Small Aircraft Transportation System
A Vision for 21st Century Transportation Alternatives

Dr. Bruce J. Holmes
NASA Langley Research Center

Abstract

The Nation's transportation system is reaching a crossroads. Current investment strategies in solving the challenges of gridlock in the air, as well as on the ground are not sufficient to satisfy burgeoning demand. Fortunately, due to emerging technologies and past research investments through NASA, the U.S. is in a unique position to test innovative alternative concepts for air transportation systems. These innovations have the potential to give Americans new choices in the way we travel, how our products are delivered, and the ways our services (*e.g.*, health care, education, maintenance, emergency services, law enforcement, and other public service functions) are transported in the 21st Century. One such innovation currently funded for FY 2001 is the NASA Small Aircraft Transportation System Program (SATS[1]). SATS technology investments, once implemented, will enable on-demand, point-to-point, high-speed personal air transportation between suburban, rural, and remote communities served by over 5, 000 public-use landing facilities distributed throughout the nation.

This document outlines the technologies developed from recent aeronautics investments that underpin the SATS concept, the SATS vision, and the five-year proof of concept SATS Program as funded by the Congress in 2001.

Background

During the 19th Century, automobiles and roads democratized travel for Americans, in a two dimensional world. In a sense, one could say that the automobile put wheels on America in the last century. The result was that economic opportunity was no longer confined to the nation's 19th century seaports, riverports and railheads. The force behind this industrial age revolution was the plummeting price, coupled with the soaring abundance, of power (in the form of horsepower and kilowatts). As the industrial age comes to a close, we are crossing the threshold into the information age. During this new age, previous paradigms in transportation will not satisfy 21st century needs, nor stimulate 21st century opportunities.

In the 21st Century, the opportunity is emerging for democratized travel in three-dimensional air space, far beyond the constraints of the existing hub-and-spoke airport and interstate highway systems. One vision, that of a Small Aircraft Transportation System (SATS), in a sense would put wings on America. The result would be economic opportunity that is not limited to the 20th century interstates and hub-and-spoke airports. The force behind the information age is the revolution in digital bandwidth and the plummeting price, coupled with the soaring abundance, of the microcomputer and telecommunications technologies.

[1] Small Aircraft Transportation System (SATS). See http://sats.nasa.gov/.

Our existing infrastructure of interstates and hubs-and-spoke airports are reaching maturity and saturation. It may surprise many to learn that for trips of less than 500 miles, the average speed from doorstep to destination is between 35 and 80 miles per hour in the hub-and-spoke system. The bad news is that as congestion increases, these speeds will likely decrease in the future. While we must invest in technologies for the hub-and-spoke system, along with investing in new runways, and developing economic incentives for management of demand, the reality is that demand will continue to soar beyond supply, even after we have made all of these important investments. Whether in the air or on the ground, gridlock will constrain economic opportunity in the information age.

The paradox is that away from the 600 hub-and-spoke airports, capacity at over 5,400 public use airports is abundant. In addition, our nation has an existing infrastructure of over 18,000 landing facilities that represent an untapped capacity reserve. Unfortunately, fewer than 10% of our public airports have precision instrument guidance, communications, and radar coverage for safe and accessible near-all-weather operations.

The good news is that as a result of the past 7 years of publicly funded NASA investments in technology for aircraft, a new generation of safe and affordable aircraft is emerging. These NASA investments were made through the Advanced General Aviation Transport Experiments (AGATE) Alliance and the General Aviation Propulsion (GAP) Program. Coupled to the Generation Aviation Revitalization Act of 1994 and burgeoning market demand, these technology investments have supported the following industrial recovery over the past five years (1995-2000):

- more than 300% growth in aircraft deliveries
- more than 350% growth in industry billings
- over 20% improvement in fleet safety
- recovery to about 20% of export deliveries
- about 10% annual growth of jobs in sector

The enabling technologies from the AGATE and GAP investments include:

- New turbine engines with revolutionary thrust-to-weight and cost metrics
- Commercial Off The Shelf (COTS)-based avionics with vast improvements in cost, reliability, and capabilities
- Highway-In-The-Sky (HITS) graphical pilot guidance systems
- New approaches to crashworthiness
- Streamlined composite airframe manufacturing techniques
- Ice protection technology
- Digital engine controls (for single-lever power control)
- Graphical weather information in the cockpit
- Advanced flight training and pilot certification processes

As a result of the AGATE and GAP investments, several new aircraft are emerging in the marketplace. However, in order that these new aircraft can serve the American traveling public, new concepts for airspace use and operation are needed. Suburban, small, rural and remote communities represent the stakeholders and major beneficiaries of this research. The end result will be safe, nearly all-weather access to any location in the nation with an existing landing facility.

The SATS Vision

SATS, once implemented, will divert pressure from the gap between demand and supply in the hub-and-spoke system, and induce growth of alternative transportation markets. Those alternative markets are defined by trips not taken, trips not imagined, or trips not possible in today's system.

Fast forward with me to the year 2010:

> Can you picture the following same-day travel choices from a city like Danville, Virginia?
>
> > Can you imagine a business trip to call on clients in Arlington, Norfolk, and Charlotte and still make it home in time for your child's little league game?
> >
> > Can you see a family of four making an affordable weekend roundtrip to visit the grandparents over 300 miles away?
> >
> > Could you appreciate having outpatient surgery at Johns Hopkins Medical Center in Maryland and returning to your own bed that night for home recovery?
> >
> > Can you consider the benefits of same day prescription drug delivery from a company in Richmond to senior citizens in Buggs Island, South Boston, and Wolf Trap?

Now imagine that the aircraft and the airports needed for the previous scenarios are readily available to the public, with jet-like performance and safety at propeller-like prices. Imagine hub-and-spoke-like airport accessibility to the smallest of neighborhood airports, without needing radar and control towers, and without needing more land for protection zones around small airports. These are the kinds of transportation mobility and accessibility that SATS technologies will enable

The vision for SATS is to provide the nation with an alternative to existing road and airline choices for travel. The SATS technologies enable entrepreneurs in the transportation industry to create access to more destinations in less transit time. More than 98 percent of the U.S. population currently lives within a 30-minute drive of over 5,000 public-use landing facilities. This infrastructure is an untapped national resource for national mobility. As a result NASA has set the goal of "reducing public travel times by half in 10 years and two-thirds in 25 years." Furthermore, this travel alternative must be cost-competitive with existing choices and meet the public expectations for safety and accessibility.

The early consumers of SATS would have access to fractional or air-taxi-like systems with hired pilot operations. SATS technology development is intended to enable

affordability of on-demand services to even the smallest of markets. Scheduled services may also appear in more dense transportation markets as entrepreneurs discover effective ways to meet market demands.

NASA envisions that the SATS technologies will enable an advanced generation of "smart" aircraft and "smart airports." These technologies will be designed to enable access to virtually any runway end or helipad in the nation, in aircraft that have jet performance at propeller-like prices.

The SATS Program

The Congressional budget appropriation for the SATS Program includes a mandate to "prove SATS works." This mandate includes demonstration of four operational capabilities, enabled by the integration of emerging technologies from two previous NASA-industry programs, AGATE[2] and GAP[3]. These four capabilities are:

(1) Higher-volume operations at airports without control towers or terminal radar facilities

(2) Lower adverse weather landing minimums at minimally equipped landing facilities

(3) Integration of SATS aircraft into a higher en route capacity air traffic management system with complex flows and slower aircraft; and

(4) Improved single-pilot ability to function competently in complex airspace

NASA will facilitate the formation of a public-private alliance to encompass state-based partnerships for the execution of the SATS Program. These partnerships will participate in continued technology development, system analysis and assessment, technology integration and flight demonstrations of the SATS operating capabilities.

The enabling technologies, developed initially under the AGATE and GAP programs, will be refined for integration by the SATS Program and will include:

- Integration of Highway-In-The-Sky (HITS) with synthetic vision systems
- Simplified software-based flight controls
- Autoland capability for the SATS class of aircraft
- Automatic Dependent Surveillance-Broadcast surveillance
- Airborne Internet communications
- Computational algorithms for automated traffic separation and collaborative sequencing

These technologies form the foundations for creating the four SATS operating capabilities.

[2] Advanced General Aviation Transport Experiments (AGATE) Alliance and research program. See http://agate.larc.nasa.gov/.
[3] General Aviation Propulsion (GAP). Website link available from http://agate.larc.nasa.gov/.

Summary

In summary, the Nation is now in a unique position to create a major innovation in consumer choices available for personal or business air transportation, shipment of goods, and delivery of services. This opportunity to innovate comes at a time when existing air and ground infrastructures are maturing and reaching saturation. Without alternatives to existing systems, the economic opportunities of the Information Age will be constrained to existing transportation infrastructures. With alternatives, new patterns of economic opportunity are enabled that need not be constrained the 20th century hub-and-spoke airport and interstate highway infrastructures.

The Small Aircraft Transportation System vision has the potential to catalyze the Nation's economic development in the Information Age with advancements in transportation mobility and accessibility. Following the successful AGATE and GAP models, by working in public/private partnership with the states, industry and universities, NASA and the FAA will collaborate on the continued development of SATS technologies. These technologies are the foundation upon which this new vision of air transportation can be built.

SATS represents a National opportunity to create an affordable and safe transportation alternative that frees people and products from today's system delays by creating access to more communities in less time.