IMPLEMENTING NEXT GENERATION AIR TRANSPORTATION SYSTEM TECHNOLOGIES

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Abstract

The transformation has begun, from the 20th century hierarchical airspace architecture of analog communication, terrestrial navigation, ground-based surveillance, and manual flight planning and route management to the 21st century distributed, digital, space-based, airborne-centric, and web-enabled, automated, trajectory-based, scalable system, which is NextGen. This paper surveys the national, historical, and technical context in which this transformation will unfold, and outlines the planning of a government/industry project in Florida for early implementation of certain integrated, cooperative NextGen operating capabilities. This is the NextGen Early Implementation Project in Florida which is based on a Memorandum of Agreement (MOA) signed on June 6, 2008, between the Federal Aviation Administration (FAA), DayJet Corporation, and the State of Florida Department of Transportation (FL-DOT) Aviation Office. The agreement establishes a "government/industry partnership for prioritizing and implementing proven technologies in Florida as a prelude to integrated national implementation of NextGen."

1.0 Introduction

The transformation has begun, from the 20th century hierarchical airspace architecture of analog communication, terrestrial navigation, ground-based surveillance, and manual flight planning and route management to the 21st century distributed, digital, space-based, airborne-centric, and web-enabled, automated, trajectory-based, scalable airspace system. This paper surveys the national, historical, and technical context in which this transformation will unfold. The paper also outlines the planning and outcomes of a government/industry project in Florida for early implementation of certain integrated and cooperative operating capabilities.

2.0 National Context for Transformation

The umbrella term for the modernization of the National Airspace System is known as the Next Generation Air Transportation System, or "NextGen." NextGen is the first major technological transformation of airspace, aircraft and airport management systems in over 50 years using digital technology to redefine every element of air transport—from communications, surveillance and navigation to air traffic management. This term was developed by the U.S. Joint Planning and Development Office (JPDO). Organized initially as the Joint Planning Office in 2000 and officially chartered in 2003 by Congress as the JPDO, a multi-agency team created the strategies for the transformation of our nation's airspace. These strategies formed the basis for the current structure of Working Groups addressing all domains of transformation.

Over a period of five years, the JPDO has established a vision, concept of operations and work plan for transformation of the U.S. air transportation system. Their work has been closely coordinated among the departments and agencies responsible for the many moving parts of the U.S. air transportation system including: the National Aeronautics and Space

Administration (NASA), Department of Defense (DOD), the Federal Aviation Administration (FAA), Department of Transportation (DOT), Department of Homeland Security (DHS), Department of Commerce (DOC), the National Oceanic and Atmospheric Administration (NOAA), and the White House Office of Science and Technology Policy (OSTP). Through the Next Generation Air Transportation System (NGATS) Institute, - a public-private partnership, – industry has participated in the JPDO efforts as well. It was vital that this architectural framework be led by the central government. The matured framework can now serve to legitimize the unique role for industry in innovating in the NAS. This new stage of development requires public-private partnerships built around operational implementation of the vision and concepts. Thus, now is the time for the Florida-based NextGen project.

In this national context, the five-year Florida project is based on a Memorandum of Agreement (MOA) signed on June 6, 2008, between the Federal Aviation Administration (FAA), DayJet Corporation, and the State of Florida Department of Transportation (FL-DOT) Aviation Office [1]. DayJet Corporation launched revenue operations in October 2007, spearheading innovation in Per-Seat, On-Demand air carrier services. The MOA establishes a "government/industry partnership for prioritizing and implementing proven technologies in Florida as a prelude to integrated national implementation of NextGen." [1].

The FAA leadership includes the Surveillance Broadcast Systems (SBS), Area Navigation/Required Navigation Performance Group, and Flight Standards Offices in Washington DC, as well as the Southern Regional Administrator's Office in Atlanta, Georgia. The project management is hosted by Embry-Riddle Aeronautical University (ERAU) in Dayton, Florida, with support in modeling and analysis of footprint benefits (in energy, carbon, and noise) led by the Florida Institute of Technology (FIT) in Melbourne, Florida. The outcomes of the project are planned to include improved safety, increased airspace capacity, reduced cost, improved environmental footprint, and increased efficiencies of fleet performance in terms of fuel and time. The beneficiaries include government at the federal, state, and local levels; industry; the flying public; and communities that gain in economic opportunity through enhanced air mobility.

A set of ingredients combine to create the unique opportunity for this project in Florida. The set includes (1) the FAA near-term progress on performance-based navigation and surveillance, (2) the Florida airports and airspace operational challenges, (3) the DayJet business model, aircraft, Florida launch markets, and real-time fleet management software systems, and (4) In the farther term, R&D results in common internet protocols over aviation spectrum, and system wide information management (known as SWIM). Over the next five years these technologies and the operating capabilities they support can be implemented by industry. The goal is less about getting everything working perfectly than it is about getting some things working in order to learn by doing how to make the systems better.

Today's air traffic system has evolved over some 80 years. In part, because of the evolutionary path, the system is not scalable in the fashion of systems that follow a digital architecture such as the OSI stack (a common picture among players in the computing and telecommunications world for how all the parts of their system fit together). Given the mix of technology and demands that are made by myriad users, the system's safety and efficiency are remarkable. However, the current system is stressed well beyond its design capacity—as one in three flights persistently encounter delays—costing U.S. passengers an estimated 320 million hours in lost time or $12 billion in 2007. With passenger demand expected to reach one billion by 2015, we face the inescapable fact that the existing system architecture will not economically scale to meet a two- to three-fold increase in air transportation demand by 2025.

The costs of attempting to increase capacity using the existing architecture are unacceptable, as are the costs of doing nothing. According to many public studies, failure to address the need for expanded capacity in our National Airspace System (NAS) by this time will cost the U.S. economy billions of dollars annually in lost economic activity. The solutions to tomorrow's challenges do not merely lie in scaling up the present system by adding controllers, airports and runways. In fact, even doubling the number of controllers, runways at large airports, radars, and control towers will not meet the challenge, much less be affordable.

3.0 Historical Context – From Seaports to Railheads to River ports to Interstates to Airports [2]

The evolution of the nation's cumulative consumption of transportation modes for long intercity trips follows rather common patterns as each mode migrates through the life cycle of the particular innovation (see the figure below). As new technologies affected infrastructure, vehicles, propulsion, fuels, and business models, each mode experienced three distinct phases within an "S" curve or logistics cycle [3]. The first gestation phase of early adopters was followed by a phase of rapid growth of the core market. As the core growth phase led to general acceptance, the third phase of maturation set in and a preferred mode of transport became dominant in certain markets.

During the mature phases of these patterns, economic considerations and aging technologies, and rigid business and regulatory models led to consolidation for efficiencies that frequently left consumers with fewer choices and less flexibility. These conditions became ripe for development and acceptance of newer, eventually more-popular technology, which more-efficiently transported more people. Today's airspace architecture, air traffic control systems, hub-and-spoke business models, and regulatory infrastructure are currently approaching the top of the "S" curve of technological innovation.

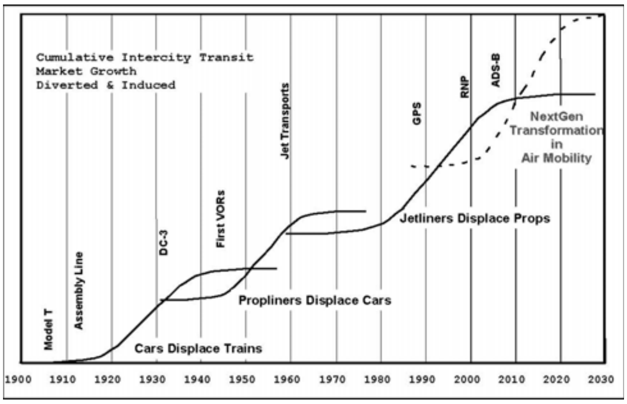

Figure 1: Notional Transportation System Innovation Life Cycles [2]

The leap from the end of a maturing life cycle to the birth of a new cycle is fraught with risk and turmoil. Yet the benefits of making the leap are reliably substantial. In making the leap, the challenge in gaining the critical mass of need and technology, investment and innovation is often the stuff of paradigm transitions. One such transition we face today requires a change in public thinking from problem solving in two dimensions to three dimensions. The nation's transportation systems community is somewhat stymied by what appears to be a futility of attempting to build our way out of road congestion. Unfortunately, in 30 states, over a third of the population faces serious road-congestion problems. In three states, over half the population is threatened by daily gridlock. Rail has not made progress either; virtually all the nation's High Speed Rail initiatives are at a standstill. Attend virtually any public hearing on state and local transportation initiatives and you will find a conversation focused on 2-D ground transportation solutions, not on integrated 2- and 3-D concepts. As the 21st Century unfolds, we need to be adept at thinking in the third-dimension, 3-D. What about the sky above as an asset of value to meeting our nation's mobility needs?

Some would argue that we have a scarcity of airspace, when in fact, airspace is in abundance. It does not help with our mental models that the morning news depicts airport delays by showing a map of the U.S. with all airborne airplanes covering the country—using aircraft icons that are the size of small states. We need a new mental model for the nation's airspace that is based on the principle and the reality of abundance.

For a more realistic image of the National Airspace System (NAS), picture the corner-to corner distance from Maine to southern California. Then imagine this 3,300 miles distance as scaled roughly down to the 340-foot corner-to-corner dimension of the in-bounds area of a football field. Consider a view of this scene from seats close to the fifty-yard line. In this image, we can see that a typical airliner would scale out about the same as a poppy seed and be very hard to spy. A really big airport (like Denver or O'Hare), in this scale, would be about the size of a bagel, and a runway would be just a fat pencil line, also quite difficult to see and handling about one airplane every minute. In addition, in the wide open spaces between those largest of airports the scene would appear almost absent of action. From this perspective, vast portions of the airspace can be imagined as far less frantically busy as our urban lore would have us believe.

The point of .this mind game is that our airspace has untapped capacity that we do not normally think about in strategically productive ways. NextGen changes our mental models in this regard.

Imagine an airway eight miles wide and five-hundred feet deep; picture these airways linking ground navigation stations designed in the past century on the basis of old airmail routes; envision these airways as only connecting between a fraction of the airports across the land; comprehend the limitations of using aviation radios on a party line with analog voice communications for direction-giving. These are the realities of the existing airspace system.

As an example, out of over 5,000 public-use airports in America, fewer than 1,000 have precision instrument landing systems and fewer than about 500 have radar surveillance. It is like building an interstate highway system and only having 20 off-ramps per state for 50 states.

On any normal day during heavy traffic hours, the airspace above the continental U.S. may have as many as 2,000 commercial and 4,000 or so smaller aircraft on IFR flight plans. As "poppy seeds over a football field," their traffic is practically insignificant; but each hour, most of these aircraft will land at just a few airports. Just 67 airports account for 90 percent of domestic passenger traffic, while almost 80 percent of all U.S. passengers are routed through 35 major hub airports.

The barriers constraining our 20th Century airspace procedures derive from the physical limitations of where we have installed radars, instrument landing systems, radio antennae, and other ground-based communication, navigation, and surveillance infrastructure. As a result, airspace appears scarce, when in fact, if these constraints are lifted, airspace is abundant. At the very least, we have vast regions of underutilized airspace, airports, and runways, all of which can become accessible in the 21st Century.

4.0 Technological Context

The birth of ATC (Air Traffic Control) and its communication, navigation and surveillance components began with controlling traffic by knowing where any given <u>airplane should be</u>, based on the flight plan, the speed of the airplane and observed winds, and the clock. Later, radar indicated the airplane's position and control was based on knowing where the <u>airplane is</u>. The next generation of ATC will be based on knowing where the <u>airplane will be</u>. The new system will take us to Trajectory-based operations, achieved through performance-based ATM (Air Traffic Management). In the new system, many traditional ground control functions will migrate into the cockpit.

The technical term for this future airspace system, "Performance-based Air Traffic Management," is based on the concept of the role of the central government in defining the performance requirements for the system, but not defining the "how" of achieving those requirements. The "how" is left to industry and users.

This shift allows these systems and their technologies to advance at the pace of technology and business instead of the pace of governmental organizations. The technological underpinnings for NextGen shift us from an analog world to a digital world and from terrestrial navigation systems to space-based GPS systems—putting more operational capability directly into the cockpit. This means that many of the radar surveillance systems of the last century can be replaced with airborne systems to safely expand the nation's airspace capacity.

The good news is that much of the technology needed to start is proven and ready. We are riding a new wave in technologies – some ground-based, but largely aircraft-, and space-based. These technologies will continue to expand in capability at an accelerated pace. Innovations such as all-glass cockpits with synthetic and enhanced vision, highway-in-the-sky (HITS), digital radios, graphical traffic, weather, terrain displays, and all-electric-all-digital airplanes, once thought unaffordable, perhaps even unachievable, have reached today's marketplace and will ultimately displace the aeronautical inventions of the 20th century. And it is only the beginning! Driven by Moore's Law, these underlying technologies have brought the digital age to aviation and with it, a new level of scalability, affordability, robustness, reliability, and safety.

The result is NextGen, with scalability of airspace capacity and of airport networks through deployment of performance-based air traffic management technologies for navigation, surveillance, and communication. These technologies individually create improvements in the NAS; collectively, they transform the NAS.

Can so-called "reliever" airports truly relieve the pressure from increasing demand on the major airports (and incidentally on the roads serving them)? Is there a business model for air service between cities where the markets are too thin to support scheduled service? What effective alternatives exist for federal subsidies to support air service for rural America as scheduled carriers consolidate and shrink their networks? Can technology infrastructure investments accelerate expansion of rural air mobility? Positive answers to these questions can be the legacy of NextGen. The NextGen Early Implementation Project in Florida offers a proving ground for those answers.

The consequences of airline deregulation in the 1970's were foreseen to include consolidation of the industry around larger companies operating larger aircraft to and from larger markets, with the resulting reduction or loss of service to suburban, rural, and remote communities. This foresight was the basis for including the Essential Air Services (EAS) program in the deregulation legislation. The basic idea was that in markets too thin to support scheduled flights, the central government would subsidize communities to buy down the cost of airline service to those affected communities.

Now however, as aircraft, airspace, airport and business model innovations have progressed over the past three decades, new opportunities have emerged to serve markets too thin for schedules. These new opportunities can be characterized as those of the "long tail [4]" of air transportation markets.

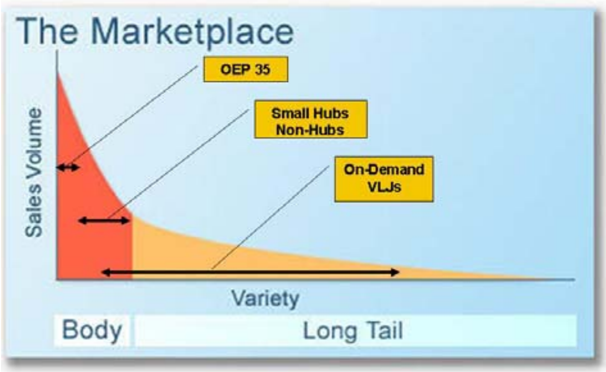

Fig. 2: The Long Tail of Air Transportation Markets (adapted from [4])

The ability of industry to aggregate and monetize consumption in the long tail of large varieties of small numbers of purchases has been aided by many scalable technologies and innovations, including the Internet and other digital and network-based systems. These innovations support scalability of the business model as a result of reducing the costs of key ingredients such as overhead, shelf life, and shelf costs for music, movies, and many other tailored, personalized, customized products and services.

In air transportation, the long tail is comprised of suburban, rural and remote markets where demand is highly variable. In some of those markets, demand can vary from none on some days and numerous on others. How can an air carrier serve such markets? DayJet Corporation has pioneered one approach with its on-demand, per-seat service. Launching this innovation required two major innovations to start and will gain significant traction for accelerated growth from the effect of NextGen on scalability. The first two innovations included a new aircraft that revolutionized the cost of speed and software that manages disruptions in complex, adaptive logistics systems. For DayJet, the aircraft is the Eclipse 500, the first Very Light Jet (VLJ) and the software is a proprietary system capable of creating near-optimal, real-time solutions to positioning passengers by the seat in aircraft with pilot assignments, all digitally. The result is scalability of a business model that reaches far into the long tail of thin markets for air travel.

NextGen operating capabilities enable accelerated growth of this business model by reducing variability and improving reliability of access to virtually any origin or destination in the network of thousands of airports serving the nation's smaller communities as well as the edges of larger cities. Together, the new aircraft business model, markets, and logistics software create a mini-platform for implementing NextGen capabilities and producing the business case proofs of the benefits for airspace users in other regions across the nation. The Florida project is designed for this purpose.

5.0 The NextGen Early Implementation Project in Florida – Outcomes and Sustainable Footprints

The FAA concept of leveraging the Florida project as a prelude to integrated national implementation is based on past experience in introducing new technologies into the National Airspace System. The precedents for projects such as the Implementation include the FAA ADS-B Capstone Project in Alaska [5], the Helicopter Association of America-FAA Gulf of Mexico Project [5], the Cargo Airlines Association-ADS-B Trials [5], the Advanced General Aviation Transport Experiments (AGATE) Alliance [6], and others. These precedents provide time-honored approaches to accelerating innovation through public-private collaboration. Many of the government and industry collaborators in the Florida project are experienced in those prior programs.

Public-private partnerships such as these serve as crucibles in which the relationships are fired between operators, OEMs, suppliers, and regulators who share motivations for advancing new concepts serving the shared public and private sector interests and investments. More effective business relationships emerge as a result of such projects. NextGen Florida Early Implementation Project participants each bring their own resources to the table.

In addition, organizations such as the Personal Air Transportation Alliance (PATA) represent operators capable of supporting more widespread deployment of the needed changes in other regions of the nation's airspace. PATA is comprised of new companies in the U.S. introducing on-demand, point-to-point air transportation services, using the emerging fleets of technologically advanced small aircraft such as the very light jets (VLJs) in regional and rural markets.

The following capabilities comprise the airborne systems for the project:

- Performance-Based Navigation (RNP ,3)
- Graphical Traffic Information

- Graphical Weather
- ADS-B in / out
- Software and display systems for spacing, merging and separation in flight path management
- Communication via IP
- Electronic Flight Bag
- Iridium Comm
- FOQA
- Machine/Enhanced Vision to reduce infrastructure cost for runway end identification

The following capabilities comprise the airport and terminal airspace systems for the project:

- State Aviation System & Airport Master Planning for NextGen
- Tailored flight paths (survey requirements)
- ADS-B to the surface for traffic and fleet tracking and management systems
- Precision minimums for all appropriate runways
- Runway Visual Range
- Remote Tower Services (Virtual Tower)
- DataComm network connectivity to aircraft and flight operations center
- SWIM integration of all facilities data

Three implementation domains are proposed for consideration: (1) the metroplex domain, (2) the secondary airports domain, and (3) the tertiary airports domain. The idea of the three domains is to frame the requirements for the new airspace procedures. The project will engage the FAA Air Traffic community in collaboration to determine which routes and which terminals will be targeted in what order, for procedure development.

- Metroplex Solutions: Airports surrounding the major metropolitan hubs can be more effective relievers of pressure in the air and on the ground, through performance-based ATM. One concept for exploration is interlaced departures and arrivals for hubs and smaller surrounding airports for increased airspace capacity as well as road congestion relief
- Secondary Airports Solutions: Routes for most efficient altitudes, shortest routes and passing capabilities for reduced fuel and carbon
- Tertiary Airports Solutions: Increased access and capacity at smaller community airports with reduced fuel and carbon

Florida's NextGen capabilities will be implemented in three phases over the next five years as follows:

Phase 1—To begin in late 2008 through 2010, the first phase of the project will focus on deploying Performance-Based Navigation to allow DayJet's fleet to fly more precise flight paths, reducing fuel burn, carbon emissions, and noise. In addition, this phase will deploy Automatic Dependent Surveillance-Broadcast (ADS-B) technology for performance-based surveillance based on GPS for airplanes that enables pilots to see other aircraft in their vicinity, improving safety while increasing airspace capacity.

Phase 2—To begin in 2009 through 2011, this phase will implement System Wide Information Management for enhanced weather awareness and management.

Phase 3—To begin in 2011 through 2013, this phase will deploy Performance-Based Communications for flight planning and flight plan management. Expanding Service Beyond the Metroplex

Air travel is extremely efficient for all classes of aircraft on the basis of speed, passengers, distance, and cost. As the climate science community gains improving understanding on the effects of aviation on the earth's atmosphere, we are eager to translate those understandings into business applications. The effects of the cost of fuel is serving as a very near-term incentive for innovative thinking and action by the aeronautical community toward those ends. Improvements in propulsion, alternative fuels and aircraft designs will be driven by these new forces in the long-term.

What can we do in the short term? Many activities are underway related to footprint, including emissions trading, offsets, and regulatory actions. Importantly, the aviation community is taking action as well. The recent launch of the Alliance for Sustainable Air Transportation (ASAT) is one example [7]. ASAT is a non-profit, public-private partnership working to implement sustainable, environmentally sound and economically viable air transportation. ASAT partners include federal, state, and local government entities, the private sector, and academic institutions.

The ASAT members recognize that our air transportation system must meet growing capacity requirements while reducing impact to the environment. Through Working Groups and programs, members are working to accelerate implementation of the Next Generation Air Transportation System).

In the short term, NextGen airspace capabilities promise to reduce the distance flown, enable more frequent trajectories at optimum altitudes, and improve fuel consumption during departures and arrivals in terminal airspace. DayJet flight trajectories are frequently more than 10-percent longer than desired and off of optimum altitudes by amounts that significantly add to fuel burn and therefore added emissions. The company anticipates fuel burn and emissions reductions of more than 10- to 15-percent, fleet-wide, as a result of NextGen operations in Florida.

How might we optimize current operations for considerations regarding carbon in the troposphere and stratosphere? While the long-term effects of greenhouse gases anywhere in the atmosphere appear clear, VLJ operators might contribute to part of the issue by avoiding contrail-producing altitudes. Answers to the questions regarding potential fuel efficiencies (and therefore carbon sourcing) could be used for carbon-optimization in flight planning. The new generation of VLJs flown in on-demand, regional air transportation service business models are gaining experience in optimum performance of their network operations. These operations share the common characteristic in flying relatively shorter segments and in making effective use of mid-altitudes – typically in the troposphere.

The initial assessments by the International Panel on Climate Change (IPCC) regarding the effects of aviation on the environment focused on flight in the stratosphere. These past studies published first in 1999 [8] and then reviewed in 2006 [9] summarize the three most important ways that aviation affects the climate:

1. Direct emissions of greenhouse gases specifically CO_2 and water vapor
2. Nitrogen oxide emissions interacting with ozone and methane
3. Contrail-induced cirrus cloud formation

Based on these operational realities, it may be desirable for this community to support research focused on the following four topics:

- Reduced effect of cloud formation due to absence of contrails by VLJs flown in the troposphere
- Comparative greenhouse effect of water vapor emitted by VLJs between 18000 and 26,000 feet, versus in the stratosphere
- Comparative effect of nitrogen oxide emitted by VLJs between 18000 and 26,000 feet on atmospheric ozone versus emissions in the stratosphere
- Implications of the effect of NOx-induced depletion of methane for NOx emissions in the troposphere

The state of the art in climate modeling is limited in terms of providing reliable estimates for the specific aviation-induced radiative forcing effects. Even so, perhaps the relative effects of stratospheric and tropospheric flight can be considered. A rule of thumb in climate science estimates that each unit of fuel burned by stratospheric air transport flights as the greenhouse effect of three times that of ground transport [10]. Further, it is estimated that the radiative forcing from persistent contrails and contrail-induced cirrus clouds (PCC) exceeds the contributions from all other aviation-induced RF combined[1]. However, quantitative analysis is absent regarding the effect of flying in the troposphere specifically by VLJs. Analysis to provide quantitative information regarding these distinctions will be valuable for operational optimization from a carbon footprint perspective.

There are immediate roles for all participants and stakeholders. State Aviation Planners can begin to Incorporate NextGen preparedness into state aviation system plans. These state-level strategic documents frame the actions by airport owners and operators to plan for NextGen. These actions will initiate the process of engraining NextGen into the infrastructure at the local levels.

The outcomes of the Florida project are expected to include:

1. Safety Benefits
2. RNP/RNAV for networked routes (including SUA solutions)
3. ADS-B OUT for fleet management, procedure compliance, and surveillance services
4. ADS-B IN for separation, spacing, merging, and offset routing
5. Tailored departure and arrival procedures including profile descents
6. Common Internet Protocols – for real-time fleet performance optimization
7. SWIM - for accurate and affordable flight planning
8. Business case for multi-Lateration with TIS-B at select locations
9. NextGen educational curriculum
10. Footprint analysis (Energy, Carbon, Noise)
11. Nested Business Cases (Federal, Industrial, State, Local)

Taken as a whole, these outcomes enable diffusion of scalable infrastructure supporting the expansion of air mobility into the "long tail" of the nation's smaller community markets.

7.0 Summary

This Florida project expands the NextGen focus beyond the confines of the 35 major hub airports and scheduled air carrier route and airspace architecture. A core concept of the "mini-NextGen" early implementation project in Florida is that with additional airports being utilized, concentrations of aircraft will drop, other things being equal. The NextGen purpose is to optimize existing airport usage and thus decongest the airways, allowing more-efficient, more-convenient, and safer and "greener" air transport.

The old saw, "all politics are local" fits the reality of NextGen: "All transformation is local." In that sense, the project will contribute to defining how the community airports evolve and adapt to NextGen systems. The result will be reduced cost of expanded airspace and access to airports. While these results will benefit the new generation of on-demand air transport operators, as well as other business and general aviation users, the most significant benefits accrue to underserved communities throughout the nation.

About DayJet

DayJet is the largest fleet operator of next-generation very light jet (VLJ) aircraft and the pioneer of a new type of regional business travel. DayJet has developed the world's first "Per-Seat, On-Demand" jet service that makes the convenience of corporate jet travel broadly available and affordable for more people and organizations, turning wasted travel time into valuable business and personal time.

"Per-Seat" means customers only pay for the seat(s) they need, not the entire aircraft. "On-Demand" means customers fly according to their individually negotiated time requirements. Business travelers can now book just the seat that they need aboard DayJet's fleet of Eclipse 500™ very light jets (VLJs); customize travel according to their time and budget requirements; fly point-to-point between regional destinations; and return home in a single day. Prices start at a modest premium to full-fare economy coach airfares.

Headquartered in Boca Raton, Florida, DayJet is the first 100% all-digital air carrier. Combined with the speed and efficiency of Eclipse 500 VLJ aircraft, DayJet "Per-Seat, On-Demand" jet service has created the next major advance in corporate productivity and regional economic development. For more information, visit www.dayjet.com/ NextGen.

8.0 References

[1] "Memorandum of agreement between the Department of Transportation, DayJet Corporation, and Florida Department of Transportation, DTFAWA-08-A-8006." Washington DC, June 6, 2006.

[2] Holmes, Bruce J., Vicky Harris, Malcolm Murphy, Charles Durkin III, and Tim Kerns, INK. "NextGen now!" DayJet Corporation white paper. *DayJet accelerates NextGen implementation.* June 2008. <http://www.dayjet.com/nextgen>.

[3] Nakicenovic, Nebojsa. "Dynamics and replacement of U.S. transport infrastructures." *National Academy of Engineering: Cities and their vital systems – infrastructure past, present, and future.* Jesse H. Ausubel and Robert Herman, eds., National Academy Press, Washington DC, 1988.

[4] Anderson, Chris. *The long tail – Why the future of business is selling less of more*. Hyperion, NY, 2006.

[5] US Department of Transportation: Federal Aviation Administration. *NextGen implementation plan 2008.* <http://www.faa.gov/about/office_org/headquarters_offices/ato/publications/nextgenplan>.

[6] NASA. "Affordable alternative transportation." *Agate-Revitalizing general aviation.* July 1996. <http://www.nasa.gov/centers/langley/news/factsheets/AGATE.html>.

[7] Alliance for Sustainable Air Transportation. *ASAT.* <www.sustainableair.org>.

[8] International Panel on Climate Change. "Summary for policy makers: Aviation and the global atmosphere." Joyce E. Penner, et al., eds.1999.

[9] Joint Planning & Development Office and Environmental Integrated Product Team and Partnership for Air Transportation Noise and Emissions Reduction."A report of findings and recommendations." *Workshop on the impacts of aviation on climate change. June 7-9, 2006* . Boston, MA, August 31, 2006.

[10] Noppel, F.; and Singh, R.: Overview of contrail and cirrus cloud avoidance technology. *Journal of Aircraft*, Vol. 44, No. 5, pp. 1721-1726, Sept-Oct 2007.

[11] Sausen, R., et al. "Aviation radiative forcing in 2000: An update on IPCC (1999)." *Meteorologische Zeitschrift; Acta Scientiarium Naturalium Universtatis Normalis Hunanensis*, Vol. 14, No. 4, pp. 555-561, Aug. 2005.

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