



Innovations Affecting 21st Century General Aviation



Aviation Insurance Association (AIA)

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NASA Langley Research Center
April 29, 2003**



Outline

- **SATS project is a limited proof of concept for specific nearer-term technologies affecting use of airspace and airports.**
- **The purpose is to enable expanded use of smaller airports and smaller aircraft for public transportation.**
- **Early business model analyses indicate a viable market for on-demand jet taxi services between rural and regional airports.**
The potential effects include:
 - **Deployment of advanced equipage, RNP, and situational awareness**
 - **Advances in training technologies and proficiency of pilots**
 - **Growth of fleet-based operations**
 - **Increased operations of single-pilot turbines under Part 91 and Part 135**
 - **More operations to more runways/ approaches at smaller airports**



What are the potential implications of these technologies on tort and insurance law, and on industry standards and incentives?



Integrated Advancements In Airspace and Aircraft

**Airspace
Capability**



- Ubiquitous Airspace Accessibility
- Automated Airspace Procedures
- Distributed Air-Ground Procedures
- NAS Evolution

Current State

Hub & Spoke
Long-Haul
GA



Point-to-Point



UAV's



Green
Aircraft



**Aircraft
Utility**



Future State

Dual-State:
On-Demand, Point-
to-point
& Hub Systems

Cost

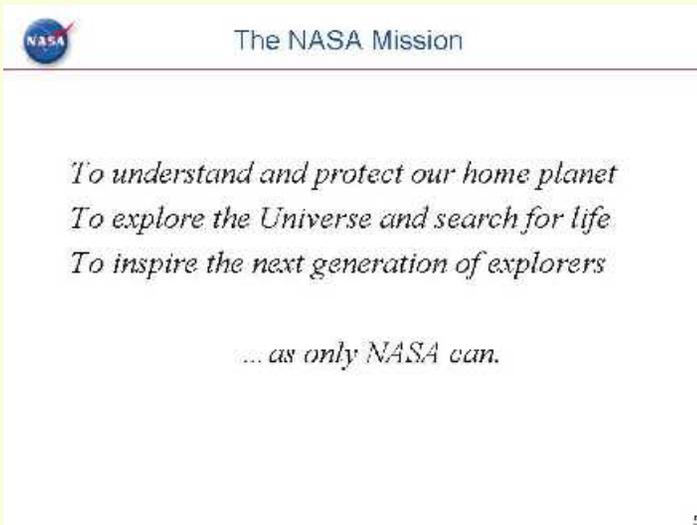
Environment

Safety/Security



Technical Context for Mobility Alternatives

1. Moore's Law on microprocessor performance
2. Gilder's Law on bandwidth performance
3. Metcalf's Law on network performance
4. The unwritten law of abundance
5. The unwritten rule of gridlock
6. Kurzweil's Law of Accelerating Returns
7. The Golden Rule of the information age



The NASA Mission

*To understand and protect our home planet
To explore the Universe and search for life
To inspire the next generation of explorers*

... as only NASA can.

5



Aeronautics
Blueprint

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012

Revolutionary Vehicles
On Demand Mobility
National Security
Education & Capacity

The Aeronautics Blueprint

- A National Imperative -

■ The cost of inaction is gridlock, constrained mobility, unrealized economic growth, and loss of U.S. aviation leadership.

Figure 3

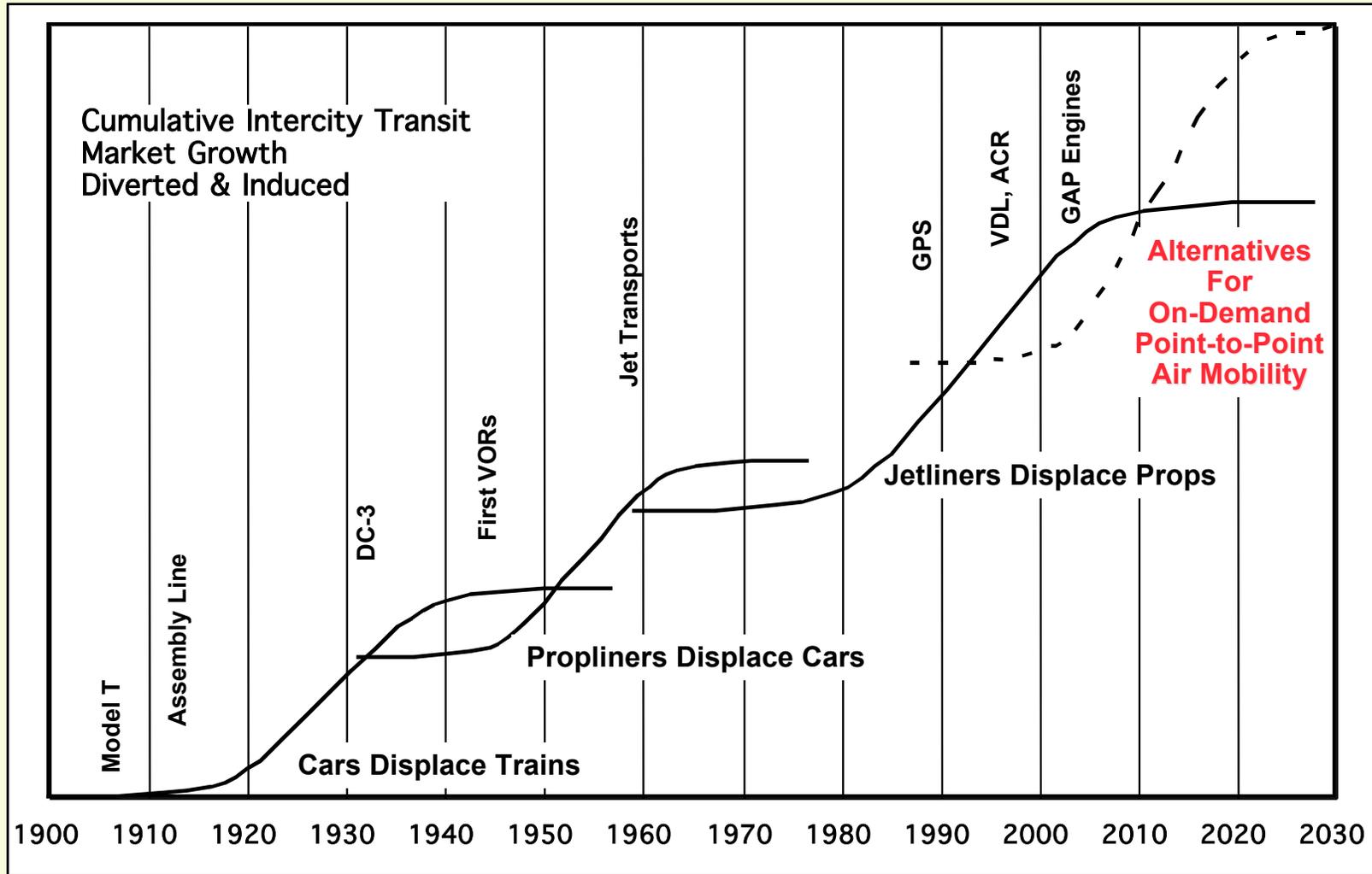


The Difficulty With Predictions...

1. **“The telephone has too many shortcomings to be seriously considered as a means of communication.”**
– Western Union executive, 1876
2. **“The problem with television is that the people must sit and keep their eyes glued on a screen; the average American family hasn’t time for it.”**
– NY Times, 1939 (World’s Fair)
3. **“I think there is a world market for maybe five computers.”**
– IBM Chairman Thomas Watson, 1943
4. **“Computers in the future may weigh no more than 1.5 tons.”**
– Popular Mechanics, 1949
5. **“There is no reason for individuals to have a computer in their home.”**
– DEC Chairman Ken Olson (DEC), 1977
6. **“640,000 bytes of memory ought to be enough for anybody.”**
– Microsoft Chief Software Architect Bill Gates, 1981



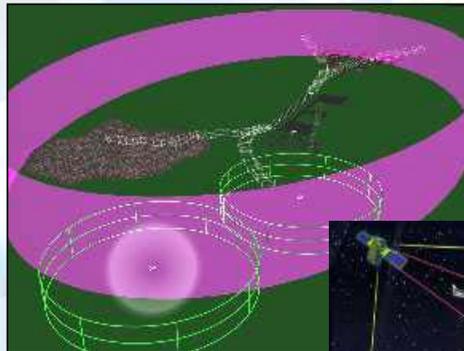
Notional Life Cycles in Transportation





Innovations Affecting 21st Century General Aviation Airspace Operations

- **A New Generation and Niche of Aircraft**
- **All-Digital Cockpit Systems (PFD+MFD)**
- **Digital Flight Controls**
- **Digital Engine Controls**
- **Airborne-collaborative Sequencing**
- **Lower Landing Minima Without ILS**



- **Airborne Internet**
- **Digital Airport Information Systems**
- **Digital Airspace Management Systems**
- **ADS-B-based Separation**
- **Non-towered Airports Procedures**
- **Non-radar Operations in IMC**

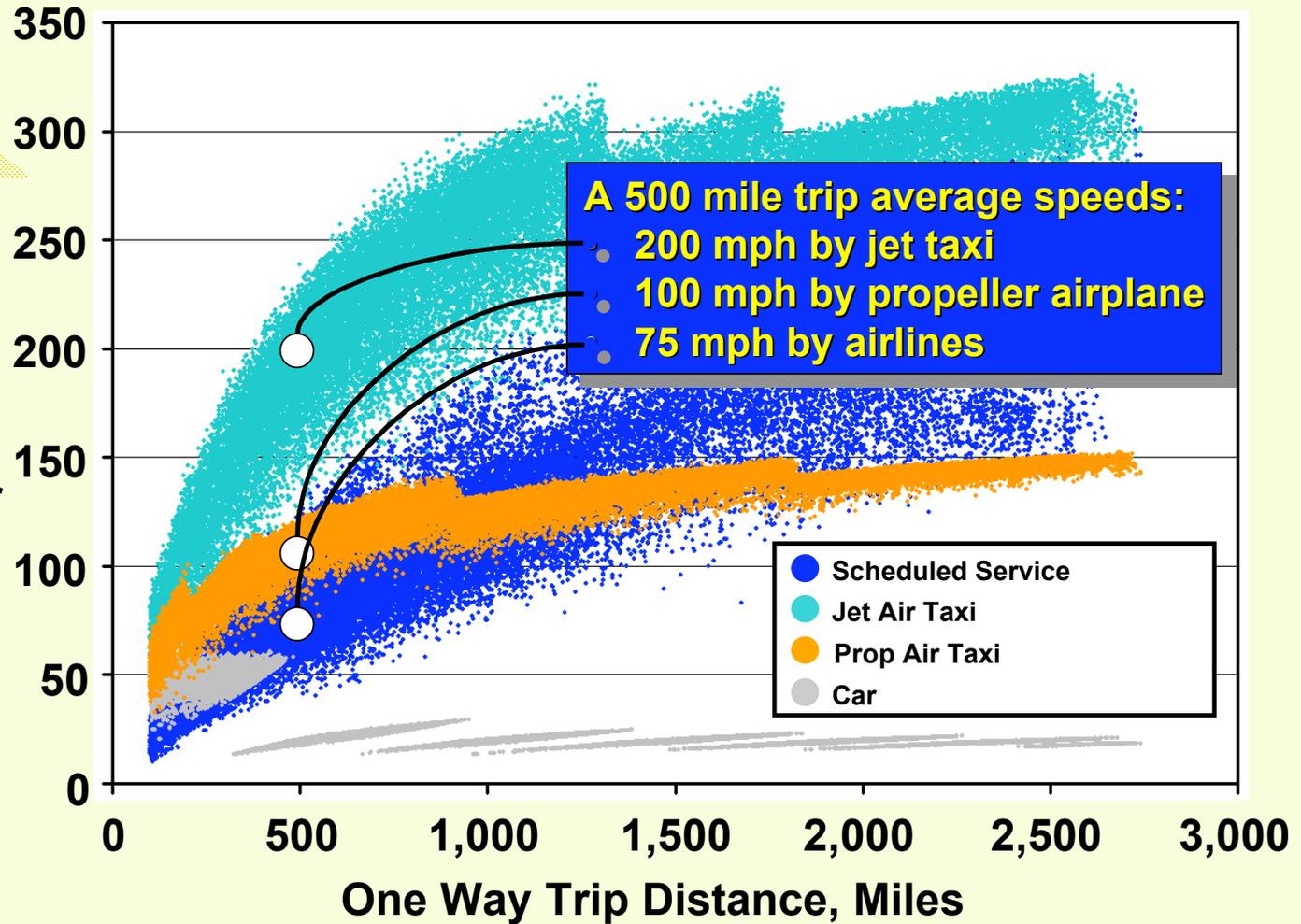


If Time is Gold

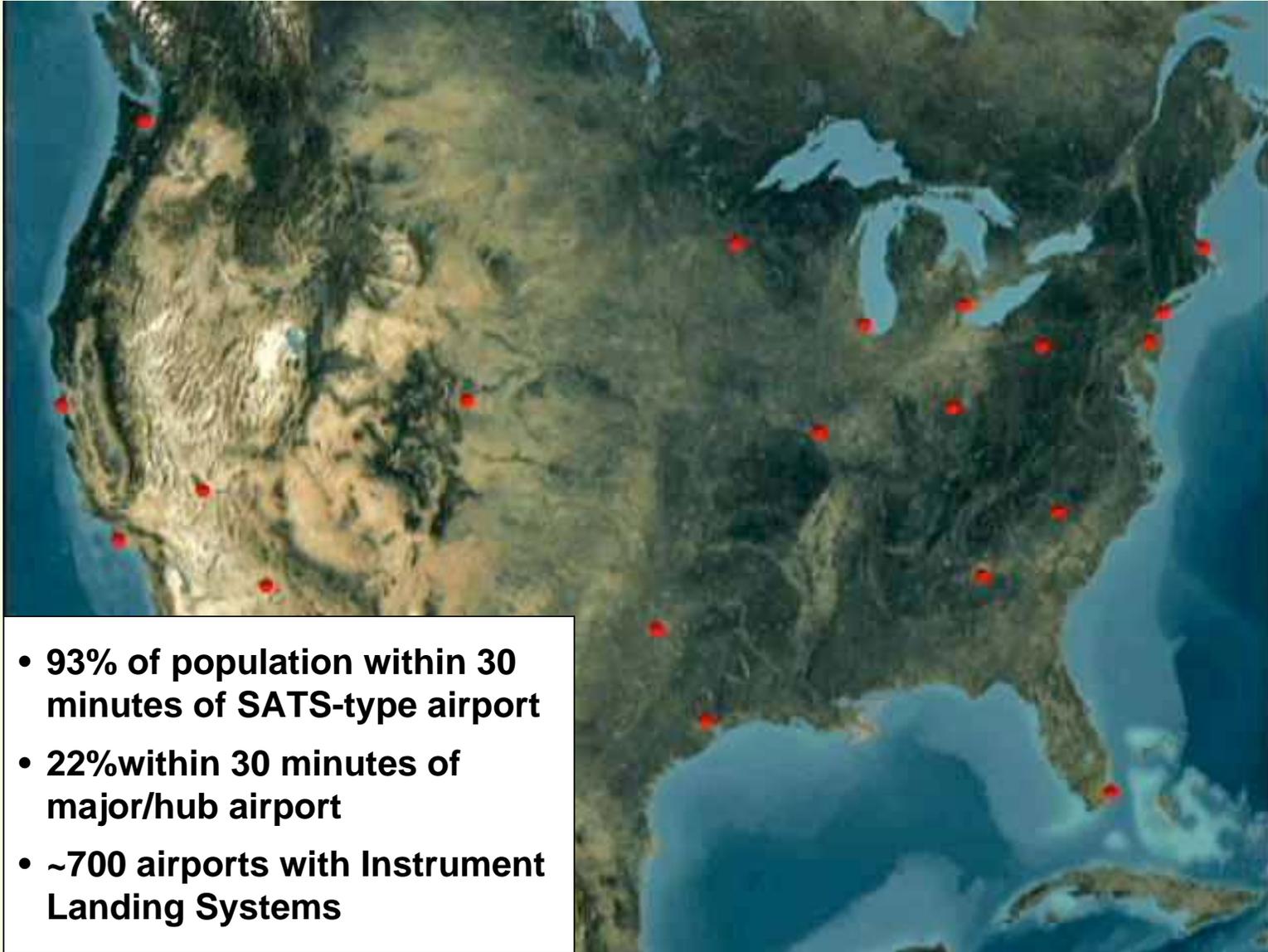
Then Door-to-Door Speed is the Coin of the Realm



Door to Door
Trip Speed,
MPH



Equitable, On-Demand, Distributed Air Mobility





Public-Private Consortium Membership

NASA

AGATE
AERIAL GATEWAY AND AIRPORT TECHNOLOGY

SATS
SOUTHWEST AIRCRAFT TECHNOLOGICAL SYSTEMS

SATS
SOUTHWEST AIRCRAFT TECHNOLOGICAL SYSTEMS

Maryland SATS
Lynchburg MAA MADL SAIC UNCC UPS

SATSLab
NORTH CAROLINA AND UPPER GREAT PLAINS

WIRGINIA SATSLab
Proving Ground for SATS Technology

National Consortium for Aviation Mobility
Freedom of Access Throughout America

NATIONAL CONSORTIUM FOR AVIATION MOBILITY (NCAM)



FAA Roles

AVR-SATS Team

- Certification Issues

Flight Standards Services

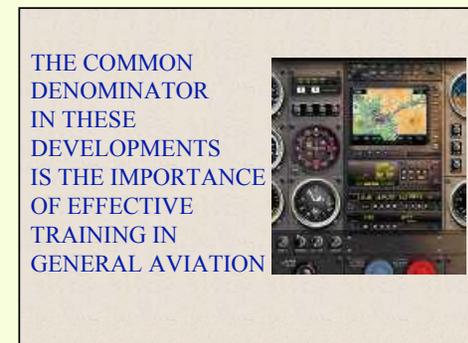
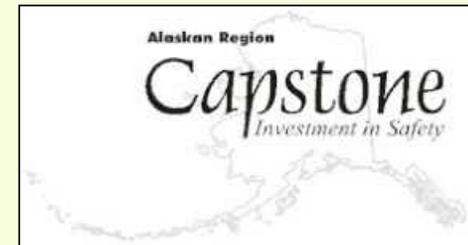
- Flight Training Technologies
- RNP-based Operations

Safe Flight 21

- Capstone

FAA Technical Center:

- Airborne Internet
- Advanced procedures simulations

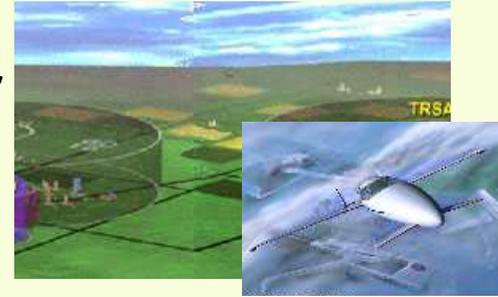




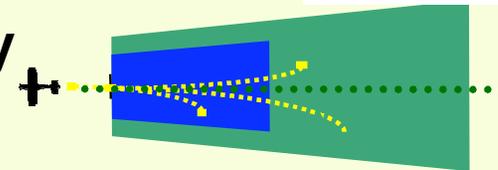
Small Aircraft Transportation System Project

Operating Capabilities for Access to All Communities/

**Higher Volume Operations in Non-Radar
Airspace and at Non-Towered Airports**



**Lower Landing Minimums at Minimally
Equipped Landing Facilities**



**Increase Single-Pilot Crew Safety &
Mission Reliability**

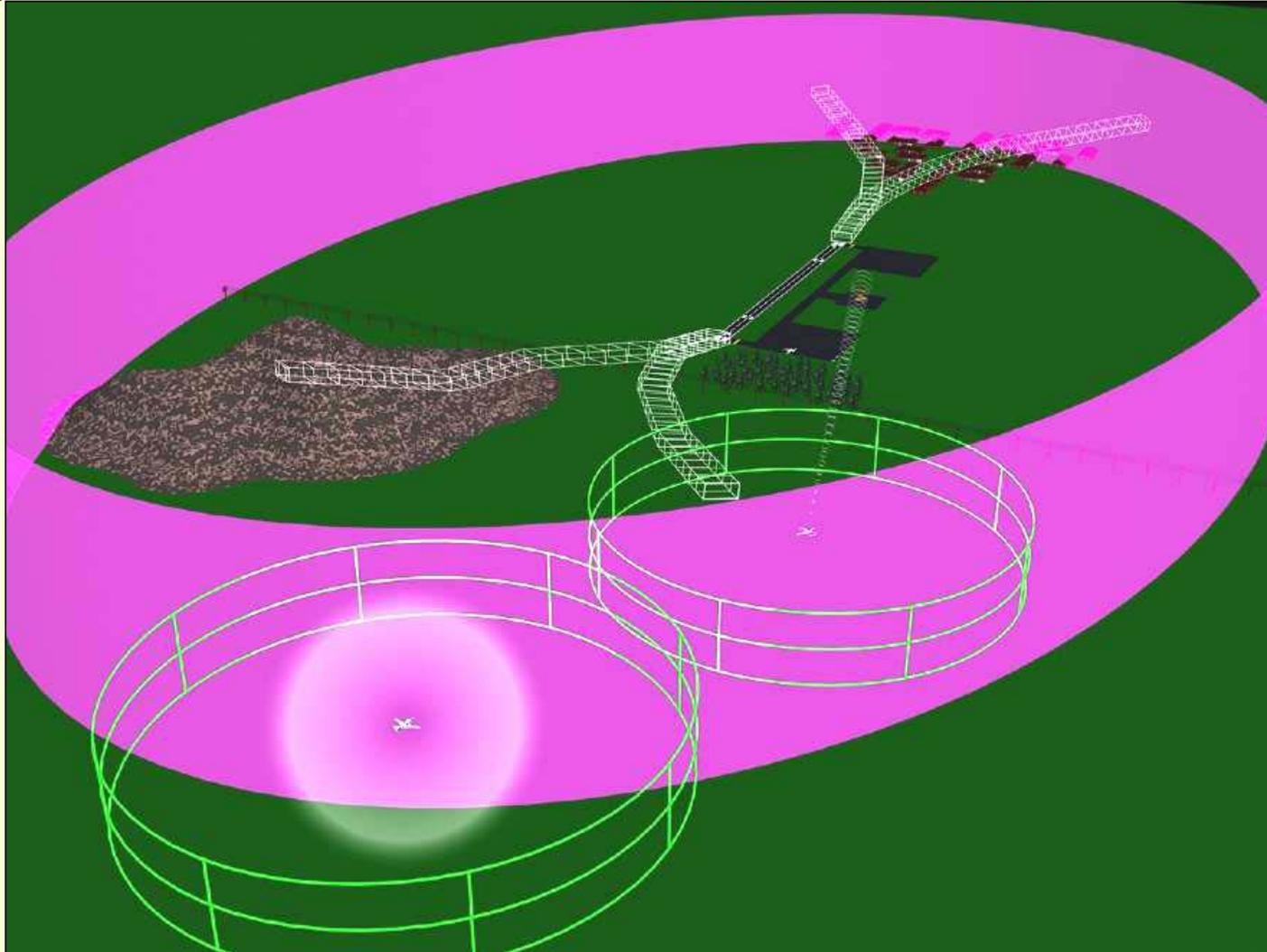


**En Route Procedures & Systems for
Integrated Fleet Operations**





SATS Operating Capabilities

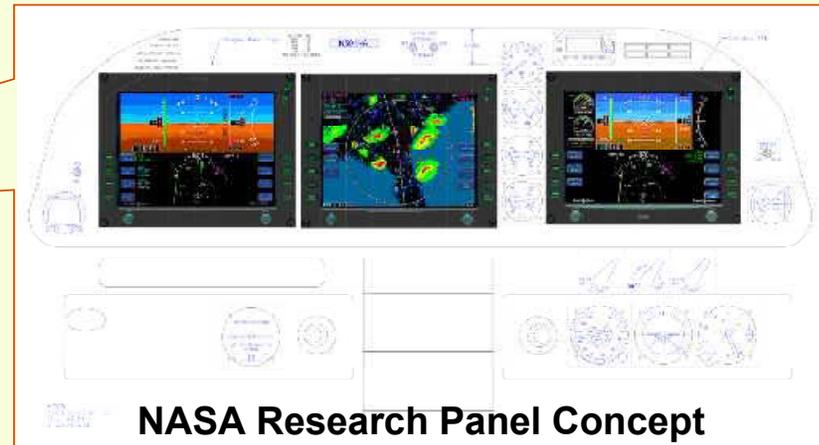






SATS Research Aircraft

NASA 501 Cirrus SR-22X



- **Digital, all-electric cockpit system architecture**
 - Dual avionics computer resources, databus, reversionary displays, and redundant power sources
 - Fully integrated IFR primary flight display (PFD) and multi-function display (MFD)
 - Digital radios / datalink for ADS-B, FIS-B, CPDLC, D-ATIS, AMM-Comm
 - GPS / DGPS / RNP RNAV
 - Synthetic vision-based terrain & obstacle graphics
 - Intuitive flight path guidance
- **Research Software Development**
 - Self-Separation: Conflict Alerting and Conflict Prevention Graphics (ASI, VSI, Nav-Hdg)
 - Sequencing software and graphics (Requested Time of Arrival - RTA waypoints)
 - Self-Controlled Airspace “Rules of the Road”



Airborne Internet Preliminary Demonstration

Accomplishment

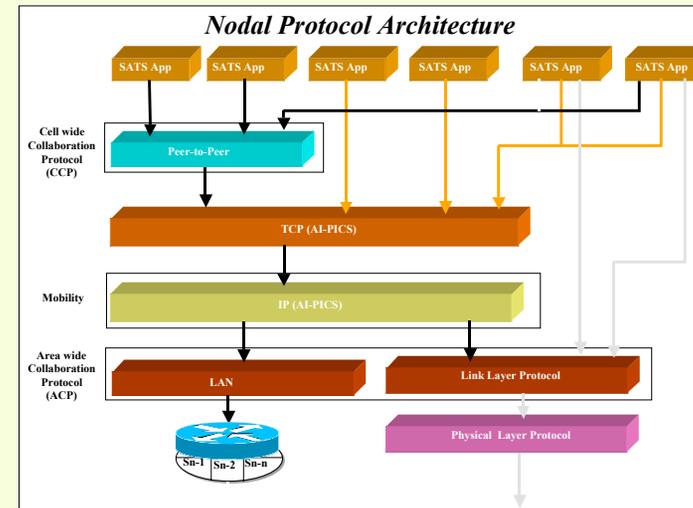
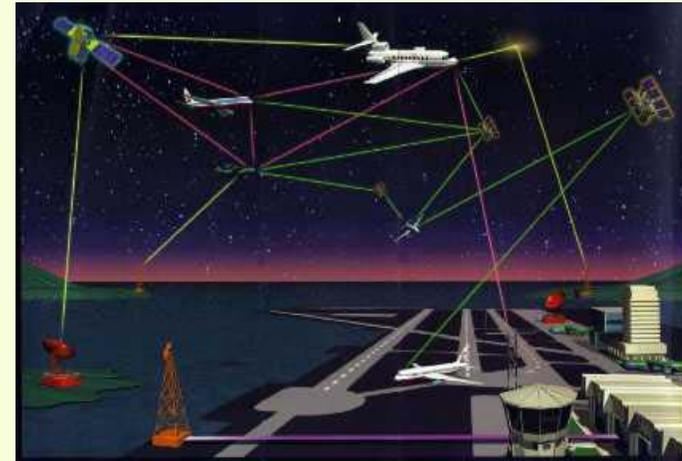
Demonstrated integrated communications, navigation, and surveillance architecture in lab testbed

Benefits

- Mobile and policy-based routing
- Service priority communications
- Secure network communications
- Point-to-point, point-to-multipoint, and broadcast addressing
- Based on open standards and protocols.
- Minimizes number of radios and antennas on an aircraft—goal is single radio for all data communications

Plans

- Evaluate candidate communication architectures
- Plan flight evaluations in 2005
- Airborne Internet Consortium Development



GLENN RESEARCH CENTER



Reducing the Cost of Speed

Cirrus



Lancair



Cessna Mustang



Eclipse



**Honda,
Toyota,
And others...**

Safir



Diamond



Adam Aircraft





North Carolina Market Assessment for On-Demand Business Travel



Hub Communities: 25 Counties - 52% Population
On-Demand Market: 75 Counties - 48% Population

Assumptions

- Business Travel (no personal travel)
- 98% Accommodation @ ≤ 3 hours
- \$1.85 per passenger ticket mile
- No weather impacts assessed

Findings:

**175 fleet of next generation jets required to serve
425 passengers/day demand
at \$1.85 per passenger-seat mile**

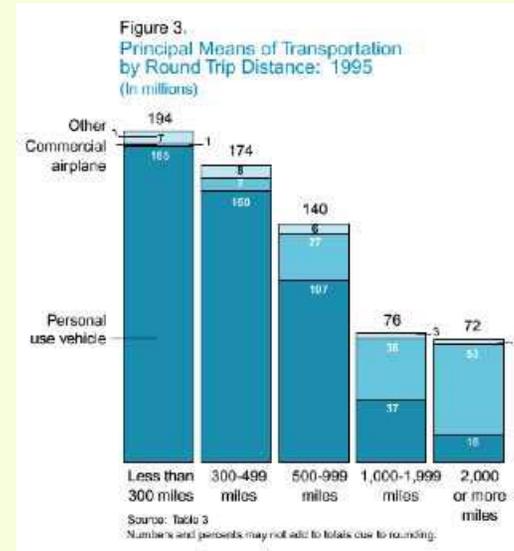
- Demand highest in communities most remote from commercial air service
- Air-taxi service best meets needs of surveyed likely business travelers
- Increased passenger volume allows higher profit margins and/or lower ticket prices and shorter accommodation intervals
- Advanced technology significantly reduces required ticket price

* Ignores potential passenger demand from "hub communities", ignores passenger travel originating external to NC, ignores leisure and vacation travel demand, uses simplified dispatch strategy with no "optimization"

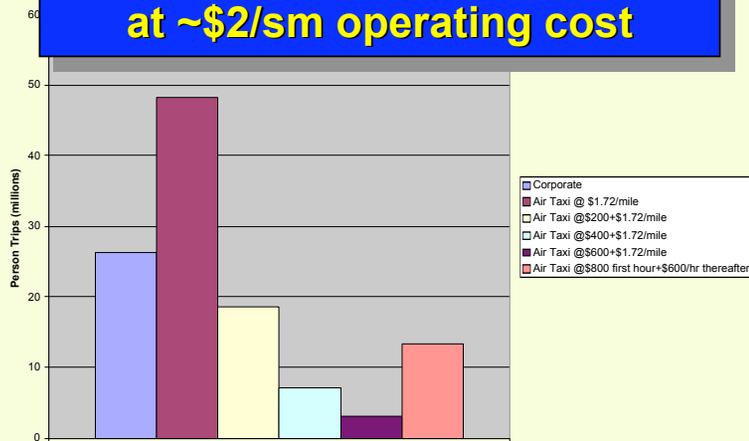


Future Aircraft Market Demand and Sensitivity Assessments

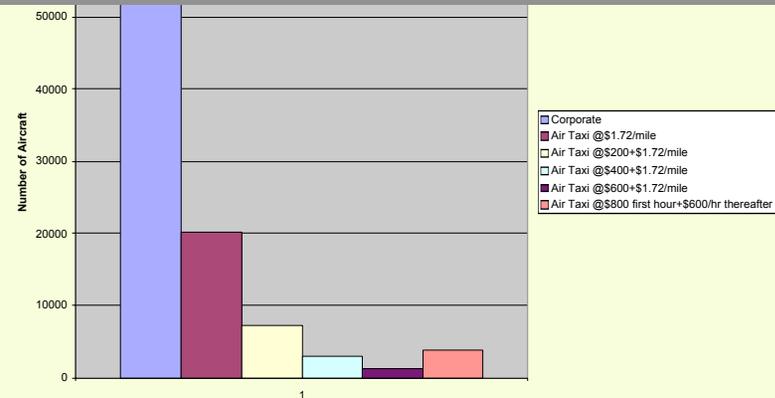
- Data Source - 1995 American Travel Survey + 2000 US Census
- Tools - Integrated Air Transportation System Evaluation Tool (IATSET), macro economic model
- Approach - Predict diverted mode choice at National level between automobile, scheduled air, and on-demand air travel based on the value of a traveler's time and the cost of the trip (NASA CR 2002-211927).



**Between 13 and 47 million trips
at ~\$2/sm operating cost**



**Between 7,000 and 52,000 aircraft
required to serve new markets**





Summary

- **SATS project is a limited proof of concept of technologies affecting use of underutilized airspace and small airports.**
- **The purpose is for expanded use of smaller airports and smaller aircraft for public transportation.**
- **Early business model analyses indicate a viable options for on-demand jet taxi services.**
- **The potential effects include:**
 - **Advanced equipage**
 - **Advances in training**
 - **Growth of fleet operations**
 - **Increased single-pilot operations**
 - **More operations at smaller airports**



What are the potential implications of these technologies on tort and insurance law, and on industry standards and incentives?

**From Wheels on America
to Wings on America**



**Equitable
On-Demand
Widely Distributed
Point-to-Any Point
21st Century Air Mobility**