and have formally engaged industry specialists to look at NextGen plans over the years. The JPDO, in particular,

has been responsible for managing public-private partnerships—along with being the primary forum for coordinating the efforts of multiple government stakeholders—with the explicit goal of bringing NextGen online by 2025.<sup>15</sup> However, the scope of the input from these industry representatives has often been confined to technical matters and the formal rulemaking process. In contrast, SESAR planning has been a government-industry partnership from the outset, with industry providing significant input on matters of program structure and timing, not just technical standards.

The FAA has recently taken strides to more actively engage U.S. industry, most notably through the creation of a government-industry task force by RTCA, a not-for-profit corporation that functions as a Federal Advisory Committee (FAC) to the FAA.<sup>16</sup> In January 2009, the FAA asked RTCA to form a group called Task Force 5 and charged it with making consensus-based recommendations pertaining to NextGen. The recommendations ultimately made by the task force—which included broad

<sup>15</sup> The JPDO is the central organization that coordinates the NextGen efforts of the Departments of Transportation, Defense, Homeland Security, Commerce, FAA, NASA and the White House Office of Science and Technology Policy

<sup>16</sup> RTCA's recommendations are used by the FAA as a basis for policy, program and regulatory decisions and by the private sector as a basis for development, investment and other business decisions.

industry representation covering both operators and manufacturers—pertained to a number of technical, operational and programmatic issues.

Ideally, a well-coordinated, cross-Atlantic, government/industry panel designed to review NextGen/SESAR implementation plans would ensure milestones, standards and mandates are harmonized and practical. This will ensure that neither operators nor manufacturers have to contend with two different sets of standards. Creating trans-Atlantic harmonization is especially vital, given that operators and air traffic management organizations throughout the rest of the world will look to the United States and Europe for leadership and guidance as they move to equip their own aircraft and upgrade or create their own aviation infrastructure.

**7. Better leverage international forums like ICAO to create comprehensive global environmental standards.**

As essential as international cooperation is in the area of ATM modernization and capacity enhancements, it is perhaps even more important in addressing growing environmental concerns. Regional schemes to monitor and enforce aviation emissions like the European Union's ETS are almost universally opposed by the broader international aviation community and have become emblematic of the problems associated with a fragmented system.

ICAO has a long history of leading and coordinating industry-wide efforts to improve civil aviation's environmental stewardship, including noise and NO<sub>x</sub> reduction, so the United States should support ICAO's role in coordinating international policy that moves the industry to CNG 2020+.

Likewise, the International Air Transport Association (IATA) would constitute an ideal partner for ICAO and the industry, acting as overall system administrator. In other words, ICAO would establish the global framework for CO<sub>2</sub> reduction, and IATA would be responsible for collecting and reporting global fuel burn data. This division of responsibility plays to the strengths of each organization, both of which are long-standing, trusted players in the international civil aviation policy and operations community.

Should this global sectoral approach to reduce aviation's CO<sub>2</sub> emissions include revenue-generating market measures, all or a significant portion of the fees paid by the airlines should be repatriated to the civil aviation industry, where the revenues can be used to fund ATM modernization programs, along with research into new airframe, engine and alternative fuel technologies.

**8. Continue to foster deeper, broader partnerships between industry and government across multiple technology areas that have the ability to help the U.S. civil aviation industry achieve CNG 2020+.**

Cooperation in fundamental R&D between relevant government agencies and industry has enabled significant breakthroughs in civil aviation dating back to the earliest days of flight. The government can augment industry's efforts to reach CNG 2020+ by continuing to make targeted investments in the areas of aircraft engine design, airframe design and the development of sustainable alternatives to jet fuel.

The FAA's CLEEN program is an excellent example of such targeted investments, with industry partners advancing technology breakthroughs that could be incorporated in aircraft platforms in less than five years. NASA's Environmentally Responsible Aviation (ERA) project is a similar effort, though it generally targets technologies that are slightly less mature, with an eye towards concepts that could be operational by 2025. The ERA program is focused primarily on the testing of unconventional aircraft configurations that feature reduced drag and reduced noise around airports, the development of composite structural concepts to reduce weight and improve fuel burn, and the testing of advanced, fuel-flexible combustor technologies that reduce engine NO<sub>x</sub> emissions. NASA is collaborating with the FAA and other federal agencies, airframe and engine manufacturers, and academic institutions on the ERA project.

Another area that seems especially promising for advancing the goal of CNG 2020+—given already impressive levels of cross-agency and government-industry cooperation—is alternative fuels research. The U.S. Air Force has been an important player in the development and use of alternative fuels and it has the potential to be a vital partner to the U.S. civil aviation industry in terms of advancing the commercial viability of biofuels. As the largest user of jet fuel within DOD, consuming roughly 2.4 billion gallons per year, the Air Force aims to have all aircraft in its current inventory—from fighters to tankers—certified to fly using alternative fuels by the end of 2012. The service has been especially aggressive in testing new biofuel blends. In March 2010, it successfully flew one of its A-10 jets using a combination of fuel derived from camelina oil and conventional jet fuel. The camelina plant is one of many feedstocks being investigated by the Air Force, which hopes to source 50 percent of its domestic aviation fuel from an alternative blend by 2016.

While the Air Force is DOD's leading user of jet fuel, its annual consumption is dwarfed by that of the U.S. civil aviation industry, which consumes roughly 10 times that of the service.<sup>17</sup> The Air Force is sharing its experience in alternative fuels—gleaned not just through recent demonstration flights, but through years of laboratory, rig and component testing—by closely cooperating with industry as part of the Commercial Aviation Alternative Fuels Initiative (CAAFI).

<sup>17</sup> Estimate provided by CAAFI.

Since its founding in 2006, CAAFI has emerged as the focal point for collaboration between airlines, aircraft and engine manufacturers, relevant government agencies and energy producers in the area of alternative fuels. The organization's sponsors include the FAA, along with three trade associations—AIA, ATA and the Airports Council International of North America (ACI-NA)—but its collaborative reach extends well beyond this important subset of sponsors, to include stakeholders from all corners of the international civil aviation industry. Over the last two years, CAAFI completed certification and qualification work that led to the approval of a new specification for alternative jet fuel that will facilitate near-term approval of a variety of sustainable plant-based biofuels. The organization has also been instrumental in creating unified R&D roadmaps to help inform investment decisions by both government entities and the private sector.

In recognition of these and other key accomplishments, CAAFI was awarded the 2010 Air Transport World Joseph S. Murphy Industry Service Award, an honor bestowed on an individual or organization that has performed outstanding service benefiting commercial air travel.

Building on the groundbreaking work of CAAFI, the recently launched "Farm to Fly" effort involves the airline industry (through ATA), Boeing and the U.S. Department of Agriculture (USDA), which serves as the lead agency within the U.S. government on feedstock development, production systems and other relevant areas. The initiative is an example of a unique industry-government partnership that epitomizes the type of cooperation that holds promise in moving industry towards CNG 2020+ while serving another important government objective. The three organizations plan to use regional opportunities and pilot programs to identify ways to meet the mutual goals of advancing sustainable aviation biofuels and promoting U.S. rural economic development.

The ambitious goal of CNG 2020+ will only be achieved if government and industry can continue to work together, rationalizing financial investments and pooling technical expertise. The foundations for successful cooperation are already in place through programs like CLEEN, forums like CAAFI and initiatives like "Farm to Fly." Building upon these strong foundations will enable future technological breakthroughs—from revolutionary engine and airframe designs to commercially viable biofuels—that firmly establish the civil aviation industry as the global benchmark for safe, environmentally-responsible transportation.

**"This recognition is a strong endorsement of CAAFI's innovative public-private partnership and recognizes the tremendous joint effort leading to significant advancements for alternative jet fuels this past year."**

*– Nancy LoBue,  
FAA Deputy Assistant Administrator for  
Policy, Planning and Environment*



## *Summary*

The companies that manufacture and service the aircraft that traverse our skies—from the largest platform designer to the smallest subcomponent supplier—have always been on the cutting edge of technological breakthroughs focused on making their products safer and more fuel-efficient. Their customers and the flying public have demanded nothing less; industry has always responded. The future of civil aviation depends on the entire industry—manufacturers and operators alike—continuing a steadfast commitment to advancing technologies and procedures that will allow aircraft to operate in a more efficient and environmentally-friendly way, without compromising the outstanding safety record the industry has built for itself. Clearly, modernizing the ATM infrastructure is a foundational objective that supports the complementary goals of safety, efficiency and environmental stewardship. The sooner a modernized ATM system is in place, the sooner every stakeholder—from the individual traveler to the global environment—will reap the far-reaching economic and environmental benefits of NextGen.

But a steadfast commitment from industry is not enough. Government stakeholders at home and abroad must serve as partners to industry in achieving these critical goals. From harmonization of systems, standards and regulations, to financial support for equipage and foundational R&D in a wide range of technology areas, government involvement is an integral piece of the puzzle in meeting the capacity and environmental challenges facing the aviation community.

## *Glossary of Acronyms and Terms*

<b>4DT</b>	<i>4-Dimensional Trajectories</i>
<b>ACI-NA</b>	<i>Airports Council International of North America</i>
<b>ADS-B</b>	<i>Automatic Dependent Surveillance-Broadcast</i>
<b>AEDT</b>	<i>Aviation Environmental Design Tool</i>
<b>AEE</b>	<i>Office of Environment &amp; Energy (FAA)</i>
<b>AIA</b>	<i>Aerospace Industries Association</i>
<b>AIP</b>	<i>Airport Improvement Program</i>
<b>APU</b>	<i>auxiliary power unit</i>
<b>ASP</b>	<i>Airspace Systems Program (NASA)</i>
<b>ATA</b>	<i>Air Transport Association</i>
<b>ATM</b>	<i>air traffic management</i>
<b>CAAFI</b>	<i>Commercial Aviation Alternative Fuels Initiative</i>
<b>CATEX</b>	<i>categorical exclusion</i>
<b>CDA</b>	<i>Conintuous Descent Arrival</i>
<b>CEQ</b>	<i>Council on Environmental Quality</i>
<b>CLEEN</b>	<i>Continuous Lower Energy, Emissions and Noise program</i>
<b>CNG 2020+</b>	<i>carbon neutral growth from 2020 and beyond</i>
<b>CNS</b>	<i>communications, navigation and surveillance</i>
<b>CO<sub>2</sub></b>	<i>carbon dioxide</i>
<b>DOD</b>	<i>Department of Defense</i>
<b>EA</b>	<i>environmental assessment</i>
<b>EC</b>	<i>European Commission</i>
<b>ECJ</b>	<i>European Court of Justice</i>
<b>EIS</b>	<i>environmental impact statement</i>
<b>ERA</b>	<i>Environmentally Responsible Aviation program</i>
<b>ETS</b>	<i>Emission Trading Scheme</i>
<b>EU</b>	<i>European Union</i>
<b>FAA</b>	<i>Federal Aviation Administration</i>
<b>FAC</b>	<i>Federal Advisory Committee</i>
<b>FMS-ATM</b>	<i>Flight Management System–Air Traffic Management</i>
<b>FONSI</b>	<i>finding of no significant [environmental] impact</i>
<b>GAO</b>	<i>Government Accountability Office</i>

## ***Glossary of Acronyms and Terms (continued)***

<b>GBAS</b>	<i>ground-based augmentation system</i>
<b>GDP</b>	<i>Gross Domestic Product</i>
<b>GHG</b>	<i>greenhouse gas(es)</i>
<b>GPS</b>	<i>Global Positioning System</i>
<b>IATA</b>	<i>International Air Transport Association</i>
<b>ICAO</b>	<i>International Civil Aviation Organization</i>
<b>JPDO</b>	<i>Joint Planning and Development Office</i>
<b>MOC</b>	<i>Memorandum of Cooperation</i>
<b>MRJ</b>	<i>Mitsubishi Regional Jet</i>
<b>NASA</b>	<i>National Aeronautics and Space Administration</i>
<b>NEPA</b>	<i>National Environmental Policy Act</i>
<b>NextGen</b>	<i>Next Generation Air Transportation System</i>
<b>NOx</b>	<i>oxides of nitrogen</i>
<b>ODA</b>	<i>Organization Designation Authorization</i>
<b>OTA</b>	<i>Other Transaction Agreement</i>
<b>PBN</b>	<i>performance-based navigation</i>
<b>R&amp;D</b>	<i>research &amp; development</i>
<b>RNAV</b>	<i>Area Navigation</i>
<b>RNP</b>	<i>required navigation procedures</i>
<b>RVSM</b>	<i>Reduced Vertical Separation Minima</i>
<b>SESAR</b>	<i>Single European Sky Air Traffic Management Research</i>
<b>SSR</b>	<i>Secondary Surveillance Radar</i>
<b>USAF</b>	<i>United States Air Force</i>
<b>USDA</b>	<i>United States Department of Agriculture</i>

